NATIONAL OPEN UNIVERSITY OF NIGERIA

FACULTY OF HEALTH SCIENCES

DEPARTMENT OF ENVIRONMENTAL HEALTH SCIENCES

COURSE CODE: EHS 514

COURSE TITLE: PEST MANAGEMENT, METHODS AND CONTROLS

COURSE GUIDE

EHS 514: PEST MANAGEMENT, METHODS AND CONTROLS

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Introduction

EHS 514 titled "**pest management, methods and controls**" is a one (1) Unit course with four (4) Modules and thirteen (13) Units.

A pest is any living organism, whether animal, plant or fungus, which is invasive or troublesome to plants or animals, human or human concerns, livestock, or human structures. It is a loose concept, as an organism can be a pest in one setting but beneficial, domesticated or acceptable in another.

Pests, such as termites, often occur in high densities, making the damage they do even more detrimental.

Animals are called pests when they cause damage to agriculture by feeding on crops or parasitizing livestock, such as codling moth on apples, or boll weevil on cotton. An animal could also be a pest when it causes damage to a wild ecosystem or carries germs within human habitats.

What you will learn in this course

In this course, you have the course units and a course guide. The course guide will tell you what the course is all about. It is general overview of the course materials you will be using and how to use those materials. It also helps you to allocate the appropriate time to each unit so that you can successfully complete the course within the stipulated time limit.

The course guide also helps you to know how to go about your Tutor-Marked Assignment which will form part of your overall assessment at the end of the course. Also, there will be regular tutorial classes that are related to this course,

where you can interact with your facilitator and other students. Please, I encourage you to attend these tutorial classes.

Course aim

The aim of this short course is to provide participants with a broad knowledge of pest and methods of controlling pest.

Course Objectives

To achieve the aim set above, there are objectives. Each unit has a set of objectives presented at the beginning of the unit. These objectives will guide you on what to concentrate / focus on while studying the unit. Please read the objectives before studying the unit and during your study to check your progress.

The Comprehensive Objectives of the Course are given below. At the end of the course the participants will be able to:

- Define the term pest
- Methods of controlling pest

Working through this course

To successfully complete this course, you are required to read each study unit, read the textbooks materials provided by the National Open University.

Reading the referenced materials can also be of great assistance.

Each unit has self-assessment exercises which you are advised to do and at certain periods during the course you will be required to submit your assignment for the purpose of assessment.

There will be a final examination at the end of the course. The course should take you about 17 weeks to complete.

This course guide will provide you with all the components of the course how to go about studying and hour you should allocate your time to each unit so as to finish on time and successfully.

Course materials

The major components of the course are:

1. Course Guide
2. Study Units
3. Text Books
4. Assignment File
5. Presentation Schedule

Study units

There are 14 study units and 4 modules in this course. They are:

Module 1

Unit 1 pest
Unit 2 Pest Control
Unit 3 Cultural control

Module 2

Unit 1 Pesticides
Unit 2 Forestry
Unit 3 General methods

Unit 4Methods for specific pests

Module 3

Unit 1 Pest management

Unit 2 Economic test

Unit 3 Economic damage

Module 4

Unit 1 Surveillance / Pest scouting

Unit 2 Pest Complex

Unit 3 Kinds of Pests

There are activities related to the lecture in each unit which will help your progress and comprehension of the unit. You are required to work on these exercises which together with the TMAs will enable you to achieve the objectives of each unit.

Presentation Schedule

There is a time-table prepared for the early and timely completion and submissions of your TMAs as well as attending the tutorial classes. You are required to submit all your assignments by the stipulated time and date. Avoid falling behind the schedule time.

Assessment

There are three aspects to the assessment of this course.

The first one is the self-assessment exercises. The second is the tutor marked assignments and the third is the written examination or the examination to be taken at the end of the course.

Do the exercises or activities in the unit by applying the information and knowledge you acquired during the course. The tutor-marked assignments must be submitted to your facilitator for formal assessment in accordance with the deadlines stated in the presentation schedule and the assignment file.

The work submitted to your tutor for assessment will count for 30% of your total course work.

At the end of this course, you have to sit for a final or end of course examination of about a three hour duration which will count for 70% of your total course mark.

Tutor-Marked Assignment

This is the continuous assessment component of this course and it accounts for 30% of the total score. You will be given Three (3) TMAs by your facilitator to answer. The three of which must be answered before you are allowed to sit for the end of course examination.

These answered assignments are to be returned to your facilitator.

You're expected to complete the assignments by using the information and material in your readings, references and study units.

Reading and researching into you references will give you a wider via point and give you a deeper understanding of the subject.

1. Make sure that each assignment reaches your facilitator on or before the deadline given in the presentation schedule and assignment file. If for any reason you are not able to complete your assignment, make sure you contact your facilitator before the assignment is due to discuss the possibility of an extension. Request for extension will not be granted after the due date unless there in exceptional circumstances.

2. Make sure you revise the whole course content before sitting or the examination. The self-assessment activities and TMAs will be useful for this purposes and if you have any comment please do before the examination. The end of course examination covers information from all parts of the course.

Course Marking Scheme

Assignment	Marks

Assignments 1 – 3	Three assignments, three marks of the three count at 10% each–30% of course marks.
End of course examination	70% of overall course marks
Total	100% of course materials.

Facilitators/Tutors and Tutorials

Sixteen (16) hours are provided for tutorials for this course. You will be notified of the dates, times and location for these tutorial classes.

As soon as you are allocated a tutorial group, the name and phone number of your facilitator will be given to you.

These are the duties of your facilitator: He or she will mark and comment on your assignment. He will monitor your progress and provide any necessary assistance you need. He or she will mark your TMAs and return to you as soon as possible.

(You are expected to mail your tutored assignment to your facilitator at least two days before the schedule date).

Do not delay to contact your facilitator by telephone or e-mail for necessary assistance if you do not understand any part of the study in the course material. You have difficulty with the self assessment activities. You have a problem or question with an assignment or with the grading of the assignment.

It is important and necessary you acted the tutorial classes because this is the only chance to have face to face content with your facilitator and to ask questions which will be answered instantly. It is also period where you can say any problem encountered in the course of your study.

Summary

In agriculture, pests are the organisms which may cause quantities or qualitative losses to our crops. E.g insects, mites, weeds, fungus, algae, snails, slugs, different pathogens, rodents etc. In A pest is any animal or plant detrimental to humans or human concerns, including crops, livestock and forestry, among others. The term is also used of organisms that cause a nuisance, such as in the home. An older usage is of a deadly epidemic disease, specifically plague. In its broadest sense, a pest is a competitor of humanity.

A pest is any living organism, whether animal, plant or fungus, which is invasive or troublesome to plants or animals, human or human concerns, livestock, or human structures. It is a loose concept, as an organism can be a pest in one setting but beneficial, domesticated or acceptable in another.

At the end of this unit, you should be able to:

- Define the term pest
- Pest control
- Cultural control
- Pesticides
- Forestry
- Physical control method

The list of questions expected to be answered is not limited to the above list. Finally, you are expected to apply the knowledge you have acquired during this course to your practical life.

I wish you success in this course.

Course Code: EHS 514

Course Title: Pest Management, Methods and Controls

Course Developer/Writer: Dr. Usman N. Gimba
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IBB University Lapai.

Module 1

Unit 1 pest
Unit 2 Pest Control
Unit 3 Cultural control

UNIT 1 PEST

1.0 Introduction

2.0 Objectives

3.0 Main content

3.1 Definition of term

4.0 Conclusion

1.0 Introduction

In a wide sense, may be defined as any organism which harms or causes damage to man directly or indirectly, is called a pest. In agriculture, pests are the organisms which may cause quantities or qualitative losses to our crops. E.g insects, mites, weeds, fungus, algae, snails, slugs, different pathogens, rodents etc.A pest is any animal or plant detrimental to humans or human concerns, including crops, livestock and forestry, among others. The term is also used of organisms that cause a nuisance, such as in the home. An older usage is of a deadly epidemic disease, specifically plague. In its broadest sense, a pest is a competitor of humanity.

A pest is any living organism, whether animal, plant or fungus, which is invasive or troublesome to plants or animals, human or human concerns, livestock, or human structures. It is a loose concept, as an organism can be a pest in one setting but beneficial, domesticated or acceptable in another.

2.0 Objectives

At the end of this unit, you should be able to talk comprehensively on the term pest.

3.0 Main content

3.1 Definition of term

In a wide sense, may be defined as any organism which harms or causes damage to man directly or indirectly, is called a pest. In agriculture, pests are the organisms

which may cause quantities or qualitative losses to our crops. E.g insects, mites, weeds, fungus, algae, snails, slugs, different pathogens, rodents etc. In A pest is any animal or plant detrimental to humans or human concerns, including crops, livestock and forestry, among others. The term is also used of organisms that cause a nuisance, such as in the home. An older usage is of a deadly epidemic disease, specifically plague. In its broadest sense, a pest is a competitor of humanity.

A pest is any living organism, whether animal, plant or fungus, which is invasive or troublesome to plants or animals, human or human concerns, livestock, or human structures. It is a loose concept, as an organism can be a pest in one setting but beneficial, domesticated or acceptable in another.

Plate 1: Image of termites

Source: "AGP - Integrated Pest Management". Retrieved 19 August2012.

Pests, such as termites, often occur in high densities, making the damage they do even more detrimental.

Animals are called pests when they cause damage to agriculture by feeding on crops or parasitizinglivestock, such as codling moth on apples, or boll weevil on cotton. An animal could also be a pest when it causes damage to a wild ecosystem or carries germs within human habitats. Examples of these include those organisms which vector human disease, such as rats and fleas which carry the plague disease, mosquitoes which vector malaria, and ticks which carry Lyme disease.

A species can be a pest in one setting but beneficial or domesticated in another (for example, European rabbits introduced to Australia caused ecologicaldamage beyond the scale they inflicted in their natural habitat). Many weeds are also seen as useful under certain conditions, for instance Patterson's curse is often valued as food for honeybees and as a wildflower, even though it can poison livestock.

The term "plant pest" has a specific definition in terms of the International Plant Protection Convention and phytosanitary measures worldwide. A pest is any species, strain or biotype of plant, animal, or pathogenic agent injurious to plants or plant products. Plants may be considered pests themselves if an invasive species.

The animal groups of greatest importance as pests (in order of economic importance) are insects, mites, nematodes and gastropods. Plant pests can be classed as *monophagous*, *oligophagous*, and *polyphagous* according to how many hosts they have. Alternatively, they can be divided by feeding type, whether biting and chewing; piercing and sucking; or Lapping and chewing. Another approach is to class them by population presence as * key pests, occasional pests, and potential pests. In

terms of population biology, there are population growth rate (r) pests; carrying capacity (k) pests; and r-k pests.

4.0 Conclusion

The term "plant pest" has a specific definition in terms of the International Plant Protection Convention and phytosanitary measures worldwide. A pest is any species, strain or biotype of plant, animal, or pathogenic agent injurious to plants or plant products. Plants may be considered pests themselves if an invasive species.

5.0 Summary

Plant pests can be classed as *monophagous*, *oligophagous*, and*polyphagous* according to how many hosts they have. Alternatively, they can be divided by feeding type, whether biting and chewing; piercing and sucking; or Lapping and chewing.

6.0 Tutor-marked Assignment

1. Define the term pest

Solution

A pest is any living organism, whether animal, plant or fungus, which is invasive or troublesome to plants or animals, human or human concerns, livestock, or human structures. It is a loose concept, as an organism can be a pest in one setting but beneficial, domesticated or acceptable in another. Pests, such as these termites, often occur in high densities, making the damage they do even more detrimental.

7.0 References

"AGP - Integrated Pest Management". Retrieved 19 August2012.

Knipling, EF (1972). "Entomology and the Management of Man's Environment". Australian Journal of Entomology. **11**: 153–167. doi:10.1111/j.1440-6055.1972.tb01618.x.

Wright, M. G.; Hoffmann, M. P.; Kuhar, T. P.; Gardner, J.; Pitcher, S. A. (2005). "Evaluating risks of biological control introductions: A probabilistic risk-assessment approach". Biological Control. **35** (3): 338–347. doi:10.1016/j.biocontrol.2005.02.002.

UNIT 2 PEST CONTROL

1.0 Introduction

It is the system of using two or more pest control methods, except chemical control, in a planned way to control pest.

Pest control is the regulation or management of a species defined as a pest, a member of the animal kingdom that impact adversely on human activities. The human response depends on the importance of the damage done, and will range from tolerance, through deterrence and management, to attempts to completely eradicate the pest. Pest control measures may be performed as part of an integrated pest management strategy.

2.0 Objectives

At the end of this unit, you will get to know how pests are been controlled.

3.0 Main content

3.1 Definition of term

In agriculture, pests are kept at bay by cultural, chemical and biological means. Ploughing and cultivation of the soil before sowing reduces the pest burden and there is a modern trend to limit the use of pesticides as far as possible. This can be achieved by monitoring the crop, only applying insecticides when necessary, and by growing varieties and crops which are resistant to pests. Where possible, biological means are used, encouraging the natural enemies of the pests and introducing suitable predators or parasites.

In homes and urban environments, the pests are the rodents, birds, insects and other organisms that share the habitat with humans and that feed on and spoil possessions. Control of these pests is attempted through exclusion, repulsion,

physical removal or chemical means. Alternatively, various methods of biological control can be used including sterilization programmes.

Pest control is at least as old as agriculture, as there has always been a need to keep crops free from pests. As long ago as 3000 BC in Egypt, cats were used to control pests of grain stores such as rodents. Ferrets were domesticated by 500 AD in Europe for use as mousers. Mongooses were introduced into homes to control rodents and snakes, probably by the ancient Egyptians.

The conventional approach was probably the first to be employed, since it is comparatively easy to destroy weeds by burning them or ploughing them under, and to kill larger competing herbivores. Techniques such as crop rotation, companion planting (also known as intercropping or mixed cropping), and the selective breeding of pest-resistant cultivars have a long history.

Red weaver ants, here feeding on a snail, have been used to control pests in China, Southeast Asia and Africa for many centuries.

Chemical pesticides were first used around 2500 BC, when the Sumerians used sulphur compounds as insecticides. Modern pest control was stimulated by the spread across the United States of the Colorado potato beetle. After much discussion, arsenical compounds were used to control the beetle and the predicted poisoning of the human population did not occur. This led the way to a widespread acceptance of insecticides across the continent. With the industrialization and mechanization of agriculture in the 18th and 19th centuries, and the introduction of the insecticides pyrethrum and derris, chemical pest control became widespread. In the 20th century, the discovery of several synthetic insecticides, such as DDT, and herbicides boosted this development.

Biological control is first recorded around 300 AD in China, when colonies of weaver ants, *Oecophylla smaragdina*, were intentionally placed in citrus plantations to control beetles and caterpillars. Also in China, ducks were used in paddy fields to consume pests, as illustrated in ancient cave art. In 1762, an Indian mynah was brought to Mauritius to control locusts, and about the same time, citrus trees in Burma were connected by bamboos to allow ants to pass between them and help control caterpillars. In the 1880s, ladybirds were used in citrus plantations in California to control scale insects, and other biological control experiments followed. The introduction of DDT, a cheap and effective compound, put an effective stop to biological control experiments. By the 1960s, problems of resistance to chemicals and damage to the environment began to emerge, and biological control had a renaissance. Chemical pest control is still the predominant type of pest control today, although a renewed interest in traditional and biological pest control developed towards the end of the 20th century and continues to this day.

Biological pest control is a method of controlling pests such as insects and mites by using other organisms. It relies on predation, parasitism, herbivory or other natural mechanisms, but typically also involves an active human management role. Classical biological control involves the introduction of natural enemies of the pest that are bred in the laboratory and released into the environment. An alternative approach is to augment the natural enemies that occur in a particular area by releasing more, either in small, repeated batches, or in a single large-scale release. Ideally, the released organism will breed and survive, and provide long-term control. Biological control can be an important component of an integrated pest management programme.

For example: mosquitoes are often controlled by putting *Bacillus thuringiensis* ssp. A bacterium that infects and kills mosquito larvae, in local water sources.

4.0 Conclusion

Classical biological control involves the introduction of natural enemies of the pest that are bred in the laboratory and released into the environment. An alternative approach is to augment the natural enemies that occur in a particular area by releasing more, either in small, repeated batches, or in a single large-scale release.

5.0 Summary

Biological control can be an important component of an integrated pest management programme.

6.0 Tutor-marked Assignment

1. List the three basic methods of controlling pest in Agriculture.

Solution

Pests can be kept at bay in Agriculture by cultural, chemical and biological means.

7.0 References

Charles Perrings; Mark Herbert Williamson; Silvana Dalmazzone (1 January 2000). The Economics of Biological Invasions. Edward Elgar Publishing. ISBN 978-1-84064-378-7.

Clercq, P.; Mason, P. G.; Babendreier, D. (2011). "Benefits and risks of exotic biological control agents". BioControl. **56** (4): 681–698. doi:10.1007/s10526-011-9372-8.

UNIT 3 CULTURAL CONTROL

1.0 Introduction

2.0 Objectives

3.0 Main content

3.1 Trap cropping

4.0 Conclusion

1.0 Introduction

Mechanical pest control is the use of hands-on techniques as well as simple equipment and devices, that provides a protective barrier between plants and insects. This is referred to as tillage and is one of the oldest methods of weed control as well as being useful for pest control; wireworms, the larvae of the common click beetle, are very destructive pests of newly ploughed grassland, and repeated cultivation exposes them to the birds and other predators that feed on them.

Crop rotation can help to control pests by depriving them of their host plants. It is a major tactic in the control of corn rootworm, and has reduced early season incidence of Colorado potato beetle by as much as 95%.

2.0 Objectives

At the end of this unit, you will get to know what is meant by the term cultural control.

3.0 Main content

3.1 Trap cropping

A trap crop is a crop of a plant that attracts pests, diverting them from nearby crops. Pests aggregated on the trap crop can be more easily controlled using pesticides or

other methods. However, trap-cropping, on its own, has often failed to cost effectively reduce pest densities on large commercial scales, without the use of pesticides, possibly due to the pests' ability to disperse back into the main field.

4.0 Conclusion

Pests aggregated on the trap crop can be more easily controlled using pesticides or other methods.

5.0 Summary

Trap-cropping, on its own, has often failed to cost effectively reduce pest densities on large commercial scales, without the use of pesticides.

6.0 Tutor-marked Assignment

1. Define the term trap-cropping

Solution

A trap crop is a crop of a plant that attracts pests, diverting them from nearby crops. Pests aggregated on the trap crop can be more easily controlled using pesticides or other methods.

7.0 References

Acosta, EW (1995–2006). "The History of Integrated Pest Management (IPM)". BioControl Reference Center. "1997: Smith and Adkisson". The World Food Prize Foundation. Retrieved 15 April 2015.

"Integrated Pest Management (IMP) Principles". United States Environmental Protection Agency. 2012.

"IPM Guidelines". UMassAmherst—Integrated Pest Management, Agriculture and Landscape Program. 2009. Archived from the original on 12 March 2012. Retrieved 13 March 2012.

MODULE 2

Unit 1 Pesticides
Unit 2 Forestry
Unit 3 General methods

UNIT 1 PESTICIDES

1.0 Introduction

Pesticides are applied to crops by agricultural aircraft, tractor-mounted crop sprayers or as seed dressings to control pests. However, successful control by pesticides is not easy; the right formulation must be chosen, the timing is often critical, the method of application is important, adequate coverage and retention on the crop are necessary. The killing of natural enemies of the target pest should be minimized. This is particularly important in countries where there are natural reservoirs of pests and their enemies in the countryside surrounding plantation crops, and these co-exist in a delicate balance. Often in less-developed countries, the crops are well adapted to the local situation and no pesticides are needed.

2.0 Objectives

At the end of this unit, you will get more enlightenment on the term pesticide.

3.0 Main content

3.1 General Overview

Where progressive farmers are using fertilizers to grow improved crop varieties, these are often more susceptible to pest damage, but the indiscriminate application of pesticides may be detrimental in the longer term.

The efficacy of chemical pesticides tends to diminish over time. This is because any organism that manages to survive the initial application will pass on its genes to its offspring and a resistant strain will be developed. In this way, some of the most serious pests have developed resistance and are no longer killed by pesticides that used to kill their ancestors. This necessitates higher concentrations of chemical, more frequent applications and a movement to more expensive formulations.

Pesticides are formulated to kill pests, but many have detrimental effects on non-target species; of particular concern is the damage done to honey-bees, solitary bees and other pollinating insects and in this regard, the time of day when the spray is applied can be important. The widely used neonicotinoids have been banned on flowering crops in some countries because of their effects on bees. Some pesticides may cause cancer and other health problems in humans, as well as being harmful to wildlife. There can be acute effects immediately after exposure or chronic effects after continuous low-level or occasional exposure. Maximum residue limits for pesticides in foodstuffs and animal feed are set by many nations.

Plate 1: Image of Budworm

Source: ^ Acosta, EW (1995–2006).

4.0 Conclusion

Maximum residue limits for pesticides in foodstuffs and animal feed are set by many nations.

5.0 Summary

Pesticides are formulated to kill pests, but many have detrimental effects on non-target species; of particular concern is the damage done to honey-bees, solitary bees and other pollinating insects and in this regard, the time of day when the spray is applied can be important.

6.0 Tutor-marked Assignment

1. Define the term pesticides in relation to Agriculture.

Solution

Pesticides are applied to crops by agricultural aircraft, tractor-mounted crop sprayers or as seed dressings to control pests. However, successful control by pesticides is not easy; the right formulation must be chosen, the timing is often critical, the method of

application is important, adequate coverage and retention on the crop are necessary.

7.0 References

Sandler, Hilary A. (2010). "Integrated Pest Management". Cranberry Station Best Management Practices. **1** (1): 12–15.

Handbook of Pest Control, Mallis, Arnold, 10th edition, Hedges, Stoy, Editor. .1499-1500

Organic Materials Review Institute, "The OMRI Product List," http://www.omri.org/OMRI_about_list.html approved product list.

^ Acosta, EW (1995–2006). "The History of Integrated Pest Management (IPM)". BioControl Reference Center.

UNIT 2: FORESTRY

CONTENT

1.0 Introduction

Forest pests present a significant problem because it is not easy to access the canopy and monitor pest populations. In addition, forestry pests such as bark beetles, kept under control by natural enemies in their native range, may be transported large distances in cut timber to places where they have no natural predators, enabling them to cause extensive economic damage.

2.0 Objectives

At the end of this unit, you will get to know what is meant by the term forest pest.

3.0 Main content

3.1 Definition of term

Pheromone traps have been used to monitor pest populations in the canopy. These release volatile chemicals that attract males. Pheromone traps can detect the arrival of pests or alert foresters to outbreaks. For example, the spruce budworm, a destructive pest of spruce and balsam fir, has been monitored using pheromone traps in Canadian forests for several decades. In some regions, such as New Brunswick, areas of forest are sprayed with pesticide to control the budworm population and prevent the damage caused during outbreaks.

4.0 Conclusion

Forest pests present a significant problem because it is not easy to access the canopy and monitor pest populations.

5.0 Summary

Pheromone traps have been used to monitor pest populations in the canopy. These release volatile chemicals that attract males. Pheromone traps can detect the arrival of pests or alert foresters to outbreaks.

6.0Tutor-marked Assignment

1. Define the term forest pest.

Solution

Forest pests present a significant problem because it is not easy to access the canopy and monitor pest populations. In addition, forestry pests such as bark beetles, kept under control by natural enemies in their native range, may be transported large distances

7.0 References

Purdue University Turf Pest Management Correspondence Course, Introduction, 2006

Klassen; W and Curtis, C. F. (2005). "1.1". In V.A. Dyck; J. Hendrichs; A.S. Robinson (eds.). Sterile Insect Technique: Principles and Practice in Area-Wide Integrated Pest Management. Netherlands: Springer. pp. 4–28.

Thomson, Linda; Bennett, David; Glenn, DeAnn; Hoffman, Ary (2 September 2003). Opender Koul; G. S. Dhaliwal (eds.). Developing Trichogramma as a Pest Management Tool. Predators and Parasitoids. CRC Press. ISBN 978-0-203-30256-9.

UNIT 3 GENERAL METHODS

1.0 Introduction

Physical pest control involves trapping or killing pests such as insects and rodents. Historically, local people or paid rat-catchers caught and killed rodents using dogs and traps. On a domestic scale, sticky flypapers are used to trap flies. In larger buildings, insects may be trapped using such means as pheromones, synthetic volatile chemicals or ultraviolet light to attract the insects; some have a sticky base or an electrically charged grid to kill them. Glueboards are sometimes used for monitoring cockroaches and to catch rodents. Rodents can be killed by suitably baited spring traps and can be caught in cage traps for relocation. Talcum powder or "tracking powder" can be used to establish routes used by rodents inside buildings and acoustic devices can be used for detecting beetles in structural timbers.

2.0 Objectives

At the end of this unit, you will get to know what is meant by the term physical pest control.

3.0 Main content

3.1 Physical pest control

Historically, firearms have been one of the primary methods used for pest control. "Garden Guns" are smooth bore shotguns specifically made to fire .22 calibersnake shot or 9mm Flaubert, and are commonly used by gardeners and farmers for snakes, rodents, birds, and other pest. Garden Guns are short range weapons that can do little harm past 15 to 20 yards, and they're relatively quiet when fired with snake shot, compared to standard ammunition. These guns are especially effective inside of barns and sheds, as the snake shot will not shoot holes in the roof or walls, or more importantly injure livestock with a ricochet. They are also used for pest control at airports, warehouses, stockyards, etc.

The most common shot cartridge is .22 Long Rifle loaded with 12 shot. At a distance of about 10 ft (3.0 m), which is about the maximum effective range, the pattern is about 8 in (20 cm) in diameter from a standard rifle. Special smoothbore shotguns, such as the Marlin Model 25MG can produce effective patterns out to 15 or 20 yards using .22 WMR shotshells, which hold 1/8 oz. of #12 shot contained in a plastic capsule.

3.2 Poisoned bait

Plate 1: Image of a poisoned bait

Source: ^ Handbook of Pest Control (10th edition)

Poisoned bait is a common method for controlling rats, mice, birds, slugs, snails, ants, cockroaches and other pests. The basic granules, or other formulation, contains a food attractant for the target species and a suitable poison. For ants, a slow-acting toxin is needed so that the workers have time to carry the substance back to the colony, and for flies, a quick-acting substance to prevent further egg-laying and nuisance. Baits for slugs and snails often contain the molluscide metaldehyde, dangerous to children and household pets.

Warfarin has traditionally been used to kill rodents, but many populations have developed resistance to this anticoagulant, and difenacoum is often substituted. These are cumulative poisons, requiring bait stations to be topped up regularly. Poisoned meat has been used for centuries to kill animals such as wolves and birds of prey. Poisoned carcasses however kill a wide range of carrion feeders, not only the targeted species. Raptors in Israel were nearly wiped out following a period of intense poisoning of rats and other crop pests.

3.3 Fumigation

Plate 2: Tent fumigation of a house in America

Source: USEPA (2012).

Fumigation is the treatment of a structure to kill pests such as wood-boring beetles by sealing it or surrounding it with an airtight cover such as a tent, and fogging with liquid insecticide for an extended period, typically of 24–72 hours. This is costly and inconvenient as the structure cannot be used during the treatment, but it targets all life stages of pests.

An alternative, space treatment, is fogging or misting to disperse a liquid insecticide in the atmosphere within a building without evacuation or airtight sealing, allowing most work within the building to continue, at the cost of reduced penetration. Contact insecticides are generally used to minimise long lasting residual effects.

3.4 Sterilization

Populations of pest insects can sometimes be dramatically reduced by the release of sterile individuals. This involves the mass rearing of a pest, sterilizing it by means of X-rays or some other means, and releasing it into a wild population. It is particularly useful where a female only mates once and where the insect does not disperse widely. This technique has been successfully used against the New World screw-worm fly, some species of tsetse fly, tropical fruit flies, the pink bollworm and the codling moth, among others.

Laboratory studies conducted with U-5897 (3-chloro-1,2-propanediol) were attempted in the early 1970s for rat control, although these proved unsuccessful. In 2013, New York City tested sterilization traps, demonstrating a 43% reduction in rat populations. The product ContraPest was approved for the sterilization of rodents by the United States Environmental Protection Agency in August 2016.

3.5 Insulation

Boron, a known pesticide can be impregnated into the paper fibers of cellulose insulation at certain levels to achieve a mechanical kill factor for self-grooming insects such as ants, cockroaches, termites, and more. The addition of insulation into the attic and walls of a structure can provide control of common pests in addition to known insulation benefits such a robust thermal envelope and acoustic noise cancelling properties. The EPA regulates this type of general-use pesticide within the United States allowing it to only be sold and installed by licensed pest management professionals as part of an integrated pest management program. Simply adding Boron or an EPA-registered pesticide to insulation is does not

qualify it as a pesticide. The dosage and method must be carefully controlled and monitored.

4.0 Conclusion

The addition of insulation into the attic and walls of a structure can provide control of common pests in addition to known insulation benefits such a robust thermal envelope and acoustic noise cancelling properties.

5.0 Summary

Populations of pest insects can sometimes be dramatically reduced by the release of sterile individuals. This involves the mass rearing of a pest, sterilizing it by means of X-rays or some other means, and releasing it into a wild population. It is particularly useful where a female only mates once and where the insect does not disperse widely.

6.0 Tutor-marked Assignment

1. Define the term Fumigation

Solution

Fumigation is the treatment of a structure to kill pests such as wood-boring beetles by sealing it or surrounding it with an airtight cover such as a tent, and fogging with liquid insecticide for an extended period, typically of 24–72 hours. This is costly and inconvenient as the structure cannot be used during the treatment, but it targets all life stages of pests.

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UNIT 4 METHODS FOR SPECIFIC PESTS

CONTENT

1.0 Introduction

Natural rodent control

Plate 1: Brown rat infestation

Source: "IPM Guidelines" (2009).

Several wildlife rehabilitation organizations encourage natural form of rodent control through exclusion and predator support and preventing secondary poisoning altogether. The United States Environmental Protection Agency notes in its Proposed Risk

Mitigation Decision for Nine Rodenticides that "without habitat modification to make areas less attractive to commensal rodents, even eradication will not prevent new populations from recolonizing the habitat."

2.0 Objectives

At the end of this unit, you should be able to know the methods of some specific pest.

3.0 Main content

3.1 Definition of term

The United States Environmental Protection Agency has prescribed guidelines for natural rodent control and for safe trapping in residential areas with subsequent release to the wild People sometimes attempt to limit rodent damage using repellents. Balsam fir oil from the tree *Abies balsamea* is an EPA approved non-toxic rodent repellent. *Acacia polyacantha* subsp. *campylacantha* root emits chemical compounds that repel animals including rats.

3.2 Pantry pests

Plate 2: The red flour beetle
Source: Sandler(2010).

The red flour beetle*Tribolium castaneum*, attacks stored grain products worldwide.Insect pests including the Mediterranean flour moth, the Indian mealmoth, the cigarette beetle, the drugstore beetle, the confused flour beetle, the red flour beetle, the merchant grain beetle, the sawtoothed grain beetle, the wheat weevil, the maize weevil and the rice weevil infest stored dry foods such as flour, cereals and pasta.

In the home, foodstuffs found to be infested are usually discarded, and storing such products in sealed containers should prevent the problem from reoccurring. The eggs of these insects are likely to go unnoticed, with the larvae being the destructive life stage, and the adult the most noticeable stage.[48] Since pesticides are not safe to use near food, alternative treatments such as freezing for four days at 0 °F (−18 °C) or baking for half an hour at 130 °F (54 °C) should kill any insects present.

3.3 Clothes moths

Plate 2: Larva, pupa and adult clothes moth *Tineola bisselliella* with characteristic damage to fabric

Source: www.google.com

The larvae of clothes moths (mainly *Tineola bisselliella* and *Tinea pellionella*) feed on fabrics and carpets, particularly those that are stored or soiled. The adult females lay batches of eggs on natural fibres, including wool, silk and fur, as well as cotton and linen in blends. The developing larvae spin protective webbing and chew into the fabric, creating holes and specks of excrement. Damage is often concentrated in concealed locations, under collars and near seams of clothing, in folds and crevices in upholstery and round the edges of carpets as well as under furniture. Methods of control include using airtight containers for storage, periodic laundering of garments, trapping, freezing, heating and the use of chemicals; mothballs contain volatile insect repellents such as 1,4-Dichlorobenzene which deter adults, but to kill the larvae, permethrin, pyrethroids or other insecticides may need to be used.

3.4 Carpet beetles

Carpet beetles are members of the family Dermestidae, and while the adult beetles feed on nectar and pollen, the larvae are destructive pests in homes, warehouses and museums. They feed on animal products including wool, silk, leather, fur, the bristles of hair brushes, pet hair, feathers and museum specimens. They tend to infest hidden locations and may feed on larger areas of fabrics than do clothes moths, leaving behind specks of excrement and brown, hollow, bristly-looking cast skins. Management of infestations is difficult and is based on exclusion and sanitation where possible, resorting to pesticides when necessary. The beetles can fly in from outdoors and the larvae can survive on lint fragments, dust and inside the bags of vacuum cleaners. In warehouses and museums, sticky traps baited with suitable pheromones can be used to identify problems, and heating, freezing, spraying the surface with insecticide and fumigation will kill the insects when suitably applied. Susceptible items can be protected from attack by keeping them in clean airtight containers.

3.5 Bookworms

Books are sometimes attacked by cockroaches, silverfish,[52] book mites, booklice, and various beetles which feed on the covers, paper, bindings and glue. They leave behind physical damage in the form of tiny holes as well as staining from their faeces. Book pests include the larder beetle, and the larvae of the black carpet beetle and the drugstore beetle which attack leather-bound books, while the common clothes moth and the brown house moth attack cloth bindings. These attacks are largely a problem with historic books, because modern bookbinding materials are less susceptible to this type of damage.

Evidence of attack may be found in the form of tiny piles of book-dust and specks of frass. Damage may be concentrated in the spine, the projecting edges of pages

and the cover. Prevention of attack relies on keeping books in cool, clean, dry positions with low humidity, and occasional inspections should be made. Treatment can be by freezing for lengthy periods, but some insect eggs are very resistant and can survive for long periods at low temperatures.

3.6 Beetles

Plate 3: House timber split open to reveal larvae of the house longhorn beetle, *Hylotrupes bajulus*, in their burrows, which are partially filled with frass.

Source: Organic Materials Review Institute, "The OMRI Product List," http://www.omri.org/OMRI_about_list.html approved product list.

Various beetles in the *Bostrichoidea* super family attack the dry, seasoned wood used as structural timber in houses and to make furniture. In most cases, it is the larvae that do the damage; these are invisible from the outside of the timber, but are chewing away at the wood in the interior of the item. Examples of these are the powder post beetles, which attack the sapwood of hardwoods, and the furniture beetles, which attacks softwoods, including plywood. The damage has already been done by the time the adult beetles bore their way out, leaving neat round holes behind them. The first that a householder knows about the beetle damage is often when a chair leg breaks off or a piece of structural timber caves in. Prevention is through

chemical treatment of the timber prior to its use in construction or in furniture manufacture.

3.7 Termites

Termites with colonies in close proximity to houses can extend their galleries underground and make mud tubes to enter homes. The insects keep out of sight and chew their way through structural and decorative timbers, leaving the surface layers intact, as well as through cardboard, plastic and insulation materials. Their presence may become apparent when winged insects appear and swarm in the home in spring. Regular inspection of structures by a trained professional may help detect termite activity before damage becomes substantial.; Inspection and monitoring of termites is important because termite alates (winged reproductives) may not always swarm inside a structure. Control and extermination is a professional job involving trying to exclude the insects from the building and trying to kill those already present. Soil-applied liquid termiticides provide a chemical barrier that prevents termites from entering buildings, and lethal baits can be used; these are eaten by foraging insects, and carried back to the nest and shared with other members of the colony, which goes into slow decline.

3.8 Mosquitoes

Plate 4: Mosquito *(Aedes aegypti)* biting a human
Source: wikipedia.org

Mosquitoes are midge-like flies in the family *Culicidae*. Females of most species feed on blood and some act as vectors for malaria and other diseases. Historically they have been controlled by use of DDT and other chemical means, but since the adverse environmental effects of these insecticides has been realized, other means of control have been attempted. The insects rely on water in which to breed and the first line of control is to reduce possible breeding locations by draining marshes and reducing accumulations of standing water. Other approaches include biological control of larvae by the use of fish or other predators, genetic control, the introduction of pathogens, growth-regulating hormones, the release of pheromones and mosquito trapping.

Birds are a significant hazard to aircraft, but it is difficult to keep them away from airfields. Several methods have been explored. Stunning birds by feeding them a bait containing stupefying substances has been tried, and it may be possible to reduce their numbers on airfields by reducing the number of earthworms and other invertebrates by soil treatment. Leaving the grass long on airfields rather than mowing it is also a deterrent to birds. Sonic nets are being trialled; these produce sounds that birds find distracting and seem effective at keeping birds away from affected areas.

4.0 Conclusion

Mosquitoes are midge-like flies in the family *Culicidae*. Females of most species feed on blood and some act as vectors for malaria and other diseases. Historically they have been controlled by use of DDT and other chemical means, but since the adverse environmental effects of these insecticides has been realized, other means of control have been attempted.

5.0 Summary

Termites with colonies in close proximity to houses can extend their galleries underground and make mud tubes to enter homes. The insects keep out of sight and chew their way through structural and decorative timbers, leaving the surface layers intact, as well as through cardboard, plastic and insulation materials.

6.0 Tutor-marked Assignment

1. Define the term carpet beetles

Solution

Carpet beetles are members of the family *Dermestidae*, and while the adult beetles feed on nectar and pollen, the larvae are destructive pests in homes, warehouses and museums. They feed on animal products including wool, silk, leather, fur, the bristles of hair brushes, pet hair, feathers and museum specimens. They tend to

infest hidden locations and may feed on larger areas of fabrics than do clothes moths, leaving behind specks of excrement and brown, hollow, bristly-looking cast skins.

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MODULE 3

Unit 1 Pest management

Unit 2 Economic test

Unit 3 Economic damage

UNIT 1 PEST MANAGEMENT

CONTENT

1.0 Introduction

Integrated Pest Management (IPM) is an effective and environmentally sensitive approach to pest management that relies on a combination of common-sense practices. IPM programs use current, comprehensive information on the life cycles of pests and their interaction with the environment. This information, in combination with available pest control methods, is used to manage pest damage by the most economical means, and with the least possible hazard to people, property, and the environment.

2.0 Objectives

At the end of this unit, you will get to know why IPM an effective and environmentally sensitive approach to pest management.

3.0 Main content

3.1 Definition of term

The Pest Management approach can be applied to both agricultural and non-agricultural settings, such as the home, garden, and workplace. IPM takes advantage of all appropriate pest management options including, but not limited to, the judicious use of pesticides. In contrast, *organic* food production applies many of the same concepts as IPM but limits the use of pesticides to those that are produced from natural sources, as opposed to synthetic chemicals.

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combination with available pest control methods, is used to manage pest damage by the most economical means, and with the least possible hazard to people, property, and the environment.

The IPM approach can be applied to both agricultural and non-agricultural settings, such as the home, garden, and workplace. IPM takes advantage of all appropriate pest management options including, but not limited to, the judicious use of pesticides. In contrast, *organic* food production applies many of the same concepts as IPM but limits the use of pesticides to those that are produced from natural sources, as opposed to synthetic chemicals.

3.2 PEST OUT BREAK

Pest outbreak is an explosive increase in population of a particular species, that occurs over a shout period of time (e.g) attack of locust, army worm etc. In epidemiology, an outbreak is a sudden increase in occurrences of a disease in a particular time and place. It may affect a small and localized group or impact upon thousands of people across an entire continent. Four linked cases of a rare infectious disease may be sufficient to constitute an outbreak. Outbreaks include epidemics, which term is normally only used for infectious diseases, as well as diseases with an environmental origin, such as a water or foodborne disease. They may affect a region in a country or a group of countries. Pandemics are near-global disease outbreaks. The terms "outbreak" and "epidemic" have often been used interchangeably. Researchers Manfred S. Green and colleagues propose that the latter term be restricted to larger events, pointing out that Chambers Concise Dictionary and Stedman's Medical Dictionary acknowledge this distinction.

When investigating disease outbreaks, the epidemiology profession has developed a number of widely accepted steps. As described by the United States Centers for Disease Control and Prevention, these include the following:[2]

- Identify the existence of the outbreak (Is the group of ill persons normal for the time of year, geographic area, etc.?)
- Verify the diagnosis related to the outbreak
- Create a case definition to define who/what is included as a case
- Map the spread of the outbreak using Information technology as diagnosis is reported to insurance
- Develop a hypothesis (What appears to be causing the outbreak?)
- Study hypotheses (collect data and perform analysis)
- Refine hypothesis and carry out further study
- Develop and implement control and prevention systems
- Release findings to greater communities

The order of the above steps and relative amount of effort and resources used in each varies from outbreak to outbreak. For example, prevention and control measures are usually implemented very early in the investigation, often before the causative agent is known. In many situations, promoting good hygiene and hand-washing is one of the first things recommended. Other interventions may be added as the investigation moves forward and more information is obtained. Waiting until the end of an investigation to implement prevention and control measures is a sure way to lose ones job. In outbreaks identified through notifiable disease surveillance, reports are often linked to laboratory results and verifying the diagnosis is straight forward. In outbreaks of unknown etiology, determining and verifying the diagnosis can be a significant part of the investigation with respect to time and resources. Several steps are usually going on at any point in time during

the investigation. Steps may be repeated. For example, initial case definitions are often established to be intentionally broad but later refined as more is learned about the outbreak. The above list has 9 steps, others have more. Implementing active surveillance to identify additional cases is often added.

3.3 PEST RESURGENCE

Pest resurgence is the rapid reappearance of a pest population in injurious numbers, usually brought about after the application of a broad-spectrum pesticide has killed the natural enemies which normally keep a pest in check.

A well-known example in rice cultivation is the resurgence of brown plant hopper (BPH). If no pesticides are used, BPH is kept under control by its natural enemies (mirid bugs, ladybird beetles, spiders and various pathogens). Pesticides kill the beneficial and create a situation where populations of BPH can multiply rapidly and thus become a man-made pest.

Resurgence can be easily avoided by not spraying pesticides. But for many farmers it is difficult to recognize that resurgence has occurred in their field. They spray regularly because they see pests in their fields, without realizing that it is actually the spraying which is causing the pest problem.

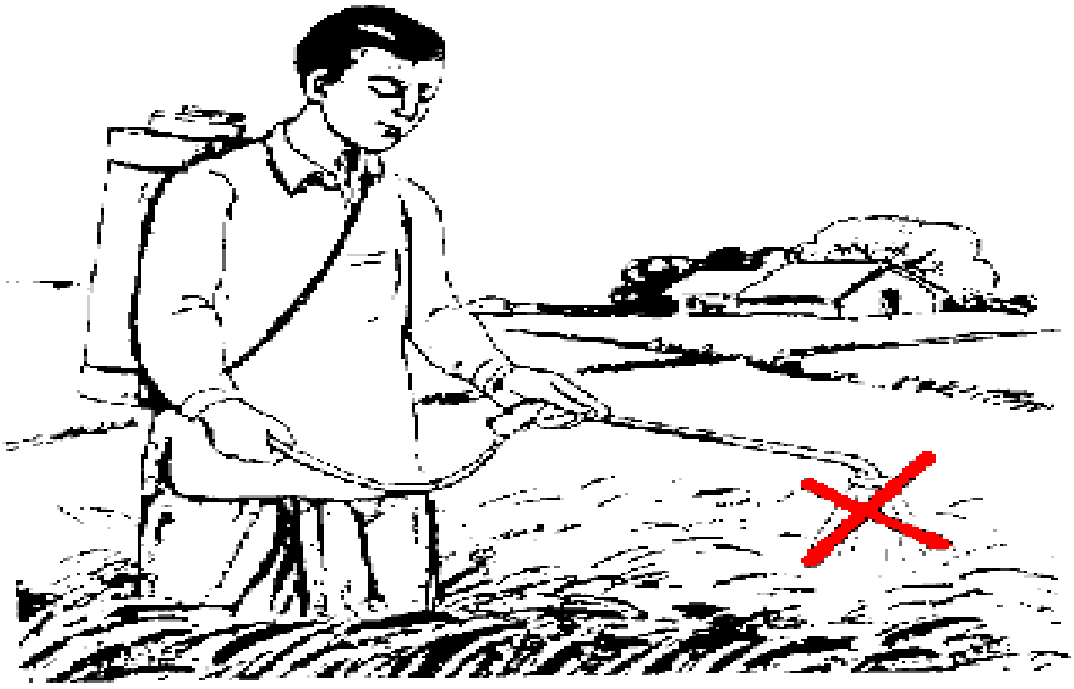

Plate 1: Image of a farmer spraying pesticides

Source: Smith(1949).

Avoid pest resurgence by not spraying toxic pesticides

Another example is about spider mites. Spider mites are normally kept under control by populations of predatory mites. If pesticides are used, the predatory mites get wiped out and the populations of spider mites can increase and become a problem. The farmer responds by spraying more (to control the spider mites) while the proper response would be to stop spraying so that predatory mites can come back to control the pest.

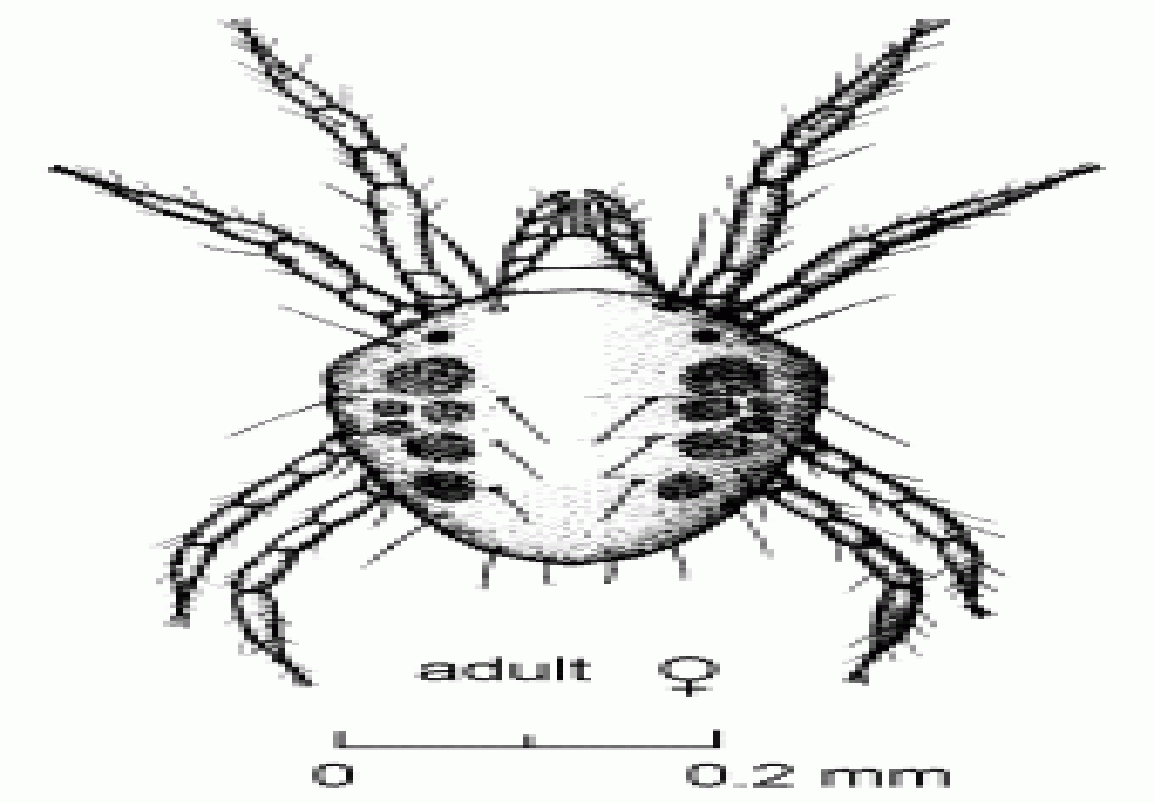

Plate 2: Spider mite (adult female)

Source: Wikipedia encyclopedia

4.0Conclusion

Resurgence can be easily avoided by not spraying pesticides. But for many farmers it is difficult to recognize that resurgence has occurred in their field. They spray regularly because they see pests in their fields, without realizing that it is actually the spraying which is causing the pest problem.

5.0 Summary

Pest resurgence is the rapid reappearance of a pest population in injurious numbers, usually brought about after the application of a broad-spectrum pesticide has killed the natural enemies which normally keep a pest in check.

6.0 Tutor-marked Assignment

1. Define the term pest resurgence.

Solution

Pest resurgence is the rapid reappearance of a pest population in injurious numbers, usually brought about after the application of a broad-spectrum pesticide has killed the natural enemies which normally keep a pest in check.

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UNIT 2 ECONOMIC TEST

CONTENT

1.0 Introduction

When the damage done to the crop by a pest, causes a loss in quality or quantity reaches to a certain proportion that can be calculated, the loss caused by such pest is called economics pest.

PEST analysis (political, economic, socio-cultural and technological) describes a framework of macro-environmental factors used in the environmental scanning component of strategic management. It is part of an external analysis when conducting a strategic analysis or doing market research, and gives an overview of the different macro-environmental factors to be taken into consideration. It is a strategic tool for understanding market growth or decline, business position, potential and direction for operations.

2.0 Objectives

At the end of this unit, you will get to know more about the PEST Analysis.

3.0 Main content

3.1 Definition of term

PEST analysis (political, economic, socio-cultural and technological) describes a framework of macro-environmental factors used in the environmental scanning component of strategic management. It is part of an external analysis when conducting a strategic analysis or doing market research, and gives an overview of the different macro-environmental factors to be taken into consideration. It is a strategic tool for understanding market growth or decline, business position, potential and direction for operations.

Variants that build on the PEST framework include:

- PESTEL or PESTLE, which adds legal and environmental factors. Popular in the United Kingdom.
- SLEPT, adding legal factors.
- STEPE, adding ecological factors.
- STEEPLE and STEEPLED, adding ethics and demographic factors (occasionally rendered as PESTLEE).
- DESTEP, adding demographic and ecological factors.
- SPELIT, adding legal and intercultural factors, popular in the United States since the mid-2000s.
- PMESII-PT, a form of environmental analysis which looks at the aspects of political, military, economic, social, information, infrastructure, physical environment and time aspects in a military context.

There is also **STEER**, which considers socio-cultural, technological, economic, ecological, and regulatory factors, but does not specifically include political factors

- Political factors relate to how the government intervenes in the economy. Specifically, political factors have areas including tax policy, labour law, environmental law, trade restrictions, tariffs, and political stability. Political factors may also include goods and services which the government aims to provide or be provided (merit goods) and those that the government does not want to be provided (demerit goods or merit bads). Furthermore, governments have a high impact on the health, education, and infrastructure of a nation.
- Economic factors include economic growth, exchange rates, inflation rate, and interest rates. These factors greatly affect how businesses operate and make decisions. For example, interest rates affect a firm's cost of capital and therefore to what extent a business grows and expands. Exchange rates can affect the costs of exporting goods and the supply and price of imported goods in an economy.
- Social factors include the cultural aspects and health consciousness, population growth rate, age distribution, career attitudes and emphasis on safety. High trends in social factors affect the demand for a company's products and how that company operates. For example, the ageing population may imply a smaller and less-willing workforce (thus increasing the cost of labour). Furthermore, companies may change various management strategies to adapt to social trends caused from this (such as recruiting older workers).
- Technological factors include technological aspects like R&D activity, automation, technology incentives and the rate of technological change. These can determine barriers to entry, minimum efficient production level and influence

the outsourcing decisions. Furthermore, technological shifts would affect costs, quality, and lead to innovation.

Expanding the analysis to PESTLE or PESTEL adds:

- Legal factors include discrimination law, consumer law, antitrust law, employment law, and health and safety law. These factors can affect how a company operates, its costs, and the demand for its products.
- Environmental factors include ecological and environmental aspects such as weather, climate, and climate change, which may especially affect industries such as tourism, farming, and insurance. Furthermore, growing awareness of the potential impacts of climate change is affecting how companies operate and the products they offer, both creating new markets and diminishing or destroying existing ones.

Other factors for the various offshoots include:

- Demographic factors include gender, age, ethnicity, knowledge of languages, disabilities, mobility, home ownership, employment status, religious belief or practice, culture and tradition, living standards and income level.
- Regulatory factors include acts of parliament and associated regulations, international and national standards, local government by-laws, and mechanisms to monitor and ensure compliance with these.

More factors discussed in the SPELIT Power Matrix include:

- Inter-cultural factors considers collaboration in a global setting.

- Other specialized factors discussed in chapter 10 of the SPELIT Power Matrix include the Ethical, Educational, Physical, Religious, and Security environments. The security environment may include either personal, company, or national security.
- Other business-related factors that might be considered in an environmental analysis include Competition, Demographics, Ecological, Geographical, Historical, Organizational, and Temporal (schedule)

4.0 Conclusion

More factors discussed in the SPELIT Power Matrix include:

- Inter-cultural factors considers collaboration in a global setting.

Other specialized factors discussed in chapter 10 of the SPELIT Power Matrix include the Ethical, Educational, Physical, Religious, and Security

5.0 Summary

PEST analysis (political, economic, socio-cultural and technological) describes a framework of macro-environmental factors used in the environmental scanning component of strategic management. It is part of an external analysis when conducting a strategic analysis or doing market research, and gives an overview of the different macro-environmental factors to be taken into consideration.

6.0 Tutor-marked Assignment

1. Define the PEST Analysis

Solution

PEST analysis (political, economic, socio-cultural and technological) describes a framework of macro-environmental factors used in the environmental scanning component of strategic management. It is part of an external analysis when conducting

a strategic analysis or doing market research, and gives an overview of the different macro-environmental factors to be taken into consideration.

7.0 References

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UNIT 3 ECONOMIC DAMAGE

CONTENT

1.0 Introduction

The amount of pest induced injury to the crop, which will justify the cost of artificial control measures is called as the economic damage

An economic threshold is the insect's population level or extent of crop damage at which the value of the crop destroyed exceeds the cost of controlling the pest.[1] Economic thresholds can be expressed in a variety of ways including the number of insects per plant or per square metre, the amount of leaf surface damage, etc. In

many cases, thresholds have been established through scientific research. Because some combinations of pests and crops have not yet been studied, some thresholds are just educated estimates.

2.0Objectives

At the end of this unit, you will get to know the Economic threshold of crops.

3.0 Main content

3.1 Definition of term

The amount of pest induced injury to the crop, which will justify the cost of artificial control measures is called as the economic damage

An economic threshold is the insect's population level or extent of crop damage at which the value of the crop destroyed exceeds the cost of controlling the pest.[1] Economic thresholds can be expressed in a variety of ways including the number of insects per plant or per square metre, the amount of leaf surface damage, etc. In many cases, thresholds have been established through scientific research. Because some combinations of pests and crops have not yet been studied, some thresholds are just educated estimates.

Sub- economic pest /Non – economic pest
A pest with a general equilibrium position far below the economic injury level; highest pest population does not reach the economic injury level.

In economics, **supply** is the amount of a resource that firms, producers, labourers, providers of financial assets, or other economic agents are willing and able to provide to the marketplace or directly to another agent in the marketplace. Supply can be in currency, time, raw materials, or any other scarce or valuable object that can be

provided to another agent. This is often fairly abstract. For example in the case of time, supply is not transferred to one agent from another, but one agent may offer some other resource in exchange for the first spending time doing something. Supply is often plotted graphically as a **supply curve**, with the quantity provided (the dependent variable) plotted horizontally and the price (the independent variable) plotted vertically.

In the goods market, supply is the amount of a product per unit of time that producers are willing to sell at various given prices when all other factors are held constant. In the labor market, the supply of labor is the amount of time per week, month, or year that individuals are willing to spend working, as a function of the wage rate.

In financial markets, the money supply is the amount of highly liquid assets available in the money market, which is either determined or influenced by a country's monetary authority. This can vary based on which type of money supply one is discussing. M1 for example is commonly used to refer to narrow money, coins, cash, and other money equivalents that can be converted to currency nearly instantly. M2 by contrast includes all of M1 but also includes short-term deposits and certain types of market funds.

A supply schedule is a table which shows how much one or more firms will be willing to supply at particular prices under the existing circumstances. Some of the more important factors affecting supply are the good's own price, the prices of related goods, production costs, technology, the production function, and expectations of sellers.

3.2 Factors affecting supply

Innumerable factors and circumstances could affect a seller's willingness or ability to produce and sell a good. Some of the more common factors are:

Good's own price: The basic supply relationship is between the price of a good and the quantity supplied. Although there is no "Law of Supply", generally, the relationship is positive, meaning that an increase in price will induce an increase in the quantity supplied.

Prices of related goods: For purposes of supply analysis related goods refer to goods from which inputs are derived to be used in the production of the primary good. For example, Spam is made from pork shoulders and ham. Both are derived from pigs. Therefore, pigs would be considered a related good to Spam. In this case the relationship would be negative or inverse. If the price of pigs goes up the supply of Spam would decrease (supply curve shifts left) because the cost of production would have increased. A related good may also be a good that can be produced with the firm's existing factors of production. For example, suppose that a firm produces leather belts, and that the firm's managers learn that leather pouches for smart phones are more profitable than belts. The firm might reduce its production of belts and begin production of cell phone pouches based on this information. Finally, a change in the price of a joint product will affect supply. For example, beef products and leather are joint products. If a company runs both a beef processing operation and a tannery an increase in the price of steaks would mean that more cattle are processed which would increase the supply of leather.

Conditions of production: The most significant factor here is the state of technology. If there is a technological advancement in one good's production, the supply increases. Other variables may also affect production conditions. For instance, for

agricultural goods, weather is crucial for it may affect the production outputs Economies of scale can also affect conditions of production.

Expectations: Sellers' concern for future market conditions can directly affect supply. If the seller believes that the demand for his product will sharply increase in the foreseeable future the firm owner may immediately increase production in anticipation of future price increases. The supply curve would shift out.

Price of inputs: Inputs include land, labor, energy and raw materials. If the price of inputs increases the supply curve will shift left as sellers are less willing or able to sell goods at any given price. For example, if the price of electricity increased a seller may reduce his supply of his product because of the increased costs of production. Fixed inputs can affect the price of inputs, and the scale of production can affect how much the fixed costs translate into the end price of the good.

Number of suppliers: The market supply curve is the horizontal summation of the individual supply curves. As more firms enter the industry, the market supply curve will shift out, driving down prices.

Government policies and regulations: Government intervention can have a significant effect on supply Government intervention can take many forms including environmental and health regulations, hour and wage laws, taxes, electrical and natural gas rates and zoning and land use regulations.

This list is not exhaustive. All facts and circumstances that are relevant to a seller's willingness or ability to produce and sell goods can affect supply. For example, if the forecast is for snow retail sellers will respond by increasing their stocks of snow sleds or skis or winter clothing or bread and milk.

Supply functions, then, may be classified according to the source from which they come: consumers or firms. Each type of supply function is now considered in turn. In so doing, the following notational conventions are employed: There are I

produced goods, each defining a single industry, and J factors. The indices i = 1,…, I and J = 1,…, J run, respectively, over produced goods (industries) and factors. Let n index all goods by first listing produced goods and then factors so that n = 1,…, I, I + 1,…, I + J. The number of firms in industry i is written L i, and these firms are indexed by l = 1,…, L i. There are K consumers enumerated as k = 1,…, K. The variable represents the quantities of factor j consumed by consumer k. This person can have endowments of good j from to . If < then person k is a supplier of j. If the opposite is true, they are a consumer of j.

The supply function is the mathematical expression of the relationship between supply and those factors that affect the willingness and ability of a supplier to offer goods for sale. An example would be the curve implied by where is the price of the good and is the price of a related good. The semicolon means that the variables to the right are held constant when quantity supplied is plotted against the good's own price. The supply equation is the explicit mathematical expression of the functional relationship. A linear example in here is the repository of all non-specified factors that affect supply for the product. The coefficient of is positive following the general rule that price and quantity supplied are directly related. is the price of a related good. Typically, its coefficient is negative because the related good is an input or a source of inputs.

3.3 The Economic Injury Level of Cotton pest is mentioned below

Pest:	Economic injury level
Jassid	1 Per leaf
Thrips	8 Per leaf
Whitefly	5 per leaf

- ❖ Whitefly 5 per leaf
- ❖ Aphid 5-7 per leaf
- ❖ Mite 10-15 per leaf
- ❖ Spotted boll worm 5-10% infestation
- ❖ Pink Boll worm 5-10% infestation

4.0 Conclusion

In economics, supply is the amount of a resource that firms, producers, labourers, providers of financial assets, or other economic agents are willing and able to provide to the marketplace or directly to another agent in the marketplace. Supply can be in currency, time, raw materials, or any other scarce or valuable object that can be provided to another agent.

5.0 Summary

An economic threshold is the insect's population level or extent of crop damage at which the value of the crop destroyed exceeds the cost of controlling the pest. Economic thresholds can be expressed in a variety of ways including the number of insects per plant or per square metre, the amount of leaf surface damage, etc. In many cases, thresholds have been established through scientific research. Because some combinations of pests and crops have not yet been studied, some thresholds are just educated estimates.

6.0 Tutor-marked Assignment

1. Define the term supply schedules

Solution

A supply schedule is a table which shows how much one or more firms will be willing to supply at particular prices under the existing circumstances. Some of the

more important factors affecting supply are the good's own price, the prices of related goods, production costs, technology, the production function, and expectations of sellers.

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MODULE 4

Unit 1 Surveillance / Pest scouting

Unit 2 Pest Complex

Unit 3 Kinds of Pests

UNIT 1: SURVEILLANCE / PEST SCOUTING

CONTENT

1.0 Introduction

The watch kept on a pest for determination of population density, dispersion and dynamics, is called surveillance or pest scouting . A grower gets knowledge of pest population only through pest scouting. On the basis of which he may see that pest has reached economic injury level or not. Other words, it is time to spray or not.

2.0 Objectives

At the end of this, you will get to know what is meant by the term surveillance or pest scouting.

3.0 Main content

3.1 Definition of term

The watch kept on a pest for determination of population density, dispersion and dynamics, is called surveillance or pest scouting. A grower gets knowledge of pest population only through pest scouting. On the basis of which he may see that pest has reached economic injury level or not. Other words, it is time to spray or not.

3.2 Crop scouting

Crop scouting is the process of precisely assessing pest pressure (typically insects) and crop performance to evaluate economic risk from pest infestations and disease, as well as to determine the potential effectiveness of pest and disease control interventions.

Scouting is usually sold as a commercial service to farmers as part of Integrated pest management. New tools are available to increase the effectiveness of crop scouting, including specialized field instruments and handheld computers with GPS, enabling geotagging of crop problems. There exists a new generation of crop scouting systems that enables growers and crop consultants to precisely and accurately locate and tag crop issues, visualize them on an aerial map and make decisions for site-specific treatments. Before starting any actual scouting, preparation is essential to provide accurate information in an efficient manner. Crop scouting is a Integrated pest management strategy that looks at many different aspects of crop production, not just any single pest or problem. Scouts must be actively observing environmental conditions, beneficial insects, pest insects, diseases, weeds, crop growth stage, and the general health of the crop in question to get a complete picture of any problems. Since field and landscape characteristics affect pest distribution, symptom expression, crop injury, and crop recovery, it is important to develop a complete field history in order to properly assess and plan management strategies. The frequency with which fields are scouted depends on the type of crop grown, stage of crop life cycle, present and expected pest(s) and their lifecycle, and environmental conditions (weather). Based on these variables, field visits should be planned to ensure that crop establishes itself, that growth proceeds with healthy development and does not proceed into a population bottleneck, and that pests do not pass the economic threshold level, after which they could become a major problem. This is generally not a problem after the crop has reached a specific stage in development (specific to variety), so the number of visits can be reduced. Frequency of visits to problem fields should not be reduced, and these fields should be strictly monitored.

Since covering the entire population of a whole field would take lots of time, sample populations must be surveyed to ensure quick and efficient data collection and distribution. Sampling patterns are completely randomized to ensure that each subdivision in a field has an equal chance of being sampled. Restrictions to these randomized sampling techniques are imposed to correct the possible error of oversampling in a specific area, and to make sure that all areas of the field are sampled.

Some of the most common randomized patterns are a predetermined zigzag or M-shaped route through rectangular shaped fields. Routes for irregular shaped fields should be made, ensuring that every subdivision of the field is visited, these randomized routes are field specific. Scouting along the edge of a field should not be practiced unless for specific pests, this kind of sampling usually does not show the baring of effects on the whole field

3.3 Method of pest scouting

There are various methods of pest scouting. The most famous are mentioned below.

1. Maryo's Method
2. Diagonal Method
3. Zig Zag Method

4.0 Conclusion

Some of the most common randomized patterns are a predetermined zigzag or M-shaped route through rectangular shaped fields. Routes for irregular shaped fields should be made, ensuring that every subdivision of the field is visited, these randomized routes are field specific.

5.0 Summary

Scouting along the edge of a field should not be practiced unless for specific pests, this kind of sampling usually does not show the baring of effects on the whole field.

6.0 Tutor-marked Assignment

1. List the methods of pest scouting

Solution

There are various methods of pest scouting. The most famous are mentioned below:

1. Maryo's Method
2. Diagonal Method
3. Zig Zag Method

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UNIT 2 PEST COMPLEX

CONTENT

1.0 Introduction

2.0 Objectives

1.0 Introduction

In many cases particular crop may be attacked by various insects and pathogen species which after that form interacting position, which is known as pest complex.

This article is about a group of very similar species. For "species-group names" in zoological nomenclature, see International Code of Zoological Nomenclature. For individuals of different species grouping together, see Mutualism (biology) § Service-service relationships.

"Cryptic species" redirects here. For the principles of hiding, see Crypsis. For a supposed creature whose existence is not scientifically recognized, see Cryptid.

2.0 Objectives

At the end of this unit, you will be enlightened on pest complex.

3.0 Main content

3.1 General Overview

In many cases particular crop may be attacked by various insects and pathogen species which after that form interacting position, which is known as pest complex.

This article is about a group of very similar species. For "species-group names" in zoological nomenclature, see International Code of Zoological Nomenclature. For individuals of different species grouping together, see Mutualism (biology) § Service-service relationships.

"Cryptic species" redirects here. For the principles of hiding, see Crypsis. For a supposed creature whose existence is not scientifically recognized, see Cryptid.
"Physiologic race" redirects here. For the mycology and phytopathology informal classification, see Race (biology) § Physiological race.

Plate 1: Image of a butterfly
The butterfly genus *Heliconius* contains some species extremely difficult to tell apart.
Source: Encyclopedia

In biology, a species complex is a group of closely related organisms that are very similar in appearance to the point that the boundaries between them are often unclear. Terms sometimes used synonymously but with more precise meanings are: cryptic species for two or more species hidden under one species name, sibling species for two cryptic species that are each other's closest relative, and species flock for a group of closely related species living in the same habitat. As informal taxonomic ranks, species group, species aggregate, and super-species are also in use.

Two or more taxa once considered conspecific (of the same species) may later be subdivided into infraspecific taxa (taxa within a species, such as bacterial strains or plant varieties), but this is not a species complex.

A species complex is in most cases a monophyletic group with a common ancestor, although there are exceptions. It may represent an early stage after speciation, but may also have been separated for a long time period without evolving morphological differences. Hybrid speciation can be a component in the evolution of a species complex.

Species complexes exist in all groups of organisms. They are identified by the rigorous study of differences between individual species, making use of minute morphological details, tests of reproductive isolation, or DNA-based methods such as molecular phylogenetics or DNA barcoding. The existence of extremely similar species may cause local and global species diversity to be underestimated. Recognizing similar but distinct species is important for disease and pest control, and in conservation biology, although drawing dividing lines between species can be inherently difficult.

A species complex is typically considered as a group of close, but distinct species. Obviously, the concept is closely tied to the definition of a species. Modern biology understands a species as "separately evolving meta populationlineage" but acknowledges that the criteria to delimit species may depend on the group studied. Thus, many species defined traditionally, based only on morphological similarity, have been found to comprise several distinct species when other criteria, such as genetic differentiation or reproductive isolation were applied.

A more restricted use applies the term to close species between which hybridization occurred or is occurring, leading to intermediate forms and blurred species boundaries. The informal classification, super species, can be exemplified by the grizzled skipper butterfly, a super species that is further divided into three subspecies.

Some authors apply the term also to a species with intraspecific variability, which might be a sign of ongoing or incipient speciation. Examples are ring species or species with subspecies, where it is often unclear if these should be considered separate species.

Several terms are used synonymously for a species complex, but some of them may also have slightly different or narrower meanings. In the nomenclature codes of zoology and bacteriology, no taxonomic ranks are defined at the level between subgenera and species,[13][14] while the botanical code defines four ranks below genera (section, subsections, series and subseries). Different informal taxonomic solutions have been used to indicate a species complex

Cryptic species

> Also called *physiologic race* (uncommon). This describes "distinct species that are erroneously classified (and hidden) under one species name" More generally, the term is often applied when species, even if known to be distinct, cannot be reliably distinguished based on their morphology. The usage *physiologic race* is not to be confused with *physiological race*.

Sibling species

> Also called *aphanic species*. This term, introduced by Ernst Mayr in 1942, was initially used with the same meaning as *cryptic species*,[7] but later authors emphasized the common phylogenetic origin. A recent article defines sibling species as "cryptic sister species", meaning "two species that are the closest relative of each other and have not been distinguished from one another taxonomically".

Species flock

Also called *species swarm*. This refers to "a monophyletic group of closely related species all living in the same ecosystem". Conversely, the term has also been applied very broadly to a group of closely related species than can be variable and widespread.

Superspecies

Sometimes used as an informal rank for a species complex around one "representative" species. Popularized by Bernhard Rensch and later Ernst Mayr, with the initial requirement that species forming a superspecies must have allopatric distributions. For the component species of a superspecies, *allospecies* was proposed.

Species aggregate

Used for a species complex, especially in plant taxa where polypoidy and apomixis are common. Historical synonyms are *species collectiva*, introduced by Adolf Engler, *conspecies*, and *grex*. Components of a species aggregate have been called *segregates* or *microspecies*. Used as abbreviation *agg.* after the binomial species name.

Sensu lato

A Latin phrase meaning "in the broad sense", it is often used after a binomial species name, often abbreviated as *s.l.*, to indicate a species complex represented by that species.

4.0 Conclusion

Several terms are used synonymously for a species complex, but some of them may also have slightly different or narrower meanings. In the nomenclature codes of zoology and bacteriology, no taxonomic ranks are defined at the level between subgenera and species, while the botanical code defines four ranks below genera (section, subsections, series and subseries).

5.0 Summary

A species complex is typically considered as a group of close, but distinct species Obviously, the concept is closely tied to the definition of a species. Modern biology understands a species as "separately evolving metapopulationlineage" but acknowledges that the criteria to delimit species may depend on the group studied.

6.0 Tutor-marked Assignment

1. List two informal taxonomic solutions to indicate species complex.

Solution

Cryptic species

Also called *physiologic race*(uncommon). This describes "distinct species that are erroneously classified (and hidden) under one species name". More generally, the term is often applied when species, even if known to be distinct, cannot be reliably distinguished based on their morphology. The usage *physiologic race* is not to be confused with *physiological race*.

Sibling species

Also called *aphanic species.* This term, introduced by Ernst Mayr in 1942, was initially used with the same meaning as *cryptic species*, but later authors emphasized the common phylogenetic origin. A recent article defines sibling species as "cryptic sister species", meaning "two species that are the closest relative of each other and have not been distinguished from one another taxonomically".

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UNIT 3 KINDS OF PESTS

CONTENT

1.0 Introduction

Any pest, which causes more loss to our crop, it is marked as major pest. (e.g) sugarcane black bug.

When damage caused by pest is slight, such pest is referred as a minor pest (e.g) sugarcane black bug.

Key pests are perennially persistent species that dominate control practices. The pest population usually remain themselves above economic injury level. (e.g) jassid, Mango hopper etc. in simple words key pest may also be defined as, an insect pest or disease normally present at some time during the growing season that causes economic damage to a crop.

2.0Objectives

At the end of this unit, you will get to know the major kinds of pests.

3.0 Main content

3.1 Kinds of Pests

1. **Major Pest:** Any pest, which casuses more loss to our crop, it is marked as major pest. (e.g) sugarcane black bug
2. **Minor pest:** When damage caused by pest is slight, such pest is referred as a minor pes (e.g) sugarcane black bug.
3. **Key Pest:** Key pests are perennially persistent species that dominate control practices. The pest population usually remain themselves above economic injury level. (e.g) jassid, Mango hopper etc. in simple words key pest may also be defined as, an insect pest or disease normally present at some time during the growing season that causes economic damage to a crop
4. **Occasional Pest:** it causes economic damage only in certan places or at certain times. Such pest have usually adequate biological or envinmental control. E.g hairy caterpillar
5. **Potential pest/ Secondary Pest:**it casuses no significant damage but due to injurious use of chemicals or cultural practices they case significant loss (e.g) miges
6. **Migrant pest:** Migrant pests are non resistant of agro-ecosystem that enter periodically for short period of time (e.g) desert locust and other four types of locust, army worms etc

What are the types of pest control?

There are two main types of pest control, which are defined below:

- *Natural control:* Natural control is collective action of environmental factors i.e., physical and biotic, that maintain number of pest population within certain upper and lower limits over a period of time.
- *Applied control/Artificial control:* Applied control includes a whole range of practices, developed or modified by men, that becomes necessary when natural control factors fail to control the pest. Applied control may be divided into following types:

  Cultural control: The cultural control is the reduction of insect population by the utilization of agricultural practices, to make environment unfavorable for pest, (e.g.) through ploughing, hoeing, irrigation, early or late sowing etc.

  Mechanical control: The control of pest by mechanical means involving operation of machinery, mechanical devices and manual effort. Mechanical control is mostly done against weeds, rats, locusts etc., in areas where labour is cheap.

  Biological control: The use of living organisms and viruses to bring down the pest population to sub-economic level. In other words,control of life through life, (e.g.) through, predators and parasitoides.
- **Genetic control:** In this propagation and release of sterile and genetically incompatible individuals is done in pest population, to check pest.
- **Chemical control:** In this toxic chemicals including pesticides, and sterilants, semi chemicals, growth regulators etc., are used to check pest population quickly.

- **Regularity** or **legislative method of control:** The control of pest **by** human controlling activities and laws. For this quarantine department is made.

- quarantine department?
- It is one of the divisions of department of plant protection government of Pakistan. Its function is to check the pests from entering into the area in which the host plants are growing, to reduce the chance of foreign pest attack.

- quarantine department?
- There are four main laws of quarantine, which are mentioned below:
- To prevent the introduction of new pest from abroad.
- To prevent the spread of established pest within country.
- Legislation to enforce the application of control measure against pest.
- Legislation to prevent the adulteration and adverse handling of insecticides.

- causal organism?
- It is an organism (i.e. fungi, bacteria, or virus) that produces a specific disease.

What is male sterile technique?

- It is the technique of genetic control of the pest, in which the reproductive capacity of the male is destroyed.

4.0 Conclusion

The use of living organisms and viruses to bring down the pest population to sub-economic level. In other words, control of life through life, (e.g.) through, predators and parasitoids.

5.0 Summary

There are basically two main types of pest control

- *Natural control:* Natural control is collective action of environmental factors i.e., physical and biotic, that maintain number of pest population within certain upper and lower limits over a period of time.
- *Applied control/Artificial control:* Applied control includes a whole range of practices, developed or modified by men, that becomes necessary when natural control factors fail to control the pest.

6.0 Tutor-marked Assignment

1. List the two main types of pest control.

Solution

- *Natural control:* Natural control is collective action of environmental factors i.e., physical and biotic, that maintain number of pest population within certain upper and lower limits over a period of time.
- *Applied control/Artificial control:* Applied control includes a whole range of practices, developed or modified by men, that becomes necessary when natural control factors fail to control the pest.

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