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Pesticide Abuses in India: Challenges and Strategies

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Abstract

Pesticides are essential in modern agriculture for protecting crops from pests and diseases, ultimately boosting food production. However, their misuse has serious repercussions for human health and the environment. Improper handling, excessive application, and inadequate protective gear during spraying expose farm workers to harmful chemicals. Chronic exposure has been linked to respiratory issues, neurological disorders, reproductive complications, and increased cancer risks. Additionally, pesticide residues can contaminate soil and water, threatening ecosystems and biodiversity. The overuse of pesticides disrupts ecological balance, leading to declines in beneficial insects, such as bees and other pollinators. This not only affects crop yields but also contributes to the emergence of pesticide-resistant pest strains. To ensure a sustainable agricultural future, it is vital to address these issues through better practices and integrated pest management strategies that minimize reliance on chemical pesticides.

1. Introduction

India is an agrarian nation, with agriculture serving as the backbone of its economy. The agricultural sector employs approximately half of the country's workforce and contributes around 16% to the national GDP. India has a diverse climate and fertile lands suitable for cultivating a wide variety of crops, including staple grains, fruits, vegetables, and cash crops. Pesticides play a crucial role in Indian agriculture by protecting crops from pests, diseases, and weeds, thereby ensuring higher yields and food security. The use of pesticides has been instrumental in combating various crop-damaging pests, such as insects, fungi, and rodents, which can cause significant losses and threaten farmers' livelihoods. Moreover, pesticides are also used in public health activities to control vector-borne diseases and unwanted plants in ornamental landscaping, parks, and gardens. They are also useful in suppressing or avoiding the proliferation of insects, pests, bacteria, fungi, and algae in electrical equipment, refrigerators, paint, carpets, paper, cardboard,

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and food packaging materials (Kim et al., 2017).

The Green Revolution helped India achieve self-sufficiency in food production and alleviate widespread hunger and malnutrition. However, the excessive and indiscriminate use of pesticides has led to several adverse consequences, raising concerns about their impact on human health and the environment. Despite the benefits of pesticides in increasing crop yields and protecting agricultural produce, their misuse and overuse have become a growing issue in India. Improper handling, lack of protective gear, and inadequate training among farmers have led to widespread exposure to toxic chemicals, resulting in various health problems and environmental degradation. To address these concerns, it is crucial to strike a balance between the judicious use of pesticides and the adoption of sustainable farming practices, such as integrated pest management (IPM) and organic agriculture. Strengthening regulations, promoting awareness, and providing adequate training to farmers are essential steps towards mitigating the negative impacts of pesticide abuses in India.

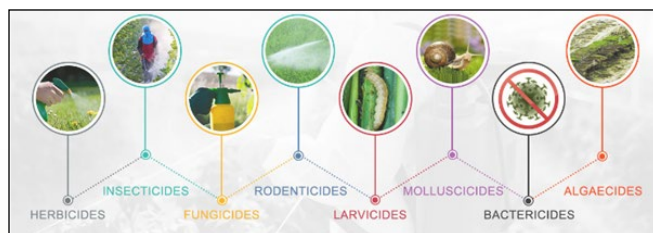


Figure 1: Pesticides

2. Pesticide Consumption and Usage Pattern in India

As per the data of FAO, India has utilized around 58160 tonnes of pesticide in 2018. Per hectare application rate of pesticide was only 0.31 kg in 2017. While consumption in China, Japan and America was around 13.07, 11.76 and 3.57 kg ha⁻¹ of pesticides respectively. So, it is clear that India applies a smaller amount of pesticides in per hectare of cropland area, but uncontrolled and haphazard pesticide usage is responsible for the presence of high pesticide residues in both natural and physical environment. Bio-pesticides consumption is only 8% in India. There are 293 pesticides registered in India, and it is reported that 104 pesticides are still being produced/used in the country despite being prohibited in two or more nations around the world. Out of total insecticides used for pest management in India, 50% are diverted

to cotton pest management. Pesticide usage patterns in India differ from those in the world as a whole. In India, insecticides, fungicides, and herbicides are used. Insecticides account for the majority of the total. Pesticide application in India is hampered by the use of low-grade pesticides and a lack of information about pesticide use. Pesticide usage without sufficient restrictions has resulted in a rise in pesticide residue identified in food items in India.

3. Status of Banned and Restricted Chemical Pesticides in India

In India, a total of 293 pesticides (March 2021) are registered for use and out of the 293 pesticides, 130 highly hazardous pesticides are banned in different countries. Pesticides like phorate, methyl parathion, phosphamidon, and captafol are listed as extremely hazardous pesticides in WHO database. These pesticides are already banned in India, but in the last five years nearly 5939 MT of these pesticides have been used. Two pesticides such as barium carbonate and coumachlor are under the category of “obsolete or discontinued for use as pesticides”. But both these pesticides are still frequently being used and consumed in India. About 56–57% of the chemical pesticides consumed in India are either banned or proposed to be banned (Pandey, 2023).

4. Pesticide Abuse

The term “abuse” of pesticides commonly refers to use, application, and storage practices that are inconsistent with the label instructions. Failure to implement risk mitigation measures and overuse and overapplication of pesticides are also among examples of misuse. Importantly, all negative consequences of pesticide use may be labelled “misuse” and blamed on indiscriminate, improper, irrational, and incorrect use of pesticides.

4.1. Incorrect mixing

Putting multiple types of pesticides together in one application creating a cocktail.

4.2. Lack of compliance with pesticide application instructions

Farmers are assumed to not be using the measurements as per the label requirements resulting in under or over-dosing (or overuse).

4.3. Incorrect pesticide application

Practices Applying pesticides with a brush, broom, leaves or cloth, often splashed from a bucket.

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4.4. *Spraying too soon to harvesting*

Re-entry intervals on the label are not followed. Workers re-enter the field too soon after spraying to weed or harvest.

4.5. *Mishandling*

Not wearing the correct plant protection equipment (PPE).

4.6. *Improper storage*

Keeping pesticides unlocked and in places with can cause exposure risks (e.g., in and under home), and not a designated hazardous facility.

4.7. *Reuse of containers for household uses*

Using pesticide contaminated containers to store water or food.

4.8. *Applying for uses not stipulated on label*

Applying a pesticide on a crop not listed on the label.
- Using pesticides to kill fish for human consumption.

4.9. *Self-poisoning or harm*

Using pesticides to kill self (human) which is not the intended purpose of pesticides.

Abuse of pesticide is because of less awareness of farmers regarding amount of uses and means of application. Additionally, carelessness or lack of consultancy about pesticide application, that may put towards incidence of pesticide residues on farm products i.e. fruits, vegetables. Mostly farmers to make the dose more effective & powerful, mixes many pesticides and reason behind it is that recommended rates are not operative because of resistance and resurgence of pests as well as to control the disease or diverse pests. Unnecessary application of pesticides, Farm workers are applying pesticides 10-15 times more than its requirement. Consumption of illegal/nongenuine pesticides, language barriers, limited education and a lack of proper training tend to be among the most significant contributing factors to improper handling and application of pesticides and also use of pesticides without label claim.

4.10. *Abuse of pesticide also includes*

- Failing to follow label or permit instructions
- Injuring people or damaging property, or using pesticides in a way that is likely to do so
- Harming a non-target plant or animal
- Using an unregistered pesticide, or possessing one and intending to use it

- Storing pesticides in containers that do not have the approved label attached
- Disposing of a pesticide or its container illegally, for example, pouring pesticide waste down a drain
- Spraying pesticides from an aircraft without a relevant EPA licence
- Spraying pesticide from an aircraft within 150 metres of a home, school or other public place without the written consent of the occupier – this does not apply to roads, travelling stock reserves and railcorp land
- Placing pesticides or empty pesticide containers in waterways (Rother, 2018).

5. Pesticide Exposure

When a pesticide comes in contacts to an organism, it is called a pesticide exposure. About 97% of all the body exposure that happens during pesticide spraying is through skin contact. The toxic effect of a pesticide exposure depends on the amount of pesticide involved and the time of its persistence i.e. how long it remains there. In our daily routine we expose several times to pesticides either directly or indirectly. Pesticide exposure is linked with various diseases including cancer, hormone disruption, asthma, allergies, and hypersensitivity. A line of evidence also exists for the negative impacts of pesticide exposure leading to birth defects, reduced birth weight, fetal death, etc. On the basis of scientific evidence, the real, predicted, and perceived risks that pesticides pose to human health (occupational and consumer exposure) and the environment are fully justified.

- Indirect exposure occurs either through dietary products such as food and drinking water, or application of insect repellents in our house or on our skin.
- Direct exposure occurs through occupational exposure such as farmers working in open fields and greenhouses, workers in the pesticide industry, and exterminators of house pests.

6. Route of Pesticide Exposure

6.1. *Oral exposures*

- Not washing hands before eating and drinking.
- Mistaking the pesticide for food.
- Accidentally splashing of pesticide.

6.2. *Inhalation exposures*

- Prolonged contact with pesticides,

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- Vapours of fumigants, dust or mist
- Use of old or inadequate pesticide application equipment.

6.3. Dermal exposures

- Not washing hands after handling of pesticides or their equipment.
- Splashing of pesticides on unprotected skin.
- Wearing pesticide contaminated clothes.
- Applying pesticides during windy weather.
- Wearing inadequate personal protective equipment while handling pesticides,
- Touching pesticide-treated surfaces.

6.4. Eye exposures

- Accidentally splashing of pesticides in eyes.
- Applying pesticides in windy weather without protection.
- Rubbing body with contaminated gloves.
- Pouring dust, granule, or powder formulations without any protection.

6.5. Acute effects

These may appear immediately or within 24 hours after exposure to a pesticide. They can be measured more accurately and easily diagnosed than delayed effects. These effects are usually observable and often curable if appropriate medical treatment is given on time. For example, nerve, skin, and eye irritation and damage, headaches, dizziness, nausea, fatigue, vomiting, abdominal pain and systemic poisoning.

6.6. Chronic effects

Those which do not appear even within 24 hours after exposure to a pesticide. These effects from pesticides are problematic to study in humans because most people are exposed to low doses of pesticides and have delayed health effects. Different types of chronic effects: Carcinogenic effect: It includes many types of cancer in humans. For example: Leukemia, Non-Hodgkins lymphoma, Brain, Bone, Breast, Ovarian, Prostate, Testicular and Liver cancers.

6.7. Allergic effects

These are harmful effects that some people develop in response to some pesticides. These effects are not to be supposed to occur during a first exposure to a pesticide. The first exposure causes the body to develop repelling

response but the later exposures result in the allergic response. This process is called sensitization, and the pesticides that cause allergic reaction are known as sensitizers. For example: Asthma or even life-threatening shock, skin irritation, such as rash, blisters, or opensores, and eye and nose irritation, such as itchy, watery eyes and sneezing (Singh et al., 2018).

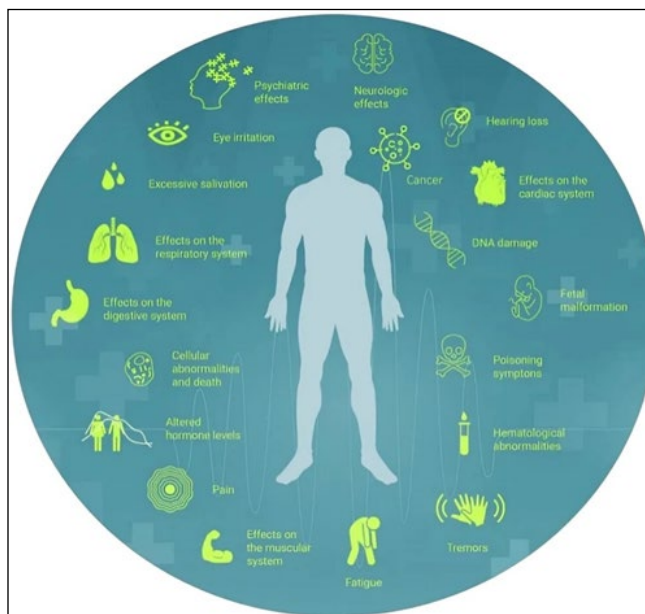


Figure 2: Effects of pesticidal exposure

7. Pesticide Behaviour in the Environment

When pesticides are applied to a target plant or disposed of, they have the potential to enter the environment. On entering the environment, pesticides can undergo processes such as transfer (or movement) and degradation. Pesticide degradation in the environment produces new chemicals. Pesticides relocate from the target site to other environmental media or non-target plants by transfer processes including adsorption, leaching, volatilization, spray drift, and runoff. The different types of chemicals indicate their differences in environmental behaviour. For example, organochlorine compounds such as DDT have low acute toxicity but show a significant ability to accumulate in tissues and persist in causing long-term damage. They have been banned from sale in most countries, but their residues remain in the environment for a long time because of their nature. While organophosphate pesticides are of low persistence, they have appreciable acute toxicity in mammals (Tudi et al., 2021).

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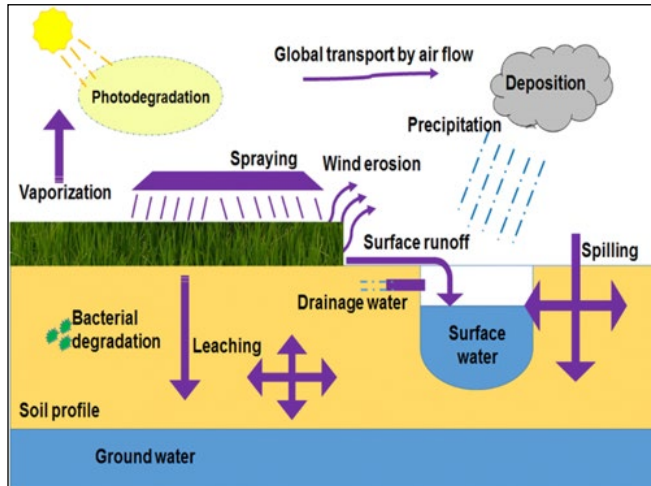


Figure 3: Pesticide behavior in the natural environment

8. Pesticide Contamination and Its Adverse Effects on The Natural Environment

Population growth and climate change contribute mainly to the increasing use of pesticides and a higher global pesticide production is estimated in the future. Although pesticides play a significant role in improving crop yields and the production of affordable and good quality food, the increasing use of pesticides also brings a number of negative effects to the environment and human health. Pesticides are used to kill pests and control weeds as a function of their chemical ingredients, therefore, they can also be toxic to other organisms, including birds, fish, beneficial insects, and nontarget plants, as well as different environmental media, including air water, soil, and crops. Such chemical residues impact human health through the environment and food contamination. Moreover, pesticide contamination moves away from the target plants, resulting in environmental pollution. Pesticides move in several ways, including to the air, through wind currents, to water, through runoff or leaching, and to plants, animals, and humans (Tudi et al., 2021).

9. Strategies for Checking the Pesticide Abuse

9.1. Strengthening regulations and enforcement

Review and update existing pesticide regulations to align with international standards and best practices. Establish strict guidelines for pesticide registration, sale, and use. Implement effective monitoring and enforcement mechanisms to ensure compliance with regulations.

Impose strict penalties for violations, such as the illegal sale or misuse of banned or restricted pesticides.

9.2. Promoting integrated pest management (IPM)

Encourage the adoption of IPM practices, which involve a combination of biological, cultural, and chemical methods to control pests. Provide training and extension services to educate farmers on IPM techniques. Facilitate access to biological control agents and encourage the use of natural predators and parasites. Promote the use of pest-resistant crop varieties and crop rotation practices.

9.3. Encouraging organic and sustainable farming practices

Provide incentives and subsidies for farmers to transition to organic or low-input sustainable agriculture practices. Establish robust certification and labelling systems for organic products. Create market linkages and promote the consumption of organic produce.

9.4. Improving training and awareness

Conduct comprehensive training programs for farmers, agricultural workers, and pesticide applicators on proper handling, storage, and application of pesticides. Raise awareness about the health and environmental risks associated with pesticide misuse. Promote the use of personal protective equipment (PPE) and safe handling practices.

9.5. Enhancing monitoring and data collection

Establish a robust system for monitoring pesticide residues in food products, water sources, and the environment. Collect and analyse data on pesticide usage, incidents of poisoning, and environmental impacts. Use this data to inform policy decisions and target interventions in areas with high pesticide abuse.

9.6. Fostering research and development

Invest in research and development of safer and more environmentally friendly pest control methods, such as biopesticides and pheromone-based technologies. Explore alternative pest management strategies, including the development of pest-resistant crop varieties.

9.7. Collaboration and stakeholder engagement

Encourage collaboration among government agencies, research institutions, non-governmental organizations (NGOs), and industry stakeholders. Facilitate knowledge-sharing and best practice exchange among farmers and communities. Involve local communities and stakeholders in decision-making processes related to pesticide use and management (Singh, 2012)

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10. Conclusion

Pesticides boost agricultural productivity but pose health and environmental hazards. Evidence from India highlights farmers lack of awareness about safe usage, ineffective regulations, banned pesticides availability, and direct delivery of unapproved pesticides. Better pesticide management laws, strict implementation, promoting organic farming, and using biopesticides can mitigate negative impacts on health and the environment.

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