Ecological Engineering for Sustainable Agriculture: Simple Concept with Greater Impact

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Abstract- National Institute of Plant Health Management maintains Organic Ecological Engineering field since 5 years for the purpose of research, training and popularization of the concept. It is key content in NIPHM curriculum for students, officials and farmers. Ecological engineering concept is beneficial to the farmers and environment in many directions and some of the findings like increase in natural enemy population and beneficial insects like pollinators in EE field over the years are presented.

Index Terms- Ecological Engineering, organic farming, sustainable agriculture, pollinators, parasitoids

I. Introduction

The term, "ecological engineering," was first coined by the late Dr. Howard T. Odum in 1962. He wrote "those cases where the energy supplied by man is small relative to the natural sources but sufficient to produce large effects in the resulting patterns and processes." Ecological engineering has recently emerged as a paradigm for considering pest management approaches that are based on cultural practices and informed by ecological knowledge rather than on high technology approaches such as synthetic pesticides and genetically engineered crops. Use of cultural techniques to effect habitat manipulation and enhance biological control is the philosophy of ecological engineering (Gurr et al. 2004 a).

Habitat manipulation aims to provide the natural enemies of pests with resources such as pollen (Hickman and Wratten 1996), nectar (Baggen and Gurr 1998), alternative prey (Abou-Awad 1998), physical refugia (Halaji et al. 2000), alternative hosts, lekking sites (Sutherland et al. 2001) and (Viggiani 2003). A wide range of approaches are being developed by researchers and employed by practitioners to ensure that appropriate forms of diversity are deployed for pest management via ecological engineering (Gurr et al. 2004 a, b and c).

Agriculture is influenced by an array of biotic and abiotic stresses; a strategic science based approach is needed to address the plant health problems and issues that affect productivity. The integrity and conservation of agro-ecosystem is vital for sustainable agriculture. Intensive use of ecosystems to enhance productivity can affect agro-ecosystems through soil erosion, water depletion/contamination, biodiversity loss, challenging pest problems and disruption in flow of ecosystem services, which will have a bearing on plant health and safe food production. (http://niphm.gov.in)

The aim of ecological engineering in agriculture ecosystem is to integrate soil and pest management strategies with regular practices of farmers for the benefit of environment and farming community. It involves knowledge of agriculture, ecology and farm economics, for restoration and construction of healthy and sustainable agriculture ecosystems. The field is increasing in breadth and depth as more and more components of crop management strategies are coming up and giving solutions to the pressing problems of indiscriminate use of chemical pesticides, excess use of fertilizers, environmental pollution due to agricultural chemicals, chemicals entering in to the food chain, and inducing pest resistance and resurgence problems.

Ecological engineering is the restoration of ecosystems that have been substantially disturbed by human activities; with incorporation of biofertilizers, particularly mycorrhiza which plays an important role in improving soil health and uptake of important macro and micronutrients by the crops (http://niphm.gov.in). Biofertilizers reduce the reliance on chemical fertilizers and supply plant nutrients at optimum levels which in turn supress development of pests. An excess of available nitrogen can increase the susceptibility of some crop plants to outbreaks of aphids, mites, white flies and hoppers. Over fertilized plants may give visual clues to insects. Nutrient stress from insufficient plant nutrients can also cause plants to be more attractive to insect-pests. Careful planning and execution of soil fertility programs (including pH) is an important component of insect pest management.

Biological control through parasitoids, predators and microbial biopesticides constitutes a significant component in holistic management of insect pests and diseases as well as abiotic stresses like drought. The application of ecological engineering for pest management includes use of cultural practices, usually based on vegetation management, to enhance biological control. Pest problems have increased tremendously due to monoculture, overlapping of crops, dense cropping, and availability of preferred host. Alternative to chemical method is biological control and in ecological engineering concept, growing flowering plants is key component to provide resources such as nectar and pollen to natural enemies to promote biological control. It includes attractant plants to attract the natural enemies, repellent plants to repel the pests, trap plants to attract and trap the crop pests, barrier/guard plants to prevent the entry of pests. It also includes trap crops that divert pests away from crops and changing monocultures to polycultures in agroecosystem.

To enhance the knowledge on Plant Health Management, National Institute of Plant Health Management is creating a pool of master trainers by training them on various aspects of plant health management strategies. The Key concept of ecological engineering (EE) is to promote environmentally sustainable plant health management practices to reduce excessive reliance on

chemicals. NIPHM is maintaining ecologically engineered fields of rice and other field crops and vegetable crops in the institute without using chemical insecticides for the past four years and getting good yields. Growing of flowering crops at NIPHM fields has resulted in multiplication of large number of beneficial insects like parasitoids and predators which are controlling the crop pests very effectively. Field studies conducted with different flowering plants at NIPHM suggested that growing of sesame, bhendi, sunflower and sunhemp attracts large number of predators and parasitoids like coccinellids, ground beetles, *Anagrus* species, *Bracon* species etc., which attack the pests.

Ecological Engineering field attracts different kinds of pollinators like honey bee species *Apis mellifera, Apis cerana indica, Apis dorsata, Apis florea, Tetragonulair iridipennis* etc., carpenter bees like *Xylocopa violacea*, *Xylocopa fenestrata* and other solitary bee pollinators like *Amegilla cingulate, Pseudapis oxybeloides*, *Nomada luteoloides, Nomia* sp., *Halictus sp*., *Megachile spp*. , etc., . The pollinators help in natural cross pollination and increases yield.

For the successful implementation of this technology motivating the farmers to follow these eco-friendly approaches on community basis and avoiding use of insecticides during the first 40 days age of the crop growth for building up of the beneficial insects for effective management of the pests is required. A collective approach by the farming community will not only suppress the pest population but also enhances the soil micro flora and enrich the soil with organic matter.

Photos: Ecological Engineering Field at NIPHM, Beneficial Insects on sunflower (2016-17)

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