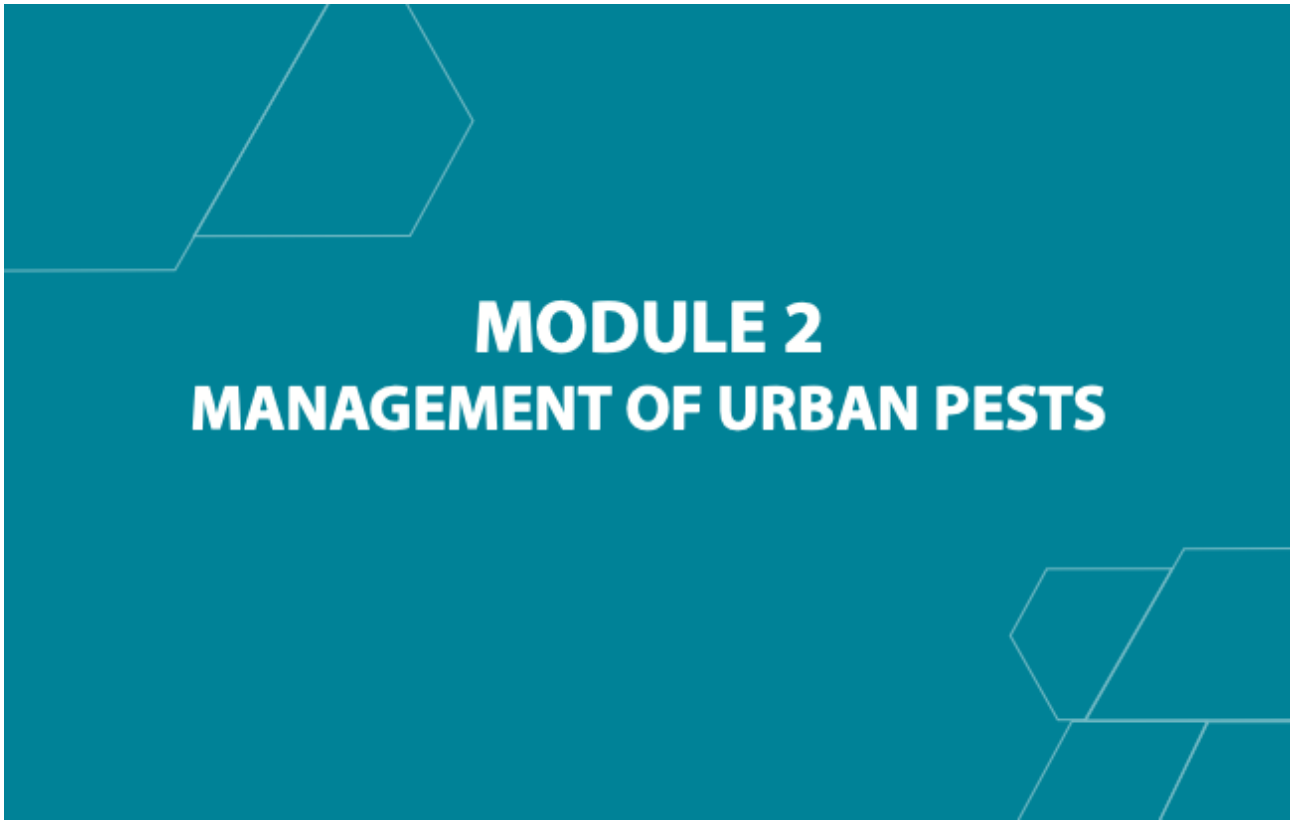

MODULE 2 MANAGEMENT OF URBAN PESTS

- Pest Management and Pest Control
- Pest Diagnosis
- Assessing Pest Activity and infestation Levels
- The Control Options
- Pesticides
- Formulations and Adjuvants

Objectives of this Module:

1. To define the terms Pest Management and Pest Control
2. To outline the steps involved in developing a pest management programme
3. To review the different types of pest management strategies
4. To discuss why these pests are of economic importance

Pest Management and Pest Control

Over the last 50 years, there has been a gradual shift from pest control to pest management. **Pest control** implies a two-strand approach, which combines the use of technology (such as use of pesticides, and pesticide application equipment) with biological knowledge (informing where, when and how to apply the technology) to reduce pest impact (by killing the pest). **Pest management**, on the other hand, aims to reduce pest impact and injury levels to a tolerable level through multiple tactics, which are not solely dependent on killing the pest. Hence, while pest control seeks to eliminate a pest organism from an area by a single—often chemical control—strategy, pest management seeks to utilise various strategies in a sustainable manner to suppress the population of the pest below the impact level.

The principles of pest management are to:

Correctly identify the pest organism and to assess and monitor the pest population to determine when the pest has reached the economic impact level and the need for action.

Select and integrate a variety of control strategies in a manner that is complementary in order to suppress the pest population.

Maintain the pest population at, or below, levels that cause economic damage, rather than trying to eradicate the pest.

Place emphasis on ecological management strategies and use chemical control as a last resort.

Treat the entire ecosystem as the management unit.

The target pest should first be correctly identified using:

- Live or dead specimens
- Faecal pellets, droppings
- Skin, fur, hair, casings, insect casts
- Damage observed

When developing a pest management programme, you should include all of the following elements:

Elements of a Pest Management Programme

- Identification of:
  - the target pest/s
  - non-target organisms
- Identification of the urban environment's main features that:
  - may impact/be impacted by, the programme
  - are favourable to the target pest/s
  - are resources for the pest/s e.g. shelter, food
- Identification of relevant pest management principles
- Identification, selection and integration of appropriate control strategies

Pest Diagnosis

In order to protect the health of human beings and the environment, while effectively suppressing pest populations, pest control options that form part of a pest management programme are usually target-specific. As a result, the pest being targeted should be correctly identified. it is, therefore, necessary to visit the affected site, inspect the damage and collect specimens for identification. Where specimens of the pest organism are not available, fecal pellets, pelt/shed casts records and other pest remnants may be used. The damage caused by the pest, or evidence of pest activity, may also be used to assist in identification. When in doubt, seek assistance from relevant professionals or institutions.

Assessing Pest Activity and Infestation Levels

Understanding the activity of pests is a very important aspect of pest management. It is the basis for deciding if and when action is to be taken against a pest. Constant monitoring and survey of pest populations is a basic tenet of any pest management programme and provides useful information on the presence or absence of the pest, the population density and distribution of the pest, and the feeding and reproductive activity of the pest.

A pest assessment involves the collection of information on pest numbers, pest activities and economic impact. these surveys can be qualitative or quantitative. Qualitative assessments usually detect the presence or absence of a pest, while quantitative assessments determine the abundance and distribution of the pest in time and space.

When doing an assessment, it is often impossible to count every individual in a pest population and hence, you will have to sample/take samples of the pest population. this usually requires:

1. A sampling technique, which is the method used to collect information on the pest.
2. A sampling programme, which indicates when and where samples should be taken.

Sampling techniques may be direct or indirect. Direct samples (direct counts, netting and traps) involve an assessment of the actual pest population, while indirect samples assess damage and other things (nests, pelts and excreta) associated with the pest.

The Control Options

There are four major types of control strategies that are available for use in a pest management programme:

1. ecological management (cultural control),
2. physical control,
3. biological control, and
4. chemical control.

Ecological Management

Ecological management involves the manipulation of the food source or the physical environment to make it less favourable for the pest organism. To successfully implement an ecological management programme, one needs to understand the ecology of the pest. it is important to determine the ecological requisites of the pest, the availability of the requisites in the environment and the behaviour of the pest in attaining those requisites.

The major pest requirements include food, water, appropriate space for feeding and reproduction, and shelter from weather extremes and natural enemies. Ecological management links to the life cycle of the insect pest.

Ecological management procedures are grouped into four major categories:

1. ***Reduction of the average favourability of the ecosystem.*** This involves lowering the pest density by reducing the availability of food, shelter and habitable space. Proper sanitation is a major component of this strategy.

2. ***Disruption of the continuity of requisite food sources.***
   This involves manipulation of the presence of the host material in time and space to eliminate the requisites of the pest.

3. ***Diversion of pest populations from the host involves diversion of the pests away from the material of economic importance.***
   This is achieved by using a repellent substance and presenting the pest with a more favourable alternative.

4. ***Reduction of the impact of pest injury.***
   This involves modification of the host material to minimise losses from injury.

Physical Controls

Physical control involves activities that physically separate the pest from its host or management area, which includes the area in which the pest lives, feeds, mates and roams/forages for food. This may involve the *driving out* of the organism *chemical or audio repellents* or the establishment of physical barriers that prevent the pest organism from gaining access to the host or the managed environment.

Strategies employed as physical control include the erection of barriers such as screens and nets; *plugging/caulking of holes and cracks/crevices, coving at the base of walls, management of ambient conditions (e.g. temperature, humidity, airflow, lighting), installing sealed garbage bins, etc.*

Screen Door

Bird Netting

Mechanical Controls

Mechanical control devices include all types of traps (e.g. snap, glue, UV, high voltage, cage, mist nets) and can involve the removal of both live and dead catch.

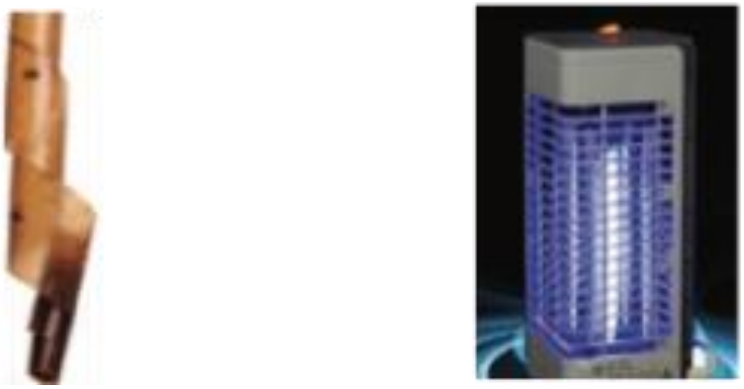

Figure 13. Forms of mechanical control e.g. sticky fly paper (left) and UV light trap (right).

Biological Control

Biological control is the use of natural enemies (organisms that prey on other organisms) to suppress the population of a pest species. There are three major biological control strategies; introduction (Classical), augmentation and conservation. Classical biological control (which involves introduction of natural enemies from the place of origin of the pest) and augmentation (releasing natural enemies in an area where the natural enemy population is low and not effective in reducing pest numbers) are forms of biological control that may not be appropriate or feasible for implementation by pest management operators. However, most operators should be able to implement conservation biological control strategies as part of a pest management programme if deemed necessary.

Conservation is a form of biological control that involves the conservation and protection of natural enemies existing in an ecosystem. *Conservation measures not traditionally a component of pest control strategies but pest management operators understand the importance of the protection of natural enemies*. This involves maintaining their habitat and reducing the use of substances that are toxic to the natural enemies.

Chemical Control

Chemical control is the use of a chemical substance to suppress a pest population. It is a quick and effective ways to reduce a pest population and is therefore an important curative method. Chemical control is, however, the most detrimental control method to human beings and the environment and should be used as a last resort. *A much safer alternative to commercial pesticides are a variety of botanical oils and plants that make effective repellents against many insects and vertebrates.*

Pesticides

Pesticides are chemical or biochemical compounds used to kill or suppress the population of organisms deemed to be pests.

Pesticides may be categorised according to:

- the target pest
- how dangerous they are to humans and the environment/ level of toxicity
- their mode of action
- their chemistry

The classification of pesticides according to these categories is illustrated in the following sections.

Target Pest Classification

This grouping is defined by the pest that the pesticide was developed to kill.

TARGET PEST	PESTICIDE CATEGORY
Mites, ticks (acari)	Acaricide/Miticide
Insects	Insecticide
Fungi	Fungicide
Weeds	Herbicide
Slugs, snails (molluscs)	Molluscicide
Nematodes	Nematicide
Mice, rats (rodents)	Rodenticide

Hazard Classification

Pesticides are categorised according to the World Health Organization (WHO) classification system, which was developed over time in consultation with countries, international agencies, and regional bodies. The WHO classification is based primarily on the acute oral and dermal toxicity to the rat (since these determinations are standard procedures in toxicology) and distinguishes between the more and the less hazardous forms of each pesticide, based on the toxicity of the technical compound and on its formulation. The classification of pesticides, according to WHO, is given in **Table 1**.

Table 1. The determination of WHO hazard classification based on acute LD50 (rat) of formulated products (mg/kg)

WHO Hazard Class	Information to appear on the label			Acute LD50 (rat) of formulation (mg/kg)			
	Hatard statement	Band colour	Hazard symbol	Oral		Dermal	
				Solid	Liquid	Solid	Liquid
Ia Extremely hazardous	**VERY TOXIC**			< 5	< 20	< 10	< 40
Ib Higly hazardous	**TOXIC**			5 - 50	20 - 200	20 - 100	40 - 400
II Moderately hazardous	**HARMFUL**			50 - 500	200 -- 2000	100 - 1000	400 - 4000
III Slightly hazardous	**CAUTION**			> 500	> 2000	> 1000	>4000
Unlikely to present a hazard in normal use				> 2000	> 3000		

The **Globally Harmonized System (GHS) of Classification and Labelling of Chemicals** is now widely used for the classification and labelling of chemicals worldwide. The GHS establishes classification criteria for physical, health and Environmental hazards, along with associated hazard communication elements, notably pictograms, signal words, and hazard statements for use on labels.

Example of GHS	
Acute oral toxicity	Category 1–4
Acute dermal (skin) toxicity	Category 1–4
Skin irritation/serious eye damage	Category 1–4

The GHS is based on harmonising major existing systems for classifying and labelling of chemicals in transport and in the workplace, in pesticides, and in consumer products. Hence, the GHS harmonisation effort should be accomplished without lowering the level of protection afforded by existing systems. It should be noted that changes in all systems would be required to achieve a single, globally harmonised system. The WHO classification is now aligned in an appropriate way in different categories with the GHS as shown in **Table 2**.

Table 2. Comparison of WHO (World Health Organisation) and GHS (Globally Harmonized System) pictograms

OLD			NEW			
Symbols		Description	GHS-Symbols		Description	Hazard statement examples
	E	Explosive		GHS01	Exploding bomb	Explodes due to fire, shock, friction or heat; danger due to fire, blast and projectiles.
	F+ F	Extremely flammable Highly flammable		GHS02	Flame	Flammable; catches fire spontaneously if exposed to air; in contact with water releases flammable gases which may ignite spontaneously.
	O	Oxidizing		GHS03	Flame over circle	May cause fire or explosion; strong oxidizer.
No equivalent				GHS04	Gas cylinder	Contains gas under pressure; may explode if heated; contains refrigerated gas; may cause cryogenic burns or injury.
	C	Corrosive		GHS05	Corrosion	May be corrosive to metals; causes severe skin burns and eye damage.
	T+ T	Very toxic Toxic		GHS06	Skull and crossbones	Small quantities are harmful or fatal.
	Xn	Harmful	No direct equivalent			
	Xi	Irritant				
No equivalent				GHS07	Exclamation mark	Harmful, irritates eyes, skin or respiratory system; large quantities are fatal.
No direct equivalent				GHS08	Health hazard	Causes allergic reactions; may cause cancer, may cause genetic defects; may damage fertility or the unborn child; causes damage to organs.
	N	Dangerous for the environment		GHS09	Environment	Harmful, toxic or very toxic to aquatic life with long lasting effects.

Mode of Action Classification

Pesticides may act by coming into contact with, or being ingested or absorbed by the target organism. The route taken by a pesticide and how it then acts on the pest can also be used to group pesticides.

Contact—kills after direct contact with pest.
Stomach—kills after pest feeds on treated material.
Systemic—substance is absorbed by leaves and roots of the plant and is transported within the plant, killing plant (herbicide) or pests which feed on the plant some distance from the point of application.

Once absorbed into the organism, they may exert their effect by different modes of action, which can affect, for example, the nervous system, the endocrine system, as well as voluntary and involuntary muscles.

Chemical Classification

The chemical structure of a pesticide determines in which group of compounds it will be placed. Below are some categories of pesticides, based on their chemical structure.

Inorganics	Lead arsenate, sulphur, boric acid, mineral oils
Botanicals	Pyrethrins, nicotine, rotenone
Organophosphorous compounds	Malathion, diazinon, dimethoate
Organochlorines	DDT, dieldrin, chlordane, endosulfan
Carbamates	Carbaryl, carbofuran, methomyl
Pyrethroids	Deltamethrin, permethrin, lambda cyhalothrin
Fumigants	Methyl bromide
Biologicals	*Bacillus thuringiensis* (BT) subspecies
Ureas	Diuron
Neonicotinoids	Imidacloprid, actamiprid, thiamethoxam
Spinosyns	Spinosad
Avermectins	Abamectin
Juvenile hormone analogues	Methoprene
Insect growth regulators (IGRs)	Tebufenozide, halofenozide
Hormones, moulting disruptors	Hydramethylnon
Inhibitors (mitochondrial, metabolic)	Aluminium phosphide, pyrimidafen
Sodium channel blockers	Indoxacarb
Synergists	Piperonyl butoxide

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Formulations and Adjuvants

Pesticides are highly toxic chemicals that must be diluted for the safety of the people who handle it during transportation and application. In addition to improving safety, pesticides are formulated to also enhance their effectiveness, ease of application, handling and shelf life. A pesticide formulation consists of the active ingredients (a.i.) and other inert ingredients (adjuvants). some of the ingredients that may be used in the formulation of a pesticide are given in table 3 below.

Table 3: *ingredients used in the Formulation of Pesticides*

INGREDIENT	PURPOSE
Active ingredient (a.i.)	The chemical that kills the pest
Solvent	This is used to dissolve the a.i.—which is often insoluble in water—before it (a.i.) can be made into a liquid formulation. The phytotoxicity, animal toxicity, combustibility, cost and odour of the solvent are taken into account when a solvent is selected. Common solvents include hexane, benzene, kerosene and xylene.
Emulsifier	A chemical which enables a pesticide solution that is insoluble in water, to be temporarily suspended in water e.g. Triton X and soap.
Spreader	This is added so that the formulation is able to be spread over the treated surface.
Sticker	This enables the a.i. to remain on the treated surface for a longer period e.g. casein, gelatin, vegetable oils, latex (which is also water-resistant).
Penetrant	This helps the a.i. to penetrate the treated surface and is especially useful in formulations targeted for sap suckers and pests found within the plant stem or leaf e.g. mineral oil.
Synergist	This enhances the ability of the a.i. to kill the pest while using the minimum amount of a.i., but does not itself possess pesticidal properties e.g. piperonyl butoxide or n-octyl bicycloheptane dicarboximide are added as synergists to pyrethrin-based pesticides.

Types of Formulations

When a pesticidal compound is manufactured, the active ingredient (a.i.) is in a fairly pure form or **technical grade material**. After formulation, the final pesticide product, which is ready for sale, is available in a wide range of forms, some of which are ready to use as they are, while others have to be diluted. Some common formulations are given in the table 4.

Concentrations of Formulations

Formulations usually indicate the amount of active ingredient present e.g. 50EC, 10g and 75WP contain 50, 10 and 75% a.i., respectively and 50, 90 and 25% additives, respectively.

Table 4: *Common Pesticide Formulations*

FORMULATION	DESCRIPTION	ADVANTAGES	DISADVANTAGES
Bait (B)	The a.i. is mixed with a food or other substance, attractive to the pest. Baits usually contain less than 5% a.i.	*Ready to use. Focused applications. Versatile - can be applied to cracks & crevices, surface areas or in bait stations.*	*May be attractive to children, pets or non-target organisms. May not be as attractive as other available foods.*
Dry Flowable (DF)	*A finely ground insoluble (a.i.) powder which can be added to water to form a suspension.*	Easy to handle and apply.	
Dust (D)	Fine, dry particles. *The dust may be the carrier for the a.i. or may be a desiccant.*	No mixing required. Simple application equipment needed.	Large scale application can pose a drift hazard and dusts tend to be expensive.
Emulsifiable Concentrate (EC)	a.i. dissolved in a petroleum solvent and mixed with an emulsifier to produce an emulsion when added to water.	Easy to mix and apply.	
Flowable (F)	Finely ground, insoluble a.i. *in suspension in a liquid (water based) carrier.*	Mixes easily in water for application.	
Granule (G)	Relatively large, coarse grains of an absorptive or soluble medium impregnated with 1-15% a.i. Applied to soil for the control of soil pests or foliar pests if the a.i. is systemic.	No mixing or dilution required. Low drift & applicator hazard. Simple application equipment required.	May be more expensive than WP or EC. May need to be incorporated into soil and requires moisture to activate.
Ready-to-Use Low Concentration Solution (RTU)	Consists of a small amount of a.i. (often 1% or less/unit volume) dissolved in organic solvent.	Requires no further dilution. Is usually non-staining and can be prepackaged in aerosol cans for professional use on structural & institutional pests.	May not be readily available. High cost per unit of a.i.
Solutions (S)	The a.i. and additive/s form a true solution *in water without the need for emulsifiers.*	Requires no agitation.	May not be easily available.
Soluble Powders (SP)	Fine particles that dissolve readily in water to form a true solution.	Easy to transport & store. Low phytotoxicity. Easily measured & mixed.Lower skin absorption than liquid formulations.	Inhalation hazard while mixing (except in soluble packaging). Few SP formulations available.
Ultra-Low-Volume concentrate (ULV)	Highly concentrated solution which is applied with little or no solution at very low volumes.	Requires no mixing. Ideal in conditions where water availability is restricted.	Requires specialised equipment, which is very expensive. Drifts even in the lightest movement of the air.

FORMULATION	DESCRIPTION	ADVANTAGES	DISADVANTAGES
Wettable Powder (WP)	Dry, finely ground, dust-like formulation containing 50% or more of a.i. which can be mixed with water for application. Particles are insoluble in water.	Easy to transport & store.Low phytotoxicity. Easily measured& mixed. Lower skin absorption than liquid formulations.	Inhalation hazard while mixing. Requires constant agitation to keep particles suspended. Abrasive to pumps & nozzles.
Microencapsulated formulation (M) or (ME)	Pesticide particles surrounded by or absorbed to an encapsulating material. May be applied as sprays or *as a drench for soil treatments*. Encapsulation prolongs the active life of the pesticide by providing a slow timed release of the a.i.once it *has been* applied.	Increased safety to the applicator. Longer residual than other formulations. Easy to mix and apply.	Constant agitation may be necessary. Bees may pick up capsules and carry them back to the hives where *the continue release of pesticide* may kill the entire hive. Persists longer in the environment.

Table 5: *A Comprehensive List of Pesticide Formulations & Abbreviations*

ABBREVIATION	TYPE OF FORMULATION	ABBREVIATION	TYPE OF FORMULATION
A	Aerosol	MTF	Multi Temperature Formulation
AF	Aqueous Flowable	P or PS	Pellets
AS	Aqueous Solution or Suspension	RTU	Ready to Use
B	Bait	S	Solution
C	Concentrate	SD	Soluble Dust
CM	Concentrate Mixture	SG	Soluble Granules
CG	Concentrate Granules	SP	Soluble Powder or Packet
D	Dust	TC	Termiticide Concentrate
DF	Dry Flowable	ULV	Ultra Low Volume
E or EC	Emulsifiable Concentrate	W or WP	Wettable Powder
F	Flowable (liquid)	WDG	Water Dispersible Granules
G	Granules	WS	Water Soluble
GL	Gel	WSG	Water Soluble Granules
LC	Liquid or Low Concentrate	WSL	Water Soluble Liquid
M or ME	Microencapsulated	WSB or WSP	Water-Soluble Bag, Powder or Packet