INTEGRATED PESTS' MANAGEMENT IN CROP PROTECTION: " IMPLEMENTATION AND BENEFITS "

Abstract

IPM places a premium on prevention, which is an important factor. Good sanitation practises, such as frequent cleaning and waste management, can help reduce conditions that attract pests in homes and businesses. Pests can be efficiently warded off by decreasing or removing sources of standing water and sealing off potential entry holes. Biological pest control is another essential part of integrated pest management. In order to control insect populations, it is sometimes necessary to release natural enemies into the scene. It has been shown effective in many agricultural and horticultural applications, for example, to release ladybirds to manage aphids or to use beneficial nematodes to combat soil-dwelling pests. Mechanical and physical controls are also encouraged by IPM. Methods such as traps, obstacles, and manual removal can be used to get rid of pests without resorting to poisons. Sticky traps to catch flying insects and mesh screens to keep them out of buildings are two examples of IPM methods. Agriculture, forestry, and urban pest management are just a few of the fields where this novel method is gaining traction and being adopted, making for a healthier and more sustainable future.

Keywords: Integrated pest management, economic threshold level, Bio-pesticides, Regulatory practices

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I. INTRODUCTION

It's possible that providing a pest-free environment is not feasible nor desirable. Instead, adopting IPM can have far-reaching effects in terms of protecting the environment, saving money, keeping people and animals well, and keeping important ecosystem components like birds, bees, butterflies, and predatory insects alive and well. IPM provides a holistic way for efficiently managing pest challenges in gardens by integrating information about pests and their life cycles with cultural practises, nonchemical treatments, and responsible pesticide use.

There are many different kinds of pests that might cause problems for a farmer or landscaper, such as insects, mites, weeds, plant diseases, animals, and birds. When dealing with pest damage in their crops, many people look for quick fixes. They have to work quickly to pull, hoe, or spray every weed they find. The importance of insects and weeds to the ecosystem, however, cannot be overlooked.

Plant succession refers to the natural process that occurs when we plant a field or establish a lawn, which ultimately results in the restoration of native and non-native plants. As the initial step in a chain of events that, if left alone, could lead to the formation of a forest, weeds that grow in a field play a crucial role in this process.

It's important to remember that many domesticated plants are weaker than their wild counterparts. Plants in cultivation need the farmer's regular or periodic attention and care in order to thrive. They have a hard time keeping up with the competition and need constant attention in order to survive in a manufactured setting.

Therefore, a healthy and long-lasting landscape or field requires a strategy that strikes a balance between pest control and protection of the ecosystem's natural processes. Integrated pest management practises, which prioritise reducing the use of toxic pesticides while increasing the prevalence of natural remedies, contribute to maintaining this delicate equilibrium. Maintaining a healthier and more resilient outdoor space is possible by allowing some insects and plants to cohabit and by eliminating pest populations in a responsible manner.

The term "pests" has deep roots in our understanding of how ecosystems function. Ecosystems, in and of themselves, do not classify any given species as a pest. Only humans, with their unique point of view, can label certain species as pests when they establish themselves in unwelcome environments. It is important to understand the regular patterns these invasive species follow if we are to control them. If you can accept this, you can develop more effective strategies for dealing with them.

II. BACKGROUND

Concerns about the adverse effects of chemical pesticides on the environment and human health are the seed from which Integrated Pest Management (IPM) grew. Pests developed resistance, ecosystems were disrupted, and food and water supplies were contaminated as a result of the widespread use of synthetic pesticides in the middle of the 20th century.

The emergence of IPM as a holistic approach to pest management that places emphasis on the integration of diverse tactics and strategies for prevention and control is one way that these problems have been addressed. In the 1950s, scientists and researchers formally introduced the idea after realising the need for a more long-term and eco-friendly method of pest control.

Integrated Pest Management (IPM) considers not only the pests themselves and their habits, but also the environment in which they thrive. Methods of cultural, biological, mechanical, and chemical pest control are all incorporated. Integrated Pest Management (IPM) seeks to reduce reliance on chemical pesticides through the implementation of more specific, effective, and cost-friendly management strategies.

IPM (Integrated Pest Management) has developed and been widely accepted as the gold standard for controlling pests. Guidelines and programmes encouraging the use of IPM principles have been created by governments, research institutions, and agricultural enterprises across the globe. The goal of integrated pest management (IPM) is to protect human health and the natural environment while yet keeping pest populations under control.

III. THE ORIGIN OF PEST CONTROL

The history of Pest Management reads like a narrative of human creativity and perseverance through trial and error. As we dive further into history, we find the first rumblings of our struggle against the tiniest enemies of nature.

The first documented usage of pesticides was discovered in ancient Sumerian culture around 2500 BC. They used sulphur compounds in ingenious ways to combat the swarms of pest insects and mites that plagued their food supplies and homes. Some 200 years before the birth of Christ, the Romans added their voice to the folklore of Pest Management by proposing oil sprays as a means of pest control.

The Chinese would write yet another chapter in this never-ending narrative as the world continued its relentless advance. The earliest accounts of biological controls were engraved into the scrolls of history around 300 ADS. They had such a deep appreciation for nature's intricate web of interdependence that they recruited predatory ants to protect their orange groves from caterpillars and beetles.

However, it wasn't until the late 19th and early 20th centuries that the epic's really pivotal moment occurred. A new era in Pest Management was heralded by the invention of the first commercial spraying equipment in 1880. Then, in 1930, synthetic organic chemicals were introduced to the market for use in combating plant infections, and this altered the landscape of pest control forever.

In the midst of this period of progress, the entomopathogen Milky Spore (Bacillus popillae) made its highly anticipated debut in the year 1940. Its use to defeat the difficult Japanese beetle has sparked renewed optimism in humanity's fight against tenacious pests.

Supervised Control was developed by enterprising California entomologists shortly after World War II, when synthetic insecticides were widely available. This new method offered an alternative to conventional pesticide programmes depending on the calendar. Supervised Control, with its foundation in a thorough knowledge of ecology and its arsenal of projected pest and natural-enemy populations, sought to find a middle ground between intervention and conservation of the natural order.

The seeds of "integrated control" were planted in the 1950s by entomologists at the University of California, Berkeley, in the fertile soil of these ground-breaking theories. The idea behind this was to find the best combination of chemical and biological controls to eliminate certain insect pests, much like a well-kept garden. Once upon a time, farmers and homeowners alike followed the adage "if a little works, a lot will work better" when it came to chemical use.

But that happy tune doesn't show up in every story of growth. In the middle of the twentieth century, a phenomenon known as the "Ecological Backlash" emerged, as the chemicals developed to combat pests ended up planting the seeds for new problems elsewhere. The use of pesticides has left a long shadow over agriculture because of issues like pest recurrence, pest replacement, and pesticide resistance. In a bizarre turn of events, researchers in 1959 found that limiting pesticide use could better control aphids because pesticides had accidentally wiped out aphid predators, resulting in a widespread pest rebound.

This is how the history of pest control unfolds: a rich tapestry of human ingenuity, scientific discovery, and unexpected consequences. The story continues to unfold, evoking wonder and humility in the face of nature's intricate network, from ancient civilizations using sulphur compounds to modern scholars battling with ecological balance.

In 1961, Geier and Clark introduced a groundbreaking idea in the field of pest management. This new strategy aimed to reduce pest problems by learning everything possible about the organisms responsible for them. With this information in hand, actions could be carefully chosen, and the ecological and economic consequences of those choices could be rigorously predicted, all with the ultimate goal of serving the best interests of humanity.

While the 1950s were a time of great advancement, they also saw a worrying trend emerge: the development of widespread insect resistance to once-miraculous pesticides like DDT. During the turbulent 1960s, this worrying tendency paved the way for a rising awareness of environmental issues. As people gained an increased appreciation for ecology, they were increasingly vocal in their opposition to the pesticide pollution that had long gone unnoticed.

The release of Rachel Carson's "Silent Spring" in 1962 was a watershed point in this awakening. Serious concerns regarding the shadowy side of pesticide use attracted widespread attention with each page. Concerned about the effects of pesticides on animals, human health, and the delicate balance of the environment, Carson and her contemporaries pushed for the adoption of more humane strategies for eradicating these pests.

Governments around the world took decisive action in response to the ferocity of popular pressure. Many nations have passed laws limiting the use of pesticides in response to accumulating evidence and passionate appeals for action. Because of growing environmental and health concerns, some pesticides, including DDT, were banned.

The term "Integrated Pest Management" (IPM) emerged in this climate of flux in 1967, thanks to the foresight of R.F. Both Smith and R. "van den Bosch" Integrated Pest Management (IPM) offered a multidisciplinary framework for controlling pest populations. In 1969, the United States National Academy of Sciences formally recognised IPM, solidifying it as an effective and promising method for eradicating pests.

In the decades that spanned the 1970s and 1980s, IPM became a popular method for controlling the insects and rodents that plagued urban trees and shrubs. Governments around the world have started adopting IPM as official policy after realising it has the ability to strike a balance between human advancement and ecological preservation. The declaration of IPM as an official Ministerial Policy in India in 1985 marked a watershed moment in the country's history of pest control.

Through the ebb and flow of history, pest control has been marked by bold new ideas, sombre epiphanies, and a deeper appreciation for the precarious balance that exists between humans and the rest of nature. As we move forward, we can look to the principles of Integrated Pest Management as a guiding light, leading us to a day when humans and other species can live in peace.

IV. DEFINITION

As an all-encompassing strategy, integrated pest management (IPM), also known as integrated pest control (IPC), combines chemical and non-chemical practises for cost-effective pest management. IPM works to reduce pest populations to below the point of economic harm. "the careful consideration of all available pest control techniques and subsequent integration of appropriate measures that discourage the development of pest populations and keep pesticides and other interventions at levels that are economically justified and reduce or minimise risks to human health and the environment," as defined by the UN's Food and Agriculture Organisation. IPM promotes the use of natural pest control methods and the cultivation of healthy crops with little interference to agricultural environments.

1. **Command and Management:** It was developed by a team of entomologists at the University of California, Riverside, headed by V. Stern in the late 1950s and was the first phrase ever coined to describe this idea. In order to preserve the ecosystem's natural enemies, "Integrated Control" emphasised the targeted application of chemicals.

2. **Controlling Pests:** Integrated Pest Management (IPM) is the modern iteration of the phrase "Pest Management," which first appeared in the 1960s. Nonetheless, many IPM principles have been used ever since humans began cultivating plants. The first impetus to explore for alternate methods of pest control came from dissatisfaction with a strictly pesticidal approach.

V. PRINCIPLES OF INTEGRATED PEST CONTROL

1. **Ecosystem Consideration:** The ecology plays a role in pest insect population control. Researching individuals their biology, behaviour, and reactions to other members of their species, to organisms of different taxa, and to biotic elements in the environment is crucial. This investigation of population shift is enabled through the study of individuals.

2. **Monitoring for Pests:** Integrated pest management relies heavily on pest surveillance and prediction. The term "surveillance" refers to the practise of keeping a close eye on anything, such as a crop or pest, in order to keep track of changes, compile relevant data, and make predictions about the future of the pest population. It consists of fundamental parts such as a. Finding out how common the pest species is.

    - The incidence rate is used to calculate the loss.
    - Estimation of monetary gains or other advantages gained through pest management. The foregoing details would be used to establish whether or not a pest control strategy is required. The presence of a few pest species should not be used as a justification for using pesticides. Information about the viability of a pest control programme can be gathered through surveillance.

3. **Making Use of ETL (Economic Threshold Levels):** When deciding to implement pest management, it is crucial to take the current population level into account. The occurrence of pest populations can be reduced if the population density of pests is kept under control. To prevent a pest population from growing to an economically damaging level, control measures must be established at a pest density known as the economic threshold.

4. **The Use of Least Restrictive Hazards:** Target pest populations should be below economic injury criteria before any chemical treatment is considered. This manner, not only will we save money, but we'll also be preventing the spread of insect populations. When it comes to applying insecticides, it's important to keep in mind

    - The insecticide's ability to kill the bug at its weakest and most helpless stage of development.
    - Using the least damaging insecticide possible on the crop.
    - Thirdly, controlling the spread of the insecticide to just the targeted region by how it's applied. Integrated Pest Management (IPM) is a set of guidelines for making decisions that will aid in the elimination of pest issues. The pest is managed in this way. This ought to be efficient, cheap, and ecologically sound. The fundamentals of an IPM plan consist of:
    - Ecosystem management and planning helps ensure that organisms do not become a nuisance.
    - Both harmful pests and helpful allies need to be named and accounted for. 3. Pest and beneficial organism populations, environmental conditions, and pest damage are all monitored.
    - Decisions About When to Treat Pests are Based on Injury and Action Thresholds.
    - Cultural, biological, physical, mechanical, and chemical treatments are all used. The objective is to eliminate pests while minimising damage to natural habitats.

- Plans for controlling pests are examined for their efficacy

VI. STRATEGIES OF IPM

1. **AIM of Selected IPM Strategies and Prescriptions:** Favour natural checks and balances. Keep people healthy, please. Reduce any unintended consequences for wildlife. Improve the world around you. Be the most likely to have lasting positive effects. cost-effective both now and in the future Be simple to use and effective in practise. Strategies Common to IPM .

2. **Do-Nothing if the Number:** of pests is below the Economic Threshold, it would not be cost-effective to eliminate them. At that point, you should do nothing but watch what happens before deciding on your next course of action to reduce the insect population.

3. **Reduce-Numbers:** Once the threshold for measurable economic harm is crossed, intervention must be based on that understanding. Methods include chemical treatments, the introduction of predatory insects, and traditional agricultural and sanitary measures.

4. **Lessen Vulnerability in Crops, Hosts, and Ecosystems:** The host plant's adaptation renders the host less vulnerable to the pathogen.

5. **Diversified Approaches Combining Different Methods can Help Maintain Control Over an Infestation.**

    - **The IPM Elements:** Locating potential pests -Step one is to pinpoint the pest in order to construct a defence. Pests, whether nematode, weed, or insect, must be identified before treatment can begin.
    - **Farmers May Wonder**
        - Which pests are here, and how advanced are they right now?
        - What does each stage of pest development mean for the crop?
        - Which factors cause a lower or higher pest population?
        - In what ways does the pest do harm?

VII. WATCHING AND MEASURING IN CONJUNCTION WITH LIMITS

The IPM component that allows us to determine the extent to which a pest poses a financial risk is crucial. Limits to damage -The number of pests existing prior to crop injury is used to calculate an estimate of the yield loss. The EIL is the Economic Injury Level. The minimum viable pest population at which economic damage can be incurred. Economists' Breakeven Point It's the population density at which action is needed to prevent economic damage from a growing pest population. IPM's main parts, listed in order of increasing complexity, are as follows:

1. **Norms of Society:** Cultural approaches of pest management involve adjusting standard farming practises to eliminate or reduce the pest population. The numerous cultural norms are outlined here.

2. **Preparing the Soil:** The factory will be more resistant to pests and conditions if the soil has been prepared to maximise root growth, water retention, nutrient availability, and stress avoidance. In order to maximise the benefit to the factory while minimising difficulties connected to disproportionate use of toxin, it is recommended to do a soil test and apply only the required quantum of toxin and lime. By creating a habitat for earthworms and microorganisms that keep the soil loose for roots and break down organic material to release nutrients, as well as by preventing soil water loss due to evaporation, organic mulch protects the factory in a number of ways. When installing mulch, whether it be organic materials like pine straw or wood chips, keep a safe distance from the box of the building, as this could provide entry for unwanted pests like voles and germs. As a top dressing, you shouldn't use ordure or compost that hasn't decomposed entirely because it can attract bugs. Research reveals that soil maintenance is harmful to soil structure; if you insist on managing the soil, do it in the autumn, when the life cycles of many pests bring them close to your face. Insects and other pests are vulnerable to the elements, human hostility, and other natural enemies when they enter through the front door. Insects in leftover crops can also be eliminated by autumn maintenance.

3. **Choice of Plants:** If you can, buy certified seeds and plants that haven't been exposed to any pests or diseases. Choose strong plants with deep, established roots. Pests and diseases that develop in greenhouses or plant beds might spread to the garden and wreak havoc on the growing plants. It's common to miss insects like whiteflies on nursery plants. If you want healthy plants, you need to acquire them from a recognised grower. If there's a danger of catching insects or diseases from a friend's plants, it's best to decline their offer. Before planting, give the plants a thorough inspection, checking the soil, the stems, the soil, and the tops of the leaves. You might try growing pest-resistant varieties.

   Cultivars are considered resistant if they either actively deter or discourage the presence of a particular pest, or if they can endure being fed upon by that pest with minimal loss of productivity or quality. It's possible that pests don't like the flavour of certain varieties. Some may have chemical or physical characteristics that prevent or reduce insect infestations. The opportunity exists to use genetic engineering to introduce genes into plants that make them less susceptible to insect infestations.

   Careful plant selection can help gardeners avoid some of the most frequent bug issues. As an illustration, instead of planting Japanese hollies, which are highly susceptible to southern red mites, you might plant native hollies like yaupon (Ilex vomitoria), winterberry (Ilex verticillata), or American holly (Ilex opaca) in your yard. Butternut squash is resistant to squash vine borer, making it a smart choice for a vegetable garden. Plants that are resistant to deer predation should be prioritised above those that are more appealing to the animals if deer are a problem in the garden. For this reason, an Eastern redbud (Cercis canadensis) is not as good a candidate as a native downy hawthorn (Crataegusmollis).

4. **Rotation:** When two consecutive years of the same crop are planted, pests tend to proliferate. Similar pests and diseases affect several related vegetable crops. Some insects overwinter as eggs in the host plant or in the soil or litter around it. Avoid planting annual rows of the same vegetable. Only every three or four years should similar crops be planted in the same area. Some tomato illnesses can be avoided by rotating crops every

five to seven years. One method of crop rotation is to alternate between growing different types of crops each year. Pests that only affect a small number of crops benefit most from crop rotation.

5. **Intercropping:** Spread the plants out around the garden rather than grouping them together. You may try putting together rows or patches with alternating sets of plants. It's likely that the surrounding mustard, broccoli, and collards are also infested by the same insects that attack cabbage, but the cabbage on the other side of the garden may be immune. The presence of unrelated plants in the region can impede the development of an insect attack by diluting the enticing odour of the favoured plants, which can prevent the insect from laying eggs or otherwise attacking the species. The spread of illnesses can be slowed by using interplanting, giving the gardener more time to come up with a strategy for dealing with the problem. Some people claim that marigolds and garlic can keep pests away, however there is little evidence to support these claims. There is some evidence to suggest that these plants are not reliable repellents in all situations.

6. **Time for Planting:** It's not uncommon for insects that normally spend the winter in the south to make the annual trek north. Plan your plants so that the majority of your crop matures after the peak bug activity has subsided. The pickleworm shouldn't get to early-maturing squash. Avoid having your squash crop destroyed by borers by starting your planting early in the season (before July). If sweet corn is planted early and harvested before 15 July, it may be possible to limit the occurrence of corn earworm. To prevent seed and root rots and to encourage rapid growth, warm-weather crops should be planted after the soil has warmed. Keep track of when you planted, where you bought your seeds, and how often pests appear.

7. **Controlling Weeds:** Pests and good bugs alike may take up residence in weeds and grasses. Getting rid of broadleaf weeds around fruit trees will help reduce spider mite populations. Weeds that are genetically near to the agricultural plants should be eradicated since they may serve as a breeding ground for harmful insects. Bugs that feed on a wide variety of plants, such as armyworms, crickets, cutworms, flea beetles, grasshoppers, lygus bugs, slugs, snails, stink bugs, and thrips, are frequently found in weedy areas and can spread to surrounding crops. Weedy areas should be mowed down and maintained with regular mowings before any planting occurs. Weeds should be cut down before planting a crop so that pests don't land on the good stuff. Beneficial insects, bees, and flies often rely on weeds for food. The monarch butterfly's larvae feed on milkweed (Asclepias spp.). Birds may use weeds as a source of food if they attract insects. The seeds of goldenrod (Solidago spp.) are a favourite food of finches and pine siskins, and the birds will also eat any insects that land on the plant. Honey bees rely on the nectar found in the blossoms of thistles, plantains, knotweed, and dandelions. Honey bees benefit from the removal of weeds after they have flowered but before they have set seed.

8. **Fallen Fruits:** Planting a crop that is particularly attractive to insects and then treating the trap crop with insecticide is another method of controlling insect pests. Soybeans, zinnias, and white roses are all effective trap crops for Japanese beetles. Harlequin bugs are drawn to radishes, turnips and mustard plants; radishes are drawn to corn and cabbage maggots; and sunflowers are drawn to Lygus plant bugs.

9. **Mechanic Procedures:** Handpicking check plants for eggs, larvae, and adults frequently. There are many useful insects. Hand-pick as many as possible if they are shown to be hazardous to the plant. Large, nonvenomous pests can be easily eliminated at any time. Instead of squashing them by hand, collect the insects and egg clusters in a coffee can or quart jar, add a little water and some dish soap, and shake vigorously.

10. **Traps:** Bug detectors and eradication trays are useful tools. But tread carefully, as many traps serve just a limited purpose or might attract the bugs you're trying to get rid of. While effective for monitoring insect populations, light traps offer little to no protection for the garden. This is especially true of black light or blue light traps, which emit ultraviolet light that is very appealing to nocturnal insects. Light traps are able to catch a large number of insects, but closer inspection reveals that they also draw in insects that are good for and bad for the environment. The attracted but uncaptured insects will continue to populate the region, potentially causing damage if they are harmful. Some wingless species are missed by these traps, as are diurnal (active during the day) rather than nocturnal (active during the night) species.

    Pests can be detected via pheromone traps, and their mating rituals can be disrupted if necessary. In order to entice males of their own species, adult females secrete a chemical odour. To attract prey, these Odours are "scented" into the traps. The lures may not be as successful if it is raining, cold, windy, or blowing in the wrong direction. Scented lures are susceptible to degradation from heat, sunshine, and poor storage. When pest numbers are low and new ones are scarce, control efforts tend to succeed.

    Some physical traps can be fashioned with minimal effort using common household items. Slugs can be easily trapped by burying a can of beer halfway. Slugs that spend the day hidden behind carefully propped boards must be found, removed, and disposed of everyday. Aphids can be lured to soapy water in yellow plastic dishpans. Boards painted yellow and gently coated with oil or grease attract whiteflies and cucumber beetles, which are then captured in the traps. Some online catalogues sell commercial sticky traps.

11. **Barriers:** Some pests can be kept out with the use of mechanical barriers, but if the pest population is too great, the barriers will be ineffective. Aphids can be deterred with aluminium foil or other reflecting mulches. Slugs can be deterred from plants by scattering crushed eggshells or hydrated lime about the soil. Copper tape serves as a strong slug barrier. Heavy mulch is helpful for controlling weeds, but it also provides a hiding place for slugs. Cutworms can be kept at bay with the help of collars made of cardboard, tin cans, or aluminium foil that are buried halfway into the ground. Seedling stems are protected from being eaten by cutworms with these. To keep tuber worm moths out of potato storage areas, screens should be installed around the perimeter. If you mound the dirt up around your grapevines, you can stop the grape root borer insects from ever hatching. Insects can't lay eggs on cheesecloth screens, but the light coming into cold frames and hot beds is diminished. Spun polyethylene floating row covers are a little more expensive, but they can be very efficient in keeping insects out of your crops. They are widely used by commercial farmers, especially for berry and cole crops. Some damaging crawling insects are stopped in their tracks by sticky barriers affixed to the trunks of trees and woody bushes.

Creating a thin film of kaolin clay, sometimes known as "China clay," over the leaves and fruit of plants can prevent damage from insects such the Colorado potato beetle, tarnished plant bug, leafhopper, mite, thrips, flea beetle, and Japanese beetle. Insects with skin irritated by this coating are less likely to feed. Spray bottle: 1 quart clay, 2 gallons water, 1 tablespoon liquid soap. To avoid clumping of the clay in the sprayer, constant agitation is required. Reapply every three weeks at the absolute least. This barrier is meant to be used before an insect problem becomes established, hence it will not function if one already exists.

Cages made of net material placed over tender seedlings protect them from predators like birds and rabbits. Wire collars wrapped around tree trunks could protect them against voles and other creatures that devour tree bark. When the fruit is ready, it can be protected from birds by draping netting over the plant. Cover ears of corn with paper bags to keep pests like birds and insects away. Wait till after pollination is finished before harvesting ears. While electric fences are effective in preventing herbivores like deer and raccoons from damaging crop yields, their installation can be time-consuming and costly.

12. **Chores of Cutting Back and Raking:** The azalea stem borer and the dogwood club gall are two pests that can be controlled by removing and discarding diseased branches from affected plants. Dogwoods should still bloom normally the next spring even if they have been cut of twigs affected with dogwood twig borers in the spring or early summer. The larvae penetrate into the stem, so removing infested twigs in late summer means cutting out more of the branch than necessary, and the plant won't have time to form new flower buds before the cold weather sets in. Fall raking of shade trees including pecans, oaks, elms and hickories helps get rid of twig girdler larvae. These long horned beetles hibernate as grubs or eggs in dead branches. The following year, new beetles will emerge in the autumn to begin their reproductive cycle. The fungus Exobasidiumcamelliae causes galls on camellia leaves, although this problem can be managed by removing affected leaves before the fungus reaches its reproductive stage.

13. **Watering and Spraying:** Insects, such as aphids, frequently congregate on the undersides of leaves. Many spider mites, aphids, and other delicate insects are dislodged and killed when a vigorous stream of water is sprayed upon plants that are afflicted. Spider mite numbers spike in dry conditions, making rain one of the best natural pest management options. Pest populations are kept in check by fungal infections that thrive in damp, foggy conditions. These pathogens target pests including chinch bugs, spider mites, and aphids. A well-watered garden is less likely to have pest problems.

Animals like squirrels, deer, and raccoons can be deterred with the use of motion-activated hose adapters that shoot a jet of water in the direction of the intruder. Targeting a specific area in need of protection, like a vegetable garden bed, maximises their effectiveness. Plants that are well-watered can better withstand attacks from pests. Weeds can be easily outcompeted by a healthy, well-watered lawn. When a tree isn't drought-stricken, it's better equipped to endure attacks from pests like voles and browse animals like deer.

14. **Heating Up:** To eliminate Colorado potato beetle larvae from potatoes without harming the plant, propane flamers can be used. Annual weeds can also be eliminated by fire. When working with fire in the garden, exercise extreme caution. When storing seed, certain hot water treatments can be employed to lessen the likelihood of illness.

15. **Disturbing Gadgets:** The ability to intimidate has a wide range of applications. Scaring devices include things like reflecting materials, noise makers, human or predator effigies, lights, lasers, fireworks, guard animals, and ultrasonic devices, but you need to know your pest and be vigilant to make sure it doesn't get used to any one way. The effectiveness of a scare device depends on whether or not the target pest can see or hear it. Starlings, who have keen eyesight, might be discouraged from roosting in a garden by regularly repositioning a scarecrow there. While illuminating the area at night and playing music can deter raccoons, it has much less of an impact on smaller rodents. Pest control services do not utilise scare tactics on insects since they do not respond to visual or auditory cues in the same way that birds and mammals do.

16. **Biological Methods:** The most crucial aspect of integrated pest management is the use of biological methods to eliminate pests and diseases. Biocontrol, in its broadest meaning, is the practise of employing beneficial organisms to combat harmful ones. That is to say, adding a novel bioagent into the habitat of pests or improving the effectiveness of those already present in the field in order to keep pest populations at a level below those causing economic loss.

17. **Parasitoids:** Parasites are organisms that lay eggs in or on their hosts and then use those hosts to complete their life cycles. If a parasitoid completes its life cycle in a different stage of host development, it will be a distinct kind of parasitoid. Parasitoids can range from eggs to adults, and from larvae to adults and from pupae to larvae. Trichogramma, Apanteles, Bracon, Chelonus, Brachemeria, Pseudogonotopus, etc. are only few of the many examples.

18. **Predators:** In other words, these are independent predatory organisms. Insects, birds, spiders, dragonflies, damselflies, ladybirds, Chrysopa species, etc., all fall within this category.

19. **Bio-Pesticides:** These microbes establish lethal circumstances in their hosts and ultimately cause the death of those hosts. Fungi, contagious organisms, and bacteria are all major categories of pathogens. Even in pests that aren't very important, some nematodes can cause problems. Fungi such as Hirsutella, Beauveria, Nomurae, and Metarhizium are notable examples since they have been documented to invade and kill a high number of insects (up to 90) in agricultural settings. The most prominent examples of infectious diseases include granulosis and nuclear polyhedrosis virus (NPV). There have been multiple reports of epidemics caused by armyworms, cut worms, splint flyers, hairy caterpillars, and factory hoppers. Two types of bacteria, Bacillus thuringiensis (B.t.) and Bacillus cereus (B.c.Popillae are an extremely typical example. Laboratory scale production of pest conditions in the form of liquid or powdered phrasings that can be spread like standard chemical fungicides is feasible and inexpensive. Bio-pesticides are another name for these expressions. In this method, a new species of bio-agent is introduced into an area where it can successfully establish itself as a predator on its host.

This action is taken only after exhaustive testing in the lab and in the field has confirmed its effectiveness. By releasing either lab-reared or field-collected bio-agents of the same species in an amount sufficient to suppress the pest population, this method increases the population of natural opponents once present in the area.

20. **Conservation:** In terms of suppressing pest populations, this is the single most crucial aspect of biological control. This procedure prevents the extinction of species by protecting them against their natural adversaries. Below are the many procedures that must be followed to safeguard the natural enemies: Parasitized egg masses can be collected and stored in bamboo cage-cum bird perches to promote the development of parasitoids while simultaneously preventing the hatching of pest larvae.

    - Informing farmers on the difference between pests and defenders so that they can avoid spraying defenders during field days.
    - Chemical spraying should be used only as a last resort, and only after the pest-defender ratio has been carefully considered.
    - Avoid using insecticides with a wide spectrum of activity.
    - When pest control is absolutely necessary, only highly selective and low-impact (REF) chemicals should be employed.
    - Strip or spot applications of pesticides should be used whenever possible.
    - Sowing and harvesting schedules might be shifted to prevent pests during their most active months.
    - Cultivating a trap crop as a buffer zone around the main fields prior to sowing the crop to attract and kill pests.
    - Root dipping and seeding are recommended for areas prone to gall midges.
    - The conservation of protectors is aided by crop rotation and intercropping as well.
    - Only apply pesticides at the safest, most effective levels recommended by the manufacturer.

21. **Methods that Use Chemicals:** When all other measures have failed to control pest populations below the economic loss, the only choice left is to use chemical pesticides. The intricacy of pest problems means that pesticides will continue to play a vital role in crop protection even if there has been significant progress in pest control research. As a result, pesticides should only be used when absolutely necessary, with caution, and after thorough monitoring of the insect population to cut down on both waste and secondary issues. Before attempting chemical control, we must have a thorough understanding of the following factors: what to spray, when to spray, where to spray, and how to spray.

22. **Maintain a Healthy Ratio of Pest Fighters to Pests:** The use of neem-based and biopesticides, two relatively safe pesticide options, is encouraged. If pests are only present in narrow bands, spraying the entire field is unnecessary. Because of the distinctive nature of human consumption of vegetables and fruits, IPM practises are especially pertinent to these types of crops. Only pesticides registered with the Crop Improvement and Biocontrol Research Council (CIB&RC) should be used on the crops that have been recommended. If a pesticide has a waiting period before it may be used again, farmers should wait until that period has passed before applying another pesticide

and harvesting the crop. When working with field crops, we need to exercise greater care and caution when employing pest management methods.

23. **Compliance with Regulations:** Government regulatory rules are being drafted as part of this process. rules are established under which seeds and infected plant materials cannot be imported into the country or transported from one region to another. These procedures are also known as quarantine and can be either domestic or international.

VIII. APPROACHES IN IPM WHEN COMPARED TO NORMAL METHOD

Parameter	Normal method	IPM
Goal	Reduce losses due to pest	Reduce costs of production, ecological and social approach
Diversity	Low to medium	High
Ecosystem Stability	Uncertain	Striving towards stability
Spatial Sale	Single farm	Entire region
Time scale	Immediate	Long term/Single season
Target	Single pest or closely related groups of pests	Several pests around crops and natural enemies
Basis for control	Past experience or Presence of pest	ETL
Principal method	Cultural, mechanical, pesticides	All components
Effect on environmental quality	Highly detrimental	Moderately detrimental/Negligible

1. **Essential Requirements for IPM**
   - Proper Identification of insect pest (s).
   - Life history and behavior of the pest.
   - Natural regulating factors.
   - Need for control measures.
   - Timing of control measures.
   - Selection of suitable control measures.
   - Farmer's participation.
   - Government support.

2. **Advantages of IPM Compared to Pesticide - Based Plant Protection Programme**
   - Sustainability
   - Economics
   - Health
   - Environment quality
   - Social and political stability
   - Local knowledge
   - Export of Agricultural Commodities

IX. IPM FOR SOME IMPORTANT CROPS:

1. IPM Of Rice

Inescts	ETL
Thrips	25 in 5 wet palm passes
Stem borer	10% dead heart 2% white ear
Gall midge	10% silver shoot
Whorl maggot	25% damaged leaves
Leaf folder	10% leaf damaged at vegetative stage 5% leaf damaged at boot leaf stage
GLH	5 per hill at vegetative stage 10 per hill at flowering stage 2 per hill at tungro endemic area
BPH	1 per tiller 2 per tiller when spider is present at 1 per hill
Ear head bug	5 bugs per 100 panicles at flowering stage 16 bugs per 100 panicle at milky stage

- Avoiding use of excess nitrogen which induces BPH and leaf folder.
- Alternate wetting and drying for BPH.
- Passing the rope on the crop and draining of water for case worm.
- Using light trap to monitor BPH, GHL and stem borer.
- Providing rouge spacing at every two-meter interval to take up the plant protection operation.
- Avoiding resurgence causing insecticide like synthetic pyrethroids, methyl parathion, fenthion and quinaphos for BPH.
- Avoiding shade for leaf folder.
- Use of Neem blended urea (1:5) which helps in the slow release of nutrients.
- Use of egg parasitoid *Trichogramma* japonicum for stem borer.
- Use of egg parasitoid *T.chilonis* and bacterial agent Bacillus thuringiensis for leaf folder.
- Use of NSKE 5% orNeem oil for Ear head bug.
- Use of resistant varieties .eg. PY3 , CO42, for BPH.

2. IPM for Sugarcane

- Trash mulching along the ridges to modify the moisture content of soil which checks the buildup of early shoot borer (ESB).
- Detrashing on 105" day for Internode borer, Mealy bugs and Scales.
- Detrashing on 150th and 210th day for leaf hopper. Avoiding excess nitrogen for leaf hopper.
- Draining excess water for scales and mealy bugs.
- Use of predators like Coccinellid beetles for scales and mealy bugs.

- Use of egg parasitoid *Trichogramma* spp. for early shoot borer and Inter node borer. Use of Granulosis virus and egg parasitoid *Sturmiopsis inferens* for Inter node borer.
- Use of egg parasitoid *Isotima javensis* for top borer.
- Use of ecto parasite Epipyrops melanoleuca for leaf hopper.

X. CONCLUSIONS AND OUTLOOK

In conclusion, Integrated Pest Management (IPM) is a long-term method for controlling pests that is gentler on the environment and healthier for people. As technology develops, emphasis is placed on ecological principles, resistance is managed, and stakeholders work together more, integrated pest control has a bright future. IPM can handle the issues caused by pests while assuring long-term sustainability since it incorporates innovative tools and methodologies, promotes biodiversity, and implements interdisciplinary approaches. We can achieve efficient pest management and leave a cleaner world for future generations if we fund research, educate the public, and use IPM practises.

XI. VIEW FROM THE FUTURE

To control pests and lessen their negative effects on crops, landscaping, and buildings, a multi-pronged strategy known as integrated pest management (IPM) is employed. This strategy reduces the usage of harmful chemical pesticides in favour of more humane and long-lasting methods of pest control. Insect pest management (IPM) shows considerable potential for mitigating pest problems and protecting future human and environmental health.

The development of new technologies is an important part of the outlook for IPM in the future. IPM has the potential to become even more precise and efficient with the rapid development of innovative tools and processes. Drone and satellite imagery, for instance, can help track pest populations over time and identify problem areas for treatment. The use of chemical pesticides can be minimised thanks to developments in genomics that make it easier to identify pest-resistant crop varieties.

IPM strategies that incorporate ecological concepts are also growing in popularity. In order to control pests successfully, it is necessary to have a thorough understanding of the relationships between these organisms. Integrative pest management (IPM) utilises natural predators, parasitoids, and diseases to keep pest populations in check by embracing ecological concepts and fostering biodiversity. This method not only enhances long-term sustainability but also decreases the need for pharmaceutical interventions.

The future of IPM will also include a strong emphasis on resistance management. Amazingly, pests can evolve resistance to pesticides over time, rendering them useless. Integrated Pest Management (IPM) is a strategy for dealing with this problem that emphasises using several types of pesticides and switching between them to keep resistant pest populations from developing. As our knowledge of resistance mechanisms grows and as new pest management technologies are developed, IPM will become increasingly useful in preventing and managing resistance.

In addition, the outlook for IPM in the future includes more people working together and sharing information. It takes a collaborative effort between farmers, researchers, extension agents, and policymakers to create and administer effective IPM programmes. In order to accomplish this, we may need to create cross-disciplinary research programmes, organise farmer-led IPM networks, and encourage open communication through means like online discussion boards and in-person conferences.

Reducing the use of chemical pesticides and encouraging more environmentally friendly methods are two primary objectives of integrated pest management (IPM). Concerns about pesticides' effects on the environment and human health have been growing, and IPM provides a remedy. IPM safeguards ecosystems by minimising chemical inputs and minimising pesticide residues through the integration of cultural, biological, and mechanical constraints.

With the development of new technologies, a heightened focus on ecological principles, resistance management, and increased collaboration, the outlook for Integrated Pest Management is bright. IPM offers a comprehensive and long-term solution to pest problems in agriculture, landscaping, and buildings. We can protect future generations' ability to live in a pest-free world by maintaining our current level of investment in IPM-related research, education, and practise.

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