

# Pesticides and Their Impact on Biodiversity and the Environment

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**Abstract:** Pesticides are biological toxins utilized by humans to eliminate pests, thereby enhancing crop yields and controlling insect vectors that spread diseases. However, the application of pesticides has resulted in significant environmental and health risks to various organisms, including humans. Overuse of these chemicals can lead to a decline in biodiversity, putting many bird species, aquatic life, and other animals at risk due to the detrimental effects of harmful pesticides. This article aims to explore the negative consequences of pesticides on biodiversity and the environment.

**Keyword:** Pesticides, Biodiversity, Environment

## I. INTRODUCTION

Pesticides are biological agents intentionally introduced into the environment to eliminate, prevent, deter, control, destroy, repel, or reduce populations of insects, weeds, rodents, fungi, and other harmful pests in agricultural, domestic, and industrial contexts. In agriculture, the application of pesticides has become a standard practice aimed at enhancing crop yields by managing pests and insect vectors that facilitate the spread of pest-related diseases [1]. The primary categories of commonly utilized pesticides include insecticides, fungicides, fumigants, and rodenticides. The usage of pesticides has significantly increased over the past few decades, with an estimated global consumption of approximately 5.2 billion pounds annually [2]. Most pesticides do not specifically target pests. The extensive application of pesticides has not only negatively impacted agro-ecosystems but has also led to changes in the physiological processes of non-target organisms [3]. It has been assessed that only about 0.1% of pesticides reach their intended targets, while the remainder contaminates the surrounding environment [4]. The risks of poisoning are influenced by factors such as dosage, toxicity, duration of exposure, and individual sensitivity [5]. The overuse and misuse of pesticides have resulted in significant health issues, economic losses, and various environmental challenges. Health problems associated with pesticide exposure include cancer, birth defects, reproductive issues, and disorders affecting the liver, kidneys, and nervous system. In many developing nations, the majority of pesticide applications are linked to adverse effects on human health and the environment due to improper usage. Furthermore, excessive pesticide application contributes to environmental pollution, including water and soil contamination, and disrupts ecosystem balance. In India, synthetic pesticides are extensively utilized to enhance crop yields. They are also employed in public health initiatives to manage insect populations, including cockroaches, mosquitoes, ticks, and flies, which can serve as vectors for diseases [6]. The primary objective of the current study is to examine the impact of pesticides on public health, biodiversity, and the environment.

## II. IMPACT OF PESTICIDES ON THE ENVIRONMENT

A significant number of farmers and agricultural workers lack literacy or have limited education, leading them to apply pesticides without adequate screening or specific information. This practice results in various hazardous effects on the environment. The frequent and unmonitored use of pesticides adversely impacts non-target organisms. In some instances, due to irregular screening, excessive pesticide application occurs after crop damage, resulting in long-lasting residues in the environment that contribute to pollution, particularly soil contamination. The excessive use of pesticides also eliminates beneficial microorganisms, thereby diminishing the soil's natural fertility. It is crucial to have a practical understanding of the physical and chemical properties of pesticides, as their solubility influences surface runoff and soil absorption capacity [7]. Pesticides can travel long distances in the environment, and their deposition in water bodies leads to water pollution. In many cases, pests develop resistance to specific pesticides due to natural selection, posing risks to non-target organisms and potentially causing their sudden death. Conversely, pesticides can be degraded through photodecomposition, microbial action, or physical and chemical reactions. However, those that remain undecomposed persist in the environment for extended periods, resulting in significant ecological damage. Long-lasting pesticides

threaten the biodiversity of both aquatic and terrestrial organisms, as they enter aquatic ecosystems and act as toxic agents, endangering aquatic plants and animals [8].

### **III. IMPACT OF PESTICIDES ON BIODIVERSITY**

Biodiversity serves as the essential basis for human existence on Earth and is crucial for our survival and sustainable development; it must be preserved at all costs [9], while also considering the importance of environmental ethics [10]. Biodiversity plays a vital role in sustaining ecological balance, which is a fundamental requirement for human survival [11]. The impact of pesticides on both aquatic and terrestrial flora and fauna, including avian species, is significant. The accumulation of pesticides within food chains poses a serious threat as it directly impacts predators and raptors. Furthermore, pesticides can indirectly diminish the populations of weeds, shrubs, and insects that serve as food sources for higher trophic levels [12]. The application of insecticides, herbicides, and fungicides has also been associated with declines in the populations of endangered animal and bird species.

Pesticides infiltrate aquatic environments such as ponds and rivers, altering the physicochemical characteristics of water and posing toxicity risks to aquatic organisms. Contaminated water from pesticides presents a significant danger to aquatic life forms, affecting aquatic plants, reducing dissolved oxygen levels, and inducing physiological and behavioral changes in fish populations. Approximately 80% of dissolved oxygen is supplied by aquatic plants, which are essential for sustaining aquatic life. The application of herbicides that kill aquatic plants leads to critically low oxygen levels, ultimately resulting in fish suffocation and decreased fish productivity. Furthermore, pesticides can seep into underground water sources through the contamination of surface water, improper disposal, and accidental spills and leaks. Pesticides applied to land can drift into aquatic ecosystems, where they are harmful to fish and non-target organisms. These pesticides not only possess inherent toxicity but also interact with other stressors, such as harmful algal blooms. The excessive use of pesticides has been linked to a decline in various fish species populations [13]. Additionally, pesticides are toxic to several amphibian species, with the herbicide glyphosate causing high mortality rates in tadpoles and juvenile frogs [14]. Aquatic animals encounter pesticides through three primary routes: dermal absorption via skin, respiratory uptake through gills, and oral ingestion of contaminated water. Pesticide exposure can also lead to sub-lethal effects on terrestrial organisms and the mortality of non-target species. The populations of beneficial insects, such as bees and beetles, can experience significant declines due to the use of broad-spectrum insecticides like carbamates, organophosphates, and pyrethroids. Insect populations have been observed to be higher on organic farms than conventional ones. Since 2006, honey bee populations have decreased by 29–36% annually.

### **IV. CONCLUSION**

Pesticides have been beneficial for farmers and society globally by enhancing agricultural productivity and offering numerous indirect advantages. However, they also have detrimental effects on the environment, such as pollution and ecosystem disruption. These issues stem from a lack of proper knowledge regarding pesticide types, levels of toxicity, insufficient monitoring, and a general unawareness of their harmful impacts on health and the environment. Concerns about the risk's pesticides pose to biodiversity and the environment have emerged, as their extensive use has made them significant environmental pollutants. Once introduced into the environment, some pesticides are quickly broken down, while others persist for extended periods, accumulating in soil and water, which adversely affects biodiversity. Although it is impossible to completely eradicate the risks associated with pesticide use, there are ways to mitigate them. The harmful effects of pesticide exposure can be reduced through various strategies, such as adopting alternative cropping practices, utilizing well-maintained spraying equipment, or opting for plant-based pesticides. The negative experiences associated with synthetic pesticides, combined with the rich biodiversity in our country, have prompted scientists to seek effective and economical pest control methods by investigating biopesticides. Therefore, it is essential to develop control measures that are selective in their action and relatively safe for non-target organisms and humans. Consequently, plant-based pesticides are favoured over synthetic alternatives due to their non-toxic nature towards both the environment and humans. In light of the current surge in human population, preserving biodiversity presents a significant challenge. The impact of pesticides can be mitigated by implementing awareness programs for farmers, providing them with specialized training on the effects of pesticides, as well as their screening and monitoring techniques.

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