

Pesticides and Its role: A review

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Abstract

Pesticides, which include a wide range of compounds such as herbicides, insecticides, and fungicides, are essential in modern agriculture and pest control operations. This abstract delves into the varied nature of pesticides, showing their classification and global occurrence. Herbicides, which account for half of all pesticide use, primarily function as plant protection chemicals, protecting crops from weed threats. Pesticides have the overarching goal of deterring, incapacitating, or eliminating pests, which can range from insects and plant pathogens to animals and disease vectors. While pesticides offer essential benefits by protecting crops, preventing the spread of diseases, and controlling nuisance pests, they are not without drawbacks. Potential toxicity to humans and unintended environmental impacts pose significant challenges.

Keywords: Pesticides, health, control, pests, insects

Introduction

Pesticides are substances that are meant to control pests. It includes herbicides, insecticides, nematocides, molluscicides, piscicides, avicides, rodenticides, bactericides, insect repellents, animal repellents, microbicides, fungicides, and lampricides. (fig.1) Pesticides are substances that are meant to control pests. ^[1]

Pesticides are substances or mixtures of substances intended for preventing, destroying, repelling, or mitigating any pest. A pest can be any organism that is considered harmful or troublesome, including insects, rodents, weeds, fungi, bacteria, and viruses. Pesticides are commonly used in agriculture to protect crops from pests and diseases, but they

Are also used in various other settings, such as homes, gardens, and public health programs. While pesticides are important in agriculture and public health because they prevent or minimize insect damage, their usage raises concerns about their potential detrimental effects on the environment, non-target creatures, and human health. As a result, pesticide use is controlled in many countries, and research and development are ongoing to improve the safety and efficacy of these compounds. IPM is a pest management strategy that integrates several pest control approaches to reduce pesticide use and promote sustainable pest management practices. ^[2, 3]

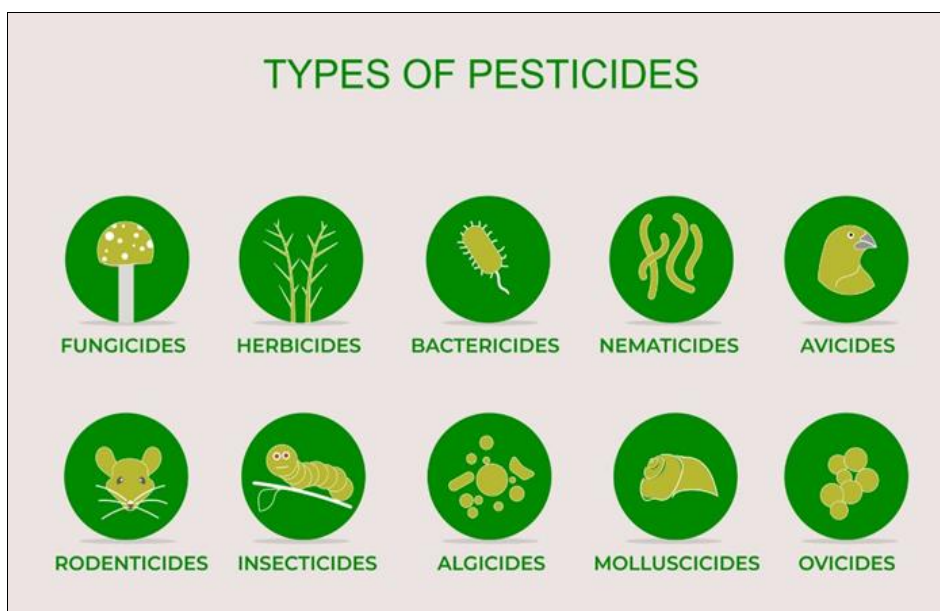


Fig 1: Type of Pesticide ^[1]

History

Pesticides have been used to protect crops since before 2000 B.C. The first pesticide discovered was elemental sulfur dusting, which was utilized in Sumer some 4,500 years ago in ancient Mesopotamia. Toxic compounds, including

arsenic, mercury, and lead, were being used to eliminate pests on crops by the 15th century. Nicotine sulfate was produced from tobacco leaves in the 17th century for use as a pesticide. In the nineteenth century, two more natural pesticides were introduced: pyrethrum, derived from

chrysanthemums, and rotenone, obtained from the roots of tropical crops. Arsenic-based insecticides dominated the market until the 1950s. [4, 5]

According to Paul Müller, DDT is a highly effective insecticide. Chlorinated such as DDT were prevalent, but by 1975, they had been supplanted by organophosphates and carbamates in the United States. Pyrethrin compounds have since become the major pesticide. In the 1960s, herbicides such as "triazine and other nitrogen-based compounds, carboxylic acids such as 2, 4-dichlorophenoxyacetic acid, and glyphosate" were prevalent. Since the establishment of the Environmental Protection Agency in 1970 and modifications to the pesticide law in 1972, pesticide use has expanded 50-fold since 1950, with an annual use of 2.3 million metric tons (2.5 million short tons) of industrial pesticides. Seventy-five percent of all pesticides are used in wealthy countries, although use is increasing in poorer countries. The National Science Foundation's Center for Integrated Pest Management presented a study on pesticide use patterns in the United States from 1997 to 2003. [6]

DDT was discovered to be preventing many fish-eating birds from breeding in the 1960s, posing a significant threat to biodiversity. Rachel Carson wrote the best-selling book, *Silent Spring*, about biological magnification. The agricultural use of DDT is currently prohibited under the Stockholm Convention on Persistent Organic Pollutants, but it is still used in some underdeveloped countries to prevent malaria and other tropical diseases by spraying on interior walls to kill or repel mosquitoes. [7]

Types of Pesticides

These are grouped according to the types of pests which they kill. (Fig1)

Grouped by Types of Pests They Kill

1. Insecticides – insects
2. Herbicides – plants
3. Rodenticides – rodents (rats & mice)
4. Bactericides – bacteria
5. Fungicides – fungi
6. Larvicides – larvae

Based on how biodegradable they are

Pesticides can also be considered as:

- **Biodegradable:** The biodegradable kind is those which can be broken down by microbes and other living beings into harmless compounds.
- **Persistent:** While the persistent ones are those which may take months or years to break down.

Another way to classify these is to consider those that are chemical forms or are derived from a common source or production method.

Chemically-related pesticides

Organophosphate: The majority of organophosphates are insecticides, and they have an effect on the nervous system by interfering with the enzyme that regulates a neurotransmitter.

Carbamate: Carbamate pesticides, like organo phosphorus pesticides, harm the brain system by altering an enzyme that regulates the neurotransmitter. However, the effects of enzymes are usually reversible.

Organochlorine insecticides: They were widely employed formerly, but many countries have banned the use of organochlorine pesticides due to their adverse health and environmental consequences, as well as their persistence (e.g., DDT, chlordane, and toxaphene).

Pyrethroid: Pyrethroids are a man-made variant of pyrethrin, a naturally occurring pesticide found in chrysanthemums (Flowers). They were designed to be as stable as possible in their environment.

Sulfonylurea herbicides: To treat weed management, sulfonylurea herbicides such as Pyriithiobac-sodium, cyclosulfamuron, bispyribac-sodium, terbacil, and sulfometuron-methyl have been sold. Sulfosulfuron, rimsulfuron, pyrazosulfuron-ethyl, imazosulfuron, nicosulfuron, oxasulfuron, nicosulfuron, flazasulfuron, primisulfuron-methyl, halosulfuron-methyl, flupyr-sulfuron-methyl-sodium, ethoxysulfuron, chlorimuron-ethyl, bensulfuron-methyl, azimsulfuron, and amidosulfuron.

Biopesticides: Biopesticides are pesticides generated from natural materials such as animals, plants, microbes, and minerals.

Benefits of pesticides

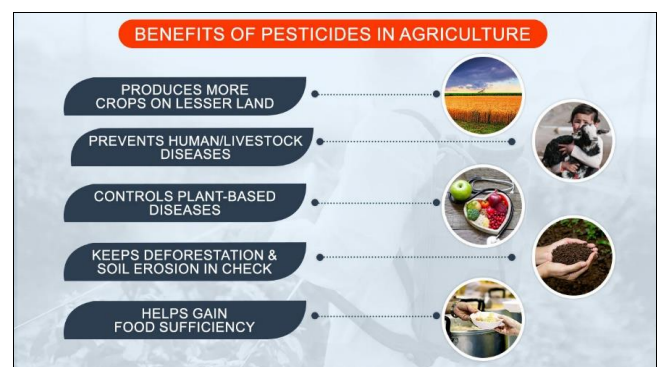


Fig 2: Benefits of pesticides [6]

Pest and plant disease vector control

- Increased crop yields
- Better crop/livestock quality (Fig 2)
- Control of invasive species

Controlling disease vectors and nuisance organisms in humans and cattle

- Human lives have been saved, and sickness has been decreased. Malaria is one of the diseases that has been controlled, with millions of lives saved or improved by the use of DDT alone.(Fig 2) [6]
- Saved animal life and illness reduction

Managing organisms that endanger other human activities and structures

- Drivers view unobstructed
- Tree/brush/leaf hazards prevented
- Wooden structures protected

The cost side of pesticide it can be costs to the environment as well as human health and costs of the development and research of new pesticides.



Fig 3: Warning [9]

Health effects

Pesticides can have both immediate and delayed health consequences for people who are exposed to them. Pesticide exposure can have a wide range of negative health impacts, from basic skin and eye irritation to more serious effects such as disrupting the brain system, hearing, mimicking hormones, causing reproductive issues, and even cancer. According to a 2007 systematic review, "most studies on non-Hodgkin lymphoma and leukemia showed positive associations with pesticide exposure," and hence cosmetic pesticide use should be reduced. There is strong evidence linking organophosphate insecticide exposure to neurobehavioral changes. There is also limited evidence for other detrimental effects of pesticide exposure, such as neurological damage, birth malformations, and fetal mortality. (Fig.3) [9]

The American Academy of Pediatrics advises reducing children's exposure to pesticides and utilizing safer alternatives. [10]

Because of weak regulation and safety procedures, developing nations account for 99% of pesticide-related mortality, despite accounting for only 25% of pesticide usage. [11]

One study discovered that pesticide self-poisoning was the method of choice in one-third of all suicides worldwide, and it advocated, among other things, stricter limitations on the pesticides that are most dangerous to humans. [12]

A 2014 epidemiological assessment discovered links between autism and pesticide exposure but concluded that the evidence was insufficient to determine that the link was causal. [13]

Occupational exposure among agricultural workers

According to the World Health Organization and the United Nations Environment Programme, 3 million agricultural laborers in poor countries are poisoned by pesticides each year, resulting in 18,000 deaths. According to one study, up to 25 million workers in underdeveloped nations may be poisoned by pesticides each year. Other occupational exposures besides agricultural workers, such as pet

Groomers, groundskeepers, and fumigators, may put people at risk of pesticide-related health consequences. [14, 15]

Pesticide use is ubiquitous throughout Latin America, where around US\$3 billion is spent each year. Pesticide poisonings have become more common in the last two decades, according to data. The most common causes of pesticide poisoning are thought to be organophosphate and carbamate pesticides. Characterizing genuine pesticide exposure is difficult due to at-home pesticide use, the use of unregulated products, and the role of illegal laborers in the agriculture economy. According to estimates, 50–80% of pesticide poisoning instances go undetected. [16]

Pesticide poisoning

Pesticides can be hazardous to humans and other non-target species, with the severity depending on the frequency and quantity of exposure. Toxicity is also affected by the rate of substance absorption, distribution within the body, metabolism, and elimination. Pesticides such as organophosphates and carbamates work by decreasing acetyl cholinesterase activity, preventing acetylcholine breakdown at the brain synapse. Excess acetylcholine can cause muscle cramps or tremors, as well as confusion, dizziness, and nausea. According to research, farm workers in Ethiopia, Kenya, and Zimbabwe have lower plasma acetyl cholinesterase concentrations, the enzyme responsible for breaking down acetylcholine acting on synapses throughout the nervous system. (Fig. 4) [17]



Fig 4: Pesticide poisoning [17]

Measuring exposure to pesticides

There are several methods for evaluating pesticide exposure, each of which produces an estimate of an individual's internal dose. Measuring biomarkers and biological effect markers are two broad approaches. The former entails measuring the parent compound or its metabolites directly in various media, such as urine, blood, and serum. Biomarkers may involve direct measurements of the chemical in the body prior to biotransformation during metabolism. Other relevant indicators may include the original compound's metabolites following biotransformation during metabolism. Toxicokinetic data can provide more specific information on how rapidly a substance is metabolized and removed from the body, as well as insights regarding exposure timing. [18]

Challenges in assessing pesticide exposure

There are numerous obstacles to measuring pesticide exposure in the general population, as well as many more that are specific to agricultural worker occupational exposures. Estimating exposure to family members and

children, in addition to farm workers, involves additional complications and may occur through "take-home" exposure from pesticide residues gathered on clothing or equipment belonging to parent farm workers and mistakenly transported into the home. Children may potentially be exposed to pesticides during pregnancy if their mothers are exposed to pesticides. Characterizing children's exposure to pesticides due to airborne drift and spray application is similarly difficult but frequently reported in underdeveloped nations. [19, 20]

Prevention

Pesticide exposure can be minimized by the use of personal protective equipment, acceptable reentry times into recently sprayed areas, and effective product labeling for hazardous compounds in accordance with FIFRA standards. Training high-risk populations, such as agricultural workers, on pesticide use and storage can lower the frequency of acute pesticide poisoning and the potential chronic health problems associated with exposure. Continued study into the hazardous human health effects of pesticides serves as a foundation for relevant policies and enforceable regulations that protect the health of all people.

Environmental effects

Pesticide use causes a slew of environmental issues. Over 98% of sprayed insecticides and 95% of sprayed herbicides end up somewhere other than their intended target, including non-target species, air, water, and soil. Pesticide drift occurs when pesticides are suspended in the air as particles are moved by wind to contaminate locations. Pesticides are one of the leading sources of water pollution, and certain pesticides are persistent organic pollutants that pollute soil and flowers (pollen and nectar). Furthermore, pesticide use can have a negative impact on adjoining agricultural activity because pests will drift to and injure crops that have not been treated with pesticides. [21]



Fig 4: Environmental effects [21]

Pesticide usage also lowers biodiversity, leads to pollinator loss, degrades habitat (particularly for birds), and endangers endangered species. Pests can acquire resistance to pesticides, prompting the development of a new chemical. To combat resistance, a higher dose of the pesticide can be applied, although this will exacerbate the problem of ambient pollution. (Fig.4) [22]

Conclusion

Pesticides are a double-edged sword in the realm of agriculture. While these chemical agents have played a pivotal role in boosting crop yields, preventing the spread of diseases, and supporting economic growth in the agricultural sector, they are not without serious drawbacks. Environmental concerns, such as soil and water contamination, harm to non-target species, and the

development of pesticide-resistant pests, underscore the need for a more sustainable and balanced approach to pest management. The impact of pesticides on human health, including potential links to respiratory issues, skin problems, and certain cancers, raises significant red flags.

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