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Pest Management in Organic Agriculture

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What is organic agriculture?

In last few decades due to careless use of pesticides without adhering to the safety norms and recommended practices, agrochemicals posed a serious health risks to humans, other living organisms, and the environment. Therefore, in recent decades, there has been a tremendous demand of safe and quality food which is free from pesticides residue. Due to these all there has been unpredicted shift in the agriculture, from agrochemical to organic agriculture.

According to Codex committee on food labeling- "Organic agriculture is a holistic production management system which promotes and enhances agro-ecosystem health including biodiversity, biological cycles and soil biological activity. It emphasizes the use of management practices in preference to the use off-farm inputs, taking into account that regional conditions require locally adopted systems. This is accomplished by using, where possible, agronomic, biological and mechanical methods, as opposed to using synthetic materials, to full fill any specific function within the system."

Global perspective

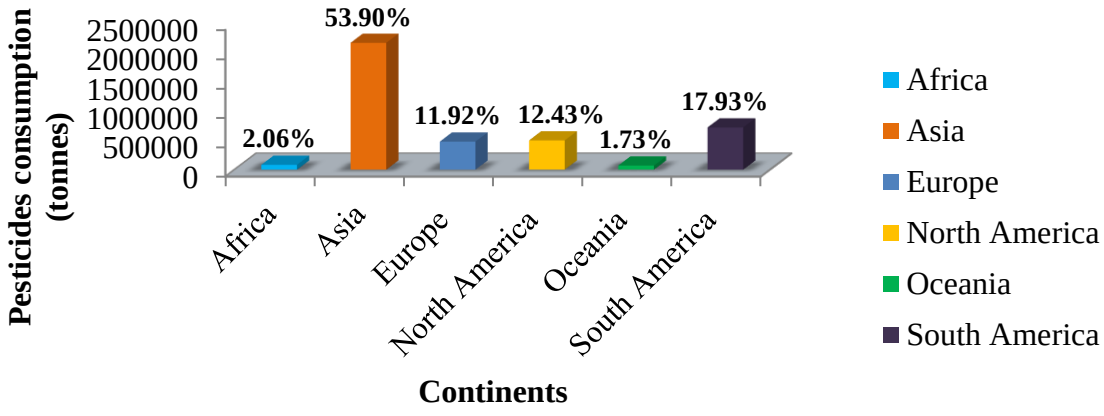

Figure 1: Consumption of different pesticides in different continents during 2018.

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After the development of agrochemicals like pesticides, fertilizer etc maximum practcies of farm remain based on them. From seed sowing to crop harvesting they have exposed to several pesticides. It could be herbicides, fungicides or insecticides that ultimately added the large amount of residue to main crop fields and crops.If we look at the world data of 2018 by FAO, the global consumption of total pesticides has reached around 4.01 Mt per year. In which Asia shares the highest i.e. 53.90 %, followed by South America (17.93%) and North America (12.43 %) of total pesticide consumption respectively. The last in the list is Oceania. It share 1.73 % of total pesticide consumption. Just opposite of it, in organic farming highest global shares is of Oceania i.e. 50% of total organic farm land in all over the world while in Asia, it only holds around 8% of it.

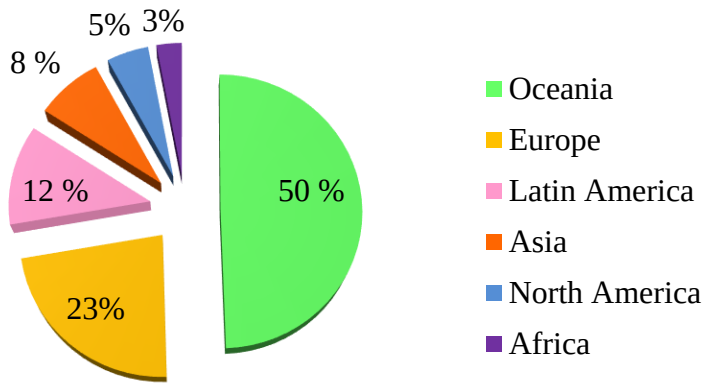

Figure 2: Global share of organic farm land during 2019.

In Indian context, there is only 4.3 m ha land certified under organic production (apeda.gov.in/organic_Products.htm). It is just a 2.75 % of total agriculture land in India. Out of 28 states and 8 UTs, Sikkim has achieved a remarkable distinction in converting entire cultivable land to under organic cultivation. The above facts are well enough to indicate the situation of agricultural practices all around the globe. If we compare the ratio of agrochemicals in the environment of Asian countries with Oceania countries, they would definitely found the higher amount of residue in Asian countries which is not safe for all living creature either directly or indirectly.

Keeping such threat under consideration, now a day's farmers initiated to do organic agriculture in some portion of their lands. It can be understand from the fact that agrochemical industries which are undergoing major changes in their compounds and

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switching over to biopesticides. This shift not only preparing a base for Integrated Pest Management (IPM) programs but also improving the sustainability of crop ecosystems.

Risk of Pest in Agriculture

Pest management in crop fields always remains among the top most hurdles of agriculture practices. According to FAO, annually there is around 20-40 % loss caused by pest in crop production. If we measure it in organic agriculture then it becomes many times more challenging then what generally we are using in our traditional agriculture for pest management. To manage the pest in organic agriculture, they need to go through some basic principle like Preventive measure, analysis of pest population, monitoring and risk assessment etc. These principles aims, to adopt ecologically sound practices that designed to prevent damaging levels after determining the pest status by regular supervision and minimize the need for curative solutions. For organic agriculture, IPM could also be an alternative. It provides the framework for pest control in organic systems, because it also emphasizes preventive tactics like enhancement of natural enemies, cultural, biotechnical methods, and plant resistance.

Steps of pest management in organic agriculture

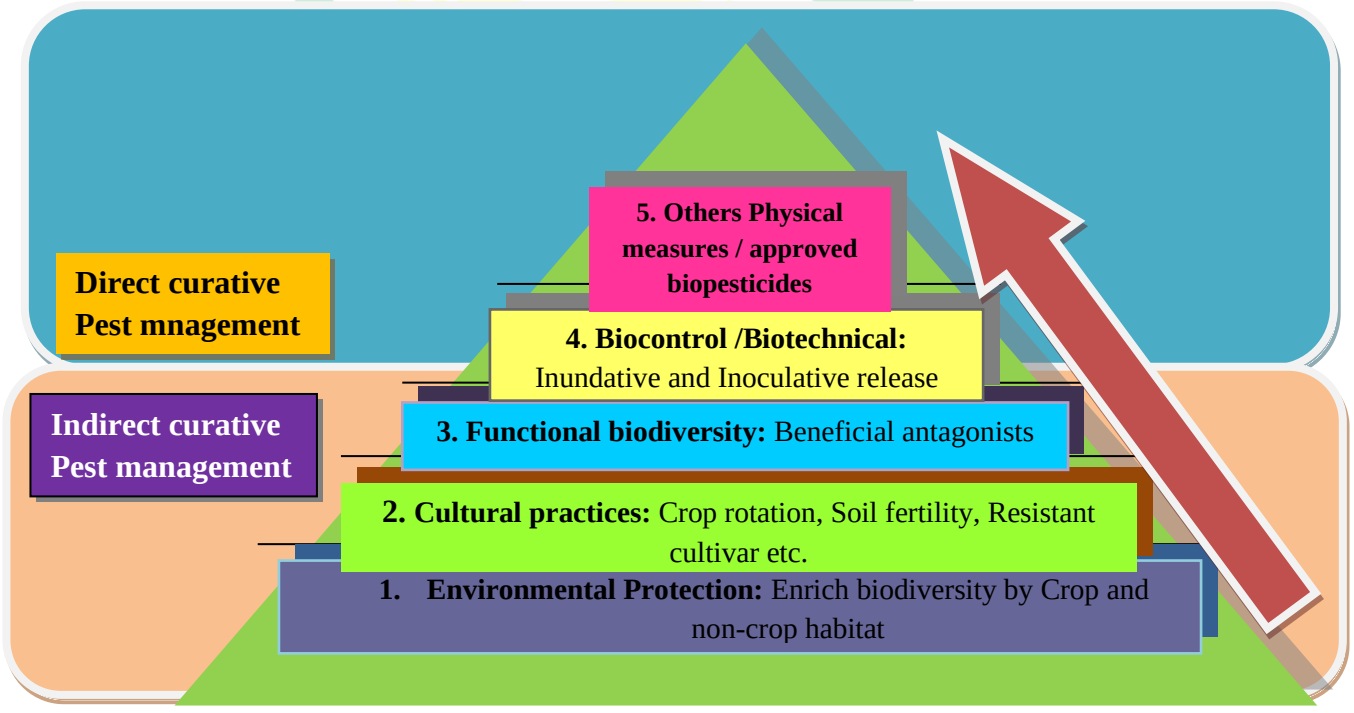

Figure 3: Central diagram of pest management in organic agriculture (Wyss et al., 2005; Zehnder et al., 2007)

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The pest management in organic agriculture relies on a two methods i.e. “Indirect, or preventive crop protection” methods and second“direct, or curative crop protection” methods. Second one could apply in case if earlier approach gets failed. Indirect crop protection is the combination of all those measures that contribute to the dynamic equilibrium of the farm ecosystem or agro ecosystem. They generally avoid colonization of pests and pathogens and regulate the abundance of pests and pathogens at low levels through biological processes. It includes Environmental Protection, Cultural practices and functional biodiversity. Direct crop protection strategy combines the different options in farm management and cropping design to limit pest populations below damaging levels and minimize the need for direct intervention. It includes Biological / Biotechnical and Biopesticides control. Let them discuss one by one

a. Indirect crop protection

i. Environmental protection:

Habitat management through farm site selection, crop isolation, and interlinking between natural and semi-natural ecosystems, offers environmental protection to the crops. Selection of farm site depends on many factors like climate, topography, soil type, crop history, and economic considerations. Site selection also decides the distribution of pest and diseases in that area. Site selection helps to generate the pre-requisite data for successful cultivation. In some cases, it has found that by selecting a site could helps to avoid the infestation of primary pest. It also helps to develop an ideal condition for the crop and natural enemies of the pest. Similarly crop isolation/rotation strategies are most effective against for those pests that do not disperse over great distances and/or that overwinter in or near host crop fields. The isolation of susceptible crops from surrounding host crops can be an effective management strategy for some vector-borne virus diseases. Interlinking of Non-crop habitats with cropping habitat are known to play an essential role for reproduction and survival of natural enemies.

ii. Cultural practices:

Cultural practice are the activities of all crop production and management techniques that utilize by farmers to maximize their crop productivity by manipulating practices for avoiding pest damage. These practices are always remains focused on eliminating or reducing the amount of the pest or pathogen present in the field. Side by side they also enhances the

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beneficial' activity in agriculture field to reduce pest and disease incidence. Cultural practices include the several strategies, like crop rotation, selection of cultivars, Inter cropping, cover cropping, mulching, soil solarization etc. Sometimes flooding, deep plowing, fire and flaming, may also be used.

Each of these methods has their advantages for example Crop rotation; it improves the quality of crops, soil fertility, and crop protection. Rotations are considered to as good for controlling host-specific pests and diseases such as potato cyst nematode. Likewise, Intercropping, it contributes to crop protection by breaking pest and disease cycles and creating barriers to the spread of pests and diseases. It also enhances arthropod biodiversity, namely natural enemies, by providing alternative food, shelter, and reproduction sites. Similarly selection of resistant and tolerant crop varieties which are adapted to local environmental conditions also very necessary in pest control strategies. Selected variety should be very well in aspect of temperature, nutrient supply, pests, and disease pressure to grow healthier and stronger against pests and diseases as well as encourage population of natural enemies indirectly by releasing some volatile form their different parts.Another practice that helps in controlling pests and diseases is soil Solarization. It has proved to be an effective method in the control of plant diseases caused by soil fungi *Fusarium oxyporum*, *Sclerotinia* spp., *Rhyzoctonia solani* and arthropods that live in the soil.

iii. Functional biodiversity

It is third step in indirect crop protection which aims to improve beneficial organism populations by managing vegetational diversity by growing like hedgerows, flower strips and sometimes repellent or trap plants to divert the pest from the crop. Functional biodiversity basically works on multiplication of beneficial species relative to pest species by adding resources that favors only beneficial. The beauty of the functional biodiversity approach is that it starts a feedback i.e. increased beneficial populations ultimately decrease the pest population, which allows minimum pesticide application, and in return it benefits natural enemies. Some cultural practice are also work in response to functional diversity like intercropping and trap cropping or even conservation biological control. They are the just event that functions in a cluster of element for ecosystem services driven within cluster diversity. Basically agro-ecosystem should to comprise in such a way that it surrounds all i.e. semi-natural or natural habitats, human settlement and infrastructure.

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Functional biodiversity always promote species richness of non-carnivore carabids and hunting spiders. In general, reduction in field size by enlarging the edge area considered to be as good for functional biodiversity under organic and conventional farming. Functional groups that are not yet enhanced by organic farming need further improved management practices and strategies. Enriched non-production areas with diverse natural or semi-natural habitats are crucial for functioning pollination service and pest control.

b. Direct crop protection

i. Biocontrol/Biotechnical control

It is the second last step in organic pest management. When cultural practices and functional biodiversity were found unable to manage the pest population then we switch over to biocontrol agents. But before using of biological control it requires a lot of background information about the biology and ecology of both pests and their associated natural enemies. However biological control of organic farm based on inoculation and inundation release.

Mass rearing should be released at times when the pest is most susceptible and natural enemies are not yet present, or they can be released in such large numbers that few individuals go untouched by their enemies. Another biocontrol method is augmentation. It relies upon continual human management and does not provide a permanent solution, unlike the classical or conservation approaches. At present there is no harmful effects have reported from natural enemies, but for successful adoption it is necessary to demonstrate that natural enemies are effective at controlling pests with no environmental effects. At now scientist has reported so many predator and parasitoids related with pest. In them few are very common for example praying mantis, dragonflies, few beetles, lace wings, flies, bugs etc. but few are very specific and are belongs to order Hymenoptera.

Biotechnical approach is little different which utilizes insects physiological mechanisms or environmental behaviour to affect organism survival. Intentionally or not, insects communicate between themselves either intra specifically or inter specifically, to reproduce (to look for a mate, courtship), locate resources, defend territory, camouflage or mimic other organisms, identify members of the same species, or even to warn other organisms of their own presence or to signal potential hazards. Communication by smell and taste occurs based on the production and emission of semiochemicals. Monitoring, mass trapping and mating disruption are also involved in this.

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ii. Biopesticides

It is last step in organic agriculture pest management. When above methods got fail to suppress the pest population in the field then we utilize it to overcome pest population from crop fields. Based on their active ingredients, biopesticides may be microbial or biochemical. Microbial pesticides consist of a microorganism such as a bacterium, fungus, virus, or protozoan. After formulated their active ingredient (a.i.) into some carrier agent, they applied as conventional pesticides. Microbial pesticides can control different kinds of pests, although each a.i. is relatively specific for its target pest. In contrast, biochemical pesticides are naturally occurring substances that control pests by non toxic mechanisms. Biochemical pesticides include substances like plant extracts (repellents, natural plant and insect regulators, and secondary metabolites). The major advantage of these biopesticides are that the chance of pest or disease resistance are very less and do not have any negative impact on the environment and public health.

Conclusion

As recent shift of traditional agrochemical pest management to organic pest management, employs an attraction to modern farmers towards organic system. Their simple implementations on field level make it as an ideal for its adoption in farmer field. The main principles on which these strategies works are preventive measure, analysis (pest population), monitoring and risk assessment. From field selection to final harvesting of crop, there are so many ecologically sound practices that designed to prevent damaging levels and minimizing the need for curative solutions. In organic farms, famers should first use preventive mechanisms i.e. Indirect crop protection methods and if necessary then use suppressive measures direct, or curative, crop protection methods. Crop diversification, rotation and the implementation of ecological infrastructures like are some of those indirect measures, which might contribute to reducing pest and disease incidences in farms. Direct pest and disease control relay on biological/biotechnical and biopesticides. Some natural pesticides (biopesticides) are approved in organic farming systems, but should only be used if no other solution exists and avoided as much as possible. Also the direct measures should only be used if the pest or disease density has reached a level at where the chances of economic losses are more.

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