Symbiotic Solutions: Pest Management in Harmony with Nature

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OPEN ACCESS

Keywords

Ecological Pest Management, Biodiversity Conservation, Sustainable agriculture, Agroecosystems resilience.

How to cite this article:

Swetha, N. and Rathinaguru, E. 2024. Symbiotic Solutions: Pest Management in Harmony with Nature. *Vigyan Varta* 5(6): 86-90.

ABSTRACT

Agricultural problems can be solved sustainably with ecological pest management, which reduces environmental effects by controlling pest populations through natural processes. This strategy encourages agroecosystem resilience by utilizing biodiversity and ecosystem services, such as habitat modification and biological control agents. At its foundation are Integrated Pest Management (IPM) techniques, which prioritize ecological balance maintenance through focused action, observation, and prevention. It reduces the need for synthetic pesticides by using techniques like crop rotation, companion planting, and pheromone use, protecting biodiversity and human health. To balance ecosystem health and agricultural output and promote long-term food production sustainability, ecological pest control is a paradigm change.

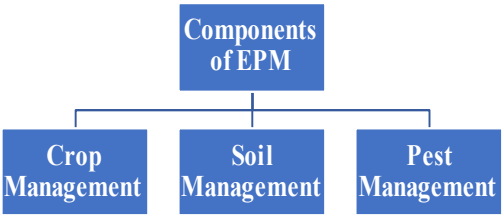
INTRODUCTION

Developing sustainable and environmentally sound pest management techniques is more important than ever in a world where human activity is progressively endangering the delicate balance of ecosystems. This is the

domain of ecological pest management, where stewardship and science coexist together in a natural dance. In this scenario, pests are controlled holistically by understanding natural cycles and the complex web of life, rather than by using harsh chemicals that damage ecosystems. Not only is eradication the aim here, but also the cultivation of balance, whereby pest populations are managed by promoting natural predators, augmenting biodiversity, and honoring the complex relationships that support the health of our world. We'll go through a world where sustainability isn't just a catchphrase but a guiding concept for preserving our ecosystem for future generations, from integrated pest management techniques to the newest advancements in biocontrol.

From threat to thrive: The mission of Ecological Pest Management:

- The overall goal of EPM is to achieve ecological sustainability while maximizing the economic gains of agriculture.
- In order to preserve the ecological balance of the farming or agricultural systems, a conscious effort is required.
- The goal is achieved broadly on the principle of ensuring the generation and transfer of knowledge to the farmers on their respective ecological systems and promoting the application of such knowledge.



Principles of EPM:

I. Managing Aboveground Habitats:

a) **Diversify plants within agroecosystems**: It is done by planting polycultures of annual crops — two or more crops simultaneously growing nearby can attract natural enemies and improve biological pest control.

II. Enhancing Beneficial:

- Beneficial organisms include predators and parasitoids and these are found far more frequently on diverse farms where fewer pesticides are used. Farms with abundant populations of beneficial species typically exhibit the following traits. *(Matthew B Thomas, 1999)*

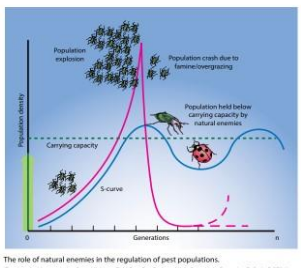
a) Fields are small and surrounded by **natural vegetation.**

b) Cropping systems are **diverse** and plant populations in or around fields include perennials and flowering plants.

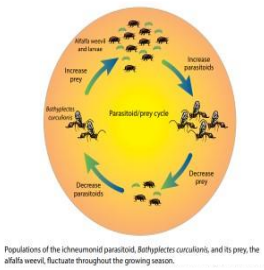
c) Crops are managed organically or with **minimal agrochemicals.**

d) Soils with **high in organic matter** and biological activity and

e) During the off-season — soil is covered with **mulch** or vegetation.



The role of natural enemies in the regulation of pest populations.



Populations of the ichneumonid parasitoid, *Bathyplectes curculionis*, and its prey, the alfalfa weevil, fluctuate throughout the growing season.

(ATTRA Pest Management Fact Sheets, Bulletin E2704)

III. Increasing the population of Natural Enemies: *(Miguel A. Altieri et.al, 2014)*

a) Provide supplementary resources: Providing resources to draw or retain natural enemies on a farm might increase their populations.

I. For instance, in North Carolina, red wasps (Polistes annularis) began to prey more heavily on tobacco hornworms and cotton leafworms when artificial nesting structures were built for them.

II. In California alfalfa and cotton plots, providing mixtures of hydrolyzate, sugar, and water increased egg-laying by green lacewings six-fold and boosted populations of predatory syrphid flies, lady beetles, and soft-winged flower beetles.

b) Manage vegetation in field margins: Field margins can become natural enemy reservoirs with good planning. These environments may be crucial places for crop pest predators to overwinter. They can also supply pollen, nectar, and other resources to their natural enemies.

Beneficial arthropods do in fact migrate from field margins into crops, as numerous studies have demonstrated, and crop rows next to wild vegetation typically experience higher levels of biological control than field centers.

I. In Germany, parasitism of the rape pollen beetle is about 50 percent greater at the edges of fields than in the middle.

II. In Michigan, European corn borers at the outskirts of fields are more prone to parasitism by the ichneumonid wasp *Eriborus terebrans.*

c) Perimeter trap cropping: Handle the plants that border fields to control certain pests. When plants like snap beans or cowpeas are grown to draw stink bugs and Mexican bean beetles away from soybeans, a technique known as perimeter trap cropping performs well. In perimeter trapping, a cash crop is totally surrounded—without a gap—by plants that are particularly alluring to target pests.

d) **Reduce Mowing Frequency to Increase Benefits:** Research financed by SARE has shown that mowing once a month, as opposed to twice or three times a month, in Washington state pear orchards, generates attractive environments for beneficial insects.

e) **Create corridors for natural enemies:**Plant a variety of flowering plants in strips every 165 to 330 feet (50–100 m) across the field to create highways of habitat for natural enemies. These hallways allow beneficiaries to move about and disperse into field centers.

f) Beetle Banks Boost Beneficial: Beetles may benefit from certain grass species. They may, for instance, offer predaceous ground beetles with overwintering habitats that regulate temperature. In the middle of cereal fields, researchers in England created "beetle banks" by planting orchard grass ridges. Two ground beetles, *Tachyporus hypnorum and Demetrias atricapillus*, which are significant predators of cereal aphids, saw a notable increase in population due to these banks.

A corridor of Alyssum acts as a highway of habitat drawing beneficial insects into this large field of lettuce.

ATTRA Pest Management Fact Sheets, Bulletin E2704)

g) Select the most appropriate plants: Because helpful insects are drawn to particular plants, flowering plants that will draw the proper beneficial bug or insects should be picked when trying to control a particular pest. Which insects can access the pollen and nectar of the flowers depends on the size and form of the blossoms. The most useful blooms are small and relatively open, as they attract most beneficial insects, especially parasitic wasps. Particularly helpful plants are those in the aster, carrot, and buckwheat families.

h) **Use weeds to attract beneficial:** Sometimes weeds make the best flowering plants to draw beneficial insects, but managing weeds this way becomes more difficult. While some weeds hold plant illnesses, provide food for insect pests, or impede the growth of cash crops, others serve as vital resources for numerous beneficial insects and enhance the biodiversity of agroecosystems.

i) **Crop Diversity increases Parasitoid Diversity:** Plant variety and parasitoid diversity are directly correlated; distinct pests are supported by various crops, ground coverings, weeds, and nearby vegetation, which in turn draws distinct parasitoid communities. Vegetative simplicity suppresses parasitoid diversity in large-scale monocultures. *Cotesia medicaginis*, the braconid wasp, is an important regulator of the alfalfa caterpillar in California's alfalfa fields. This immaculate system of butterflies and wasps seems to have migrated from native clovers to irrigated alfalfa in the California region of the United States of America.

IV. Enhance plant defences against pests:

A healthy plant is your best line of defense against insect infestations. In response, robust plants can activate inbred defense systems to repel insect pests, making them more resilient to their attacks. By enhancing soil quality and creating ideal growing conditions, such as enough (but not excessive) water and nutrients, one can strengthen natural defenses. For instance, a cotton plant releases a particular chemical signal blend into the air when a beet armyworm nibbles on it. This signal is detected by female parasite wasps, who utilize it to find the armyworm. *(Reagan M. Waskom,1995).*

V. No-till Cover Crops Yield Soil and Pest Benefits:

Mark Vickers, a fourth-generation cotton and peanut farmer, chose to experiment with cover crops and no-till farming on his property due to the steep 7 percent slopes. His extremely erodible soils were held in place by his conservation-tillage method.

Many of Vickers' pest issues were resolved by his new farming techniques and routine manuring with chicken litter. This demonstrates how a no-tillage technique can lessen pest infestation and soil disturbance in an ecologically friendly manner.

Difficulties faced in EPM:

a) A number of extremely potent pests still lack a known "biological controller." Producers frequently resort to using insecticides when these pests appear.

b) EPM is not easy to implement and requires substantial knowledge and monitoring for the combined components of the system to produce success.

c) Perhaps the biggest drawback to the EPM approach is that biological control is not a ‘quick fix’.

d) No single biological controller works in every situation. A controller that works well in one soil type, for example, may not work at all in another soil type.

CONCLUSION

With consideration for the fragile balance of our ecosystems, ecological pest management provides a sustainable solution. We not only preserve our crops but also promote biodiversity and maintain the condition of our world by utilizing the power of nature's own processes. To ensure a prosperous future for everybody, let's adopt this comprehensive approach to agriculture.

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