



## Pesticide applications in Agriculture and its Environmental and Human Health Impacts

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### ABSTRACT

The use of chemicals in modern agriculture has significantly increased productivity is very common now a days. There has been an increase in the concentration of pesticides in food and in our environment, with associated negative effects on human health and the environment. The excessive use of pesticides has generated increasing concerns on the negative effects of human health as well as the environment. Impact on the environment of Pesticides can pose serious distress on soil, water, territory, and other vegetation. The pesticides application directly kill the insects, pest, weeds and pathogens but it also indirectly can be harmful and toxic on to the host of the other organism which are birds, beneficial insects, and all other non-target plant and animals. Insecticides are usually the most extremely toxic class of pesticides; however, herbicides can also pose risks to non-target organisms. With this concern most of the pesticides and chemicals are non-biodegradable, and as a result of bioaccumulation, they can enter into the food chain and eventually distress human and animal health, on the whole environment and ecosystem.

**Key words:** Pesticides; Acute and Chronic effects; Environmental hazards

### 1) INTRODUCTION

The word pesticide encloses a broad array of compounds together with insecticides, fungicides, herbicides, rodenticides, molluscicides, nematocides, plant growth regulators and variety of other supplementary chemicals used in agriculture practices [1]. Among these, organochlorine (OC) insecticides, apply successfully in preventing a number of diseases, for instance of malaria and typhus, were forbidden or banned after the 1960s in the majority of the industrially advanced countries. The commencement of the other synthetic insecticides organophosphate (OP) insecticides in the 1960s, carbamates in 1970s and pyrethroids in 1980s and the prologue of herbicides and fungicides in the 1970s–1980s donated significantly to pest control and agricultural productivity. In an ideal world a pesticide must be fatal to the targeted pests, excluding to non-target species, together with human beings. Unfortunately, this is not the condition, so the use and misuse of pesticides had made a controversy in worldwide and it remains the same in the present scenario. The widespread use of these chemicals, under the aphorism, “if little is good, a lot more will be better” has played major devastation with human beings and another living creature [2].

Pesticides are used to destroy the pests and insects which are harmful for crops and damage them. The applications of pesticides have many benefits and positive impacts to

the crops and its productivity but on the other hand they also pose serious harm and negative impacts on food chains, food webs and over all ecosystem and environment. The excessive and uncontrolled use of pesticides can be dangerous to biodiversity, various aquatic biota including fishes, avian including many birds and terrestrial animals may reach at the verge of extinction and have a serious threat on there survival. Pesticides application is a matter of concern for sustainability, existence and worldwide stability. There are several means to protect human health and environmental hazards associated with pesticides in agriculture, including, development and use of safe and environment friendly pesticide formulations, application of alternative pest control strategies in an IPM approach such as host plant resistance and bio-control [2, 3].

### 2) BENEFITS OF PESTICIDES

Pesticides are very important and demanding it's have many primary and secondary benefits which directly impact on humankind and there development. Some of the benefits include that they will help marginal farmers to produce more profit from the less land resource, save them from major losses which faced by them due to pest and diseases and give them better productivity. The

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secondary benefits includes that it can transform developing countries to large scale food produces, it can save the time of hand weeding, it can also prevent the stored stocks from the rodents, mites, bugs molds and other pests. They may be subtle, less intuitively apparent, or of longer period of time. It follows to facilitate for secondary advantages it is consequently more complicated to establish cause and effect, but on the other hand they can be prevailing validations for pesticide application. For example, the advanced cabbage yield may fetch supplementary income that could be put towards children's education or medical concern, leading to healthier, improved educated inhabitants. There are a range of secondary benefits identified, ranging from healthier people to sustainable biodiversity.

### **3) DISADVANTAGES OF PESTICIDES APPLICATION**

#### **Air pollution by pesticide**

Pesticides can increase by volatilize and may be blown by wind speeds into in close proximity and areas. Subsequent factors influence to the diffusion of pesticide in the air, along with the weather conditions at the time of application, temperature and relative humidity [4]. Ground spraying generates a reduced amount of spread than aerial spraying.

#### **Water pollution by pesticide**

There are four major paths through which pesticides get into the water. First is to contaminate water when they are spraying. Ex. Rice cultivation - it may infiltrate, or percolate, through the soil. Secondly, it may be carried to the water as runoff carried to water by eroding soil. After contaminate the water it makes countless problems. Application of herbicides to bodies of water can cause fish kills, reduce the quality of drinking water, and reduce the amount of water available for cultivation and also changing by and large physical characteristics of water bodies. Insecticides are characteristically more lethal to aquatic life in comparison to herbicides and fungicides [5]. Pesticide residues in air and water are a foremost distress as they are the foundation of the serious threat to biological communities. Pesticides gain entry into the water all the way through accidental spillage, industrial effluent, surface run off and transportation and also from pesticide treated soils, wash down of spray equipment's following spray operation, float into water points, aerial spray to control water-inhibiting pests etc. Pesticides get into air through spray drift, volatilization from the indulgenced surfaces, and aerial application of pesticides [6].

#### **Ground water contamination**

Groundwater pollution owing to pesticides is a universal problem. According to the United States Geological Survey (USGS), as a minimum 143 different pesticides and 21 transformation products have been found in ground water, including pesticides from every major chemical class. During a study and survey in India, the collection of water samples was done from the different hand pumps and wells and it was estimated that 58 % samples in Bhopal were contaminated with Organo Chlorine pesticides and the results were beyond the EPA limits [7]. When the

ground water is polluted with toxic chemicals, it might take years around for the contamination to fritter away or else be uncontaminated.

#### **Pesticides and soil environment**

The accumulation of pesticides in the soil also resulted due to the application of pesticides in agriculture and in other areas. Unsystematic use of pesticides further deteriorates the physical and chemical properties of soil and stressed soils to the much greater extent. The fate of pesticides in soil is determined by soil properties such as degradation, transportation, and adsorption and desorption. Effects of pesticides in soil include alterations of soil microbial diversity and biomass, affects soil vital biochemical reactions, influence mineralization of soil organic matter along with affecting and Disturbing local metabolism and also alter soil enzymatic activity.

#### **Pesticide effect on plants**

Root nodule formation in plants benefits the world financial system \$10 billion in synthetic nitrogen fertilizer once a year. Particularly pentachlorophenol hampers with legume rhizobium chemical [8]. Attenuation of these symbiotic chemical can resulted in decreased nitrogen fixation. Pesticides can exterminate bees and also reduce the pollinators. In US farmers lose approximately \$200 million around a year from reduced crop pollination because of pesticides application to the fields [9].

#### **Pesticide effect on animals**

Pesticides application can result in reduction of some animals' necessary food resources. The Residues of these chemicals can have property to travel up to the food chains. An earthworm plays a major role in digesting organic matter and increase nutrient content in the top layer of soil. Pesticides have detrimental effects on development and reproduction of earthworm's population. The extended limits of the pesticides can pose serious impact on the human survival and dive birth to many defects and diseases in animals as well as in humans. At a larger extent exposed species or persons can be associated with cancer, endocrine disturbance, reproductive defects, neurological disorders and toxicity, kidney and liver diseases, birth deficiencies, developmental changes and genetic alterations [10].

#### **Effect on Birds**

The US approximates that 72 million birds are killed by pesticides in the United States each year. DDT-stimulated egg shell contraction has particularly influenced European and North American bird populations. Some types of fungicides to some extent toxic to birds and mammals, but may kill earthworms, which can in turn decrease populations of the birds. The paraquat, when sprayed on bird eggs, causes growth irregularities in embryos and reduces the number of chicks that hatch successfully [11]. The study was conducted between January 2011 and March 2017 in Ahmedabad and Coimbatore on 550 Indian peafowl *Pavo cristatus* comes in Scedule I undr Indian Wild Life Protection Act 1972) accumulalation of pesticides residues named hexachlorocyclohexane (HCH), dichlorodiphenyl-trichloroethane (DDT), endosulfan, heptachlor, dicofol, dieldrin and cholipyrifos were confimed in the

organs and tissues of the bird. It was also mentioned that Peafowl from Ahmedabad was accumulated significantly ( $p < 0.05$ ) higher doses of total pesticide (149.0 ng/g) in comparison to birds from Coimbatore (47.8 ng/g). Presence of chlorinated pesticides is a serious issue of consideration for the survival of peafowl along with other avian fauna [12]

### **Bio magnification**

If any individual constantly consume contaminated rations it will accumulate in the body. All organism are component of food chain consequently, toxins stored in the fats & oils pass one trophic level to next trophic level. With the higher trophic levels of the food chain more concentration of the pesticide is found known as biomagnifications [13]. As a result it becomes a danger exposed to mankind since they are also present at the top of the food chains. Bio magnification is the cumulative increase in the quantity of the pesticides due to its persistent and non-biodegradable nature among the organs at each successive level of food chain. So it resumes the fact that organisms at the top levels of food chain experience greater impairment as contrasted to those at lower levels. For example, out of 36 species collected from three lakes of northeastern Louisiana (USA) that was found to contain residues of 13 organ chlorines [14].

### **Impact on Non-target Organisms**

A study was conducted on Colonial Nesting Birds and their breeding grounds in Vedanthangal and Koonthankulam Bird Sanctuaries of Tamil Nadu. The presence of organochlorine pesticide (OCP) residues in the tissues of 76 birds belonging to 14 species was found dead in the month of March 2008 and March 2010. Among all the residues found the concentration of HCH was maximum. The range of pesticides residues was varying widely among the species and accumulation pattern was in the order HCH>endosulfan>DDT>heptachlorepoxyde>dieldrin. Pesticides, namely p,p-DDE and  $\beta$ -HCH. DDT and its metabolites along with HCH and isomers, dieldrin, and heptachlor epoxyde were found below the threshold limit. The reason was considered as there were no proper earthen dykes due to this runoff from agriculture lands enters during monsoon in the sanctuaries. The long term exposure in lower limits can also be dangerous for birds survival and their breeding grounds [15]. Rest of all amount of these chemicals apply for the purpose end up in the environment and travel along with food chain consequently harm each and every component of the environment including our natural resources and all the non-target organism together with human beings.

### **Effect on target organism**

In the recent past there has been an increase in pesticide application targeting a broad spectrum of pests. This has lead to the pest adapting or moving to new environments. This is attributed to gene mutation, increase in no. of generations, change in population growth rate. This in turn has lead to pest resurgence & resistance to pesticides [16].

### **Resistance development**

Resistance might be defined as a heritable alteration in the sensitivity of a pest population that is reflected in the

replicated disintegration of a produce to attain the expected level of control while used according to the recommended doze for that pest species [17]. The resistant population will continue to multiply until they become the dominant proportion of a population. When the permanent resistance in any organism the application of pesticides could not have effective results or higher dozes can be necessary to apply to develop any effect.

The number of resistant species between organisms is on the increase in insects and mites it positioned at 600 in 1990 and get higher to 700 in the year 2001 [18]. When pesticides are used at longer period of time several pest develop resistance to the pesticide. As a result of resistance developed in the pest, they are very difficult to control. For this reason famers have to increase the concentration or change the pesticide by this way it resulted in more & more detrimental effects on environment and accumulation of higher concentrations continues on each passing day.

### **Resurgence**

Resurgence is termed as the rapid re-emergence of a pest population in deleterious numbers by subsequent pesticide application [19]. Persistent & wide range pesticides exterminate even beneficial & natural enemies account for the resurgence of pest. Other factor leading to resurgence will also include enhance in feeding and reproductive rates of insect pests [20].

### **Superbugs**

Weeds and plant-disease organisms also grow to be resistant 520 insect in addition to mite species, 273 weed species, 150 plant diseases, as well as 10 rodent species (mostly rats) have increased genetic resistance to pesticides not less than 17 insect pest species become resistant to all major classes of insecticides [21, 22].

### **Formation of New Pests**

Alteration of minor pest into major pests is the major damage because of pesticides applications. The natural predators, parasites, & competitors of a pest may also be killed by a pesticide it permits the pest population to rebound for instance to control insect pests on lemon trees caused an outbreak of a scale insect (a sucking insect that attacks plants) that had not been a problem [23, 24].

## **4) HEALTH EFFECTS OF PESTICIDES**

Acute effects due to the exposure of the pesticides application may be abdominal pain, dizziness, headaches, nausea, vomiting, with skin and eye problems as the Pyrethrins, insecticides frequently used to kill common bug, can cause a potentially deadly circumstances if inhaled during the application [25]. Many studies have examined the development of the cancerous cases in the exposed population. The epidemiological studies also reflect that the reason of almost more than 2 % of the cancer is the widespread use of pesticides [26,27]. Associations of pesticides exposure have been found with leukemia, lymphoma, brain, kidney, breast, prostate, pancreas, liver, lung, and skin cancers [28]. A mother's industrial exposure to pesticides at some point in pregnancy is correlated with an increase in her child's

threat of leukemia, Wilms' tumor, and brain cancer [29]. Neurological the risk of developing Parkinson's disease is 70% larger in those exposed to even lower intensity of pesticides. Inhabitants with Parkinson's were 61% more expected to report direct cases of pesticide application. Reproductive effects due to pesticides have also strong evidence which links pesticide exposure to birth defects, fetal death and altered fetal growth [30]. It was also found that young once that were at any cases exposed to pesticides had a stumpy birth weight and had imperfect growth and development. A number of pesticides including di-bromo-chlorophane and 2, 4-D has been related with impaired fertility in males [31].

### **Residues of Pesticides**

Residues of pesticides are also found in human blood like Organochloro insecticides in the samples of blood serum in rural areas among all the pesticides HCH (Hexachlorocyclohexane) and DDT (Dichloro Diphenyl Trichloroethane) were chief contaminants as a residue [32]. Residues in human milk have laid probable risk to infants the residues of Hexa-chloro-benzen a fungicide is found in human milk and fat. Residues are also found in the food supplies and average daily ingestion as concentration of pesticides varies to a great extent, the concentration of DDT and HCH are found in ground nut and sesame oils in Tamil Nadu [33]. Residues in environmental samples for example residues in aerosols in Ahmedabad vary from 2.06-18.96ng/m<sup>3</sup> of BHC and DDT and HCH found 47.4-256.9mg/L in drinking water samples [34].

### **Ecological effects of pesticides**

The extreme ecological impact due to pesticides is loss of species diversity between the food chains and food webs, effects on pollinators, effects on nutrient cycling in ecosystem [35, 36, 37, 38], effects on soil erosion, structure and fertility, effects on water quality, impacts on human beings, effects on birds along with this Food Contamination and harmful impact on aquatic life [39, 40, 41]. Over and above these chemical formulations can disrupt the natural equilibrium among the pest and predators and also result bounce back of some pest population. The outbreak of the secondary pest and pest resistance are some of the major drawbacks of the pesticides application. Moreover, all these collective disruptions in ecological system pesticides are known to be very harmful for overall ecosystem and ecological components including soil, air and water.

## **5) PESTICIDE TRAGEDIES**

### **1. Kasargodu Endosulfon tragedy**

Aerial spraying of Endosulfan ever since 1976 in cashew cultivated areas spread over 4500 hectares three times in a year approximately 15 villages within Kasaragod district. The cashew plantation in the area belongs to the state owned Public Sector Company named Plantation Corporation of Kerala (PCK). Aerial spray of Endosulfan using helicopters was commended by Government bodies to reduce the cost of manual labour. But it has been banned by the Supreme Court of India w.e.f. 13-05-2011 for production, use & sale, all over India due to its

devastating impact on ecosystem and on human health [42].

### **2. Bhopal Gas Tragedy**

Bhopal's pesticide plant was constructed in 1969 to manufacture Sevin, a pesticide used all the way through Asia to kill beetles, weevils and worms. The plant was managed by Union Carbide India, Limited. The leak began on December 2, 1984, while water entered a tank that was inured to store methyl isocyanate, a toxic gas and a key constituent in seven. The water responded with the gas, causing excessive pressure and heat that perhaps caused the tank to burst out. The tank discharged 40 tons of poisonous gas into the ambient air. The toxic cloud was mainly of methyl isocyanate, a hazardous compound that can irritate the throat and eyes, cause chest pain and shortness of breath, and, in higher doses trigger convulsions, lung failure and cardiac arrest [43, 44].

### **3. Bihar Food Poisoning**

17 July 2014, a new outburst of pesticide comes as food poisoning happened in Bihar, India. According to reports, 23 children died and more than 48 people undergo medical treatment. The poisoning occurred from the eating of a free lunch of rice, soybeans and lentils cooked in the oil contaminated with monocrotophos, an organophosphate pesticide. The oil was stored in a pesticide container and sold to the schools [45].

## **6) CONCLUSION**

Pesticides have now turn out to be a necessary part of agricultural production; on the other hand, numerous pesticides are not simply degradable they remain in soil, percolate to groundwater and surface water and pollute the wider environment [46]. Some of the adverse effects associated with pesticide application have materialized in the form of increase in resistant pest population; decline on beneficial organisms for example predators, pollinators and earthworms, alter in soil environment, and contamination of aquatic systems. Depending on their chemical properties, pesticides can cross the threshold to enter among the organism; bio accumulates in food chains and as a result influences human health. Some of acute and chronic poisoning, with effects of varying severity on human health diseases have now emerged as a consequence of intake of polluted water, air, or food. This is the time that necessitates the proper use of pesticides to protect our environment and eventually health hazards associated with it [47]. To reduce the intensive use of pesticides, it is an urgent need to promote the organic farming practices and search for the effective bio pesticides or biological agents to manage agricultural pests with the aim of moderate the use of chemical pesticides [48].

The undesirable impacts of pesticides on non target organisms, particularly natural enemies of insects and their pollinators, have received the most attention in this regard because of their value in integrated pest management (IPM) and pollination processes, respectively [49]. The destruction of natural enemies can trigger pest problems as they play an important role in regulating pest population levels. The extinction of predator's population

can also result in secondary pest outbreaks, which were not originally very damaging pests due to loss of their predators or parasites. Along with natural enemies, populations of soil and aquatic arthropods are also considerably disturbed because of indiscriminate pesticide use in agriculture. Pesticides degenerate soil invertebrates including nematodes, micro-arthropods, earthworms, and other small organisms that play an important role in soil ecosystems [50, 51, 52, 53]. In short we can conclude at excessive and uncontrolled use of any substance or chemical can lead to destructive effect in long run and it is also true for pesticides. So it is better to use in sustainable, controlled and wise manner to overcome all the side effects and imbalance.

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