The Use of Pesticides in Agriculture and Their Impact on Health and the Environment: A Legal Framework in India

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Abstract

The Green Revolution allowed developing countries like India to defeat continual food scarcity by producing more food and different agricultural products by using high-yielding varieties of seeds and increasing the use of chemical fertilizers, for example. Urea is the most commonly used fertilizer. The utilization of pesticides to kill the pests and insects that attack crops and harm them. The intention of the introduction of pesticides was to control and prevent insects and disease in the field. They've suffered for years as a result of the pesticides being used continuously. After the green revolution, the practice of using pesticides allowed growth and sustainability of grains but had negative effects on the environment and human health. This article will shed light on the excessive use of pesticides in agriculture and the legal and regulatory framework in India.

Keywords

Pesticides, Environment, Health, Law

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1. Introduction

Pesticides—chemical (and increasingly biological) agents used to control agricultural pests—play a pivotal role in India's drive to increase crop yields and meet the demands of its massive population. India ranks among the world's top producers of agricultural chemicals. In the 2022–23 agricultural season, over 16.7 million hectares (~25% of cropland) were treated with pesticide formulations from a pool of approximately 330 active molecules[1].

However, this intensive pesticide use has sparked deep concern. Adverse outcomes include harmful residues in food, contamination of soil and water, disruption of ecosystems, long-term health risks, and acute poisoning incidents. This article examines:

I. Indian agriculture's use of pesticides: patterns, trends, and types.
II. Health and environmental impacts: from acute poisoning to soil and water pollution and biodiversity loss
III. Regulatory/legal framework: under national and international law
IV. Key case studies: such as endosulfan and neonicotinoids
V. Challenges and the road ahead

2. Pesticide Use in Indian Agriculture

2.1 Scale and Patterns

India's per-hectare pesticide consumption (~0.5/ kg/ha) remains modest compared to nations like Japan (12/ kg), the USA (4.5/ kg), and Korea (6/ kg). Nevertheless, given its vast arable area, over 61,000 tonnes of pesticides were applied annually, making India the world's ninth-largest consumer.

Usage is concentrated in irrigated and intensive zones—Punjab, Haryana, Maharashtra, and Uttar Pradesh—driven by shifts to high-yield and cash crops (e.g., cotton, vegetables) and fuelled by pest pressure exacerbated by climate variability.

2.2 Chemical vs Bio pesticides

While synthetic agrochemicals dominate, bio-pesticides are gaining traction. These eco-friendly agents, derived from microbes and botanical extracts, currently comprise only ~9% of the market—biopesticide use grew from 219/ t in 1996–97 to ~7,200/ t in 2022–23[2]. Integrated Pest Management (IPM) trials have shown that using biopesticides can cut chemical application intensity by 45–66%, depending on the crop.

3. Health and Environmental Impacts

3.1 Acute and Chronic Health Outcomes

Acute Poisoning & Suicide India records thousands of pesticides poisoning cases yearly. For instance, at the Andhra Medical College in Visakhapatnam, 80%

of 195 poisoning deaths in 2023 involved pesticides—nearly 40% due to paraquat ingestion[3]. These substances are frequently used in intentional self-harm, affecting farm workers and urban populations alike.

Occupational Exposure Studies in Karnataka found that 22% of farmers mixed pesticides with bare hands, 26% lacked protective gear while spraying, and many stored pesticides near living areas—leading to symptoms like headaches, dizziness, skin rashes, and respiratory difficulties[4].

Vulnerable Groups A PAN India report revealed that 82% of pesticides used in Tamil Nadu's floriculture farms were highly hazardous, affecting the sanitation and health of minor workers aged 9–13. Symptoms reported included headaches, vomiting, tremors, and skin irritation[5].

3.2 Long Term Consequences

Some pesticide residues- like endosulfan and DDT, have been linked to long-term health problems, such as:

- Cancer, especially for organophosphates and probable carcinogens
- Neurological deficits, particularly in youth exposed to neurotoxins
- Endocrine disruption and reproductive disorders

In Kerala and Karnataka, endosulfan bioaccumulation led to birth defects, cancers, mental disabilities, and miscarriages—prompting severe legal scrutiny and bans[6].

3.3 Effects on the Environment

Soil Health

Chemical pesticides disrupt soil microbial diversity and biochemical processes. Over time, residues build up, reduce nutrient cycling, and degrade soil fertility[7].

Water Contamination

Studies have found residues—including DDT, HCH, endosulfan, malathion, chlorpyrifos, atrazine, and cypermethrin—above WHO and BIS safety thresholds in groundwater and surface water across Indian regions, leading to biomagnification through the food chain[8].

Biodiversity Decline

Neonicotinoids, in particular, have dramatically affected pollinators. A study from Pant Nagar University showed a steep drop in honeybee numbers, threatening broader ecological and agricultural stability[9]. Endosulfan also inflicted drastic ecological damage in Kerala—including 40–70% reductions in plant biodiversity and harm to aquatic and butterfly populations.

4. Legal and Regulatory Framework in India

India's legislative architecture governing pesticides operates across multiple domains: labels, bans, residue limits, and environmental oversight.

4.1 The Insecticides Act, 1968 & Rules, 1971

This Constitutes the foundational regulation framework, covering:

- **Import, manufacture, sale, transport, and use** of insecticides
- **Central and State-level oversight bodies** (Central Insecticides Board & Registration Committee, and State Pesticide Testing Laboratories)[10]. The Central Insecticide Laboratory enforces quality standards.

Banned and Restricted Pesticides

As of March 2024:

- 339 active ingredients and 946 formulations are registered
- 29 pesticides are banned, 5 are production-prohibited but allowed for manufacturing, and 16 have had registration refused. Noteworthy recent bans and restrictions include:
- **Carbofuran** (all but encapsulated granules banned)
- **Chlorpyrifos, Dimethoate, Malathion, Mancozeb, Monocrotophos, Oxyfluorfen, Quinalphos**, and **Trifluralin** have had use limited in specific crops[11].

Requirements for Labeling

Labels are mandatory, with toxicity indicated by colored diamond symbols—red (extremely toxic), yellow (highly toxic), blue (moderately toxic), and green (lowest toxicity). In addition, labels must include usage instructions, antidotes, flammability warnings, and hazard symbols.

4.2 Maximum Residue Limits (MRLs)

FSSAI enforces MRLs for pesticide residues in food products. In 2023, it responded to Hong Kong's ban of spice mixes citing ethylene oxide, asserting compliance with India's stringent residue norms.

4.3 Proposed Pesticide Management Bill, 2020

This draft bill aims to overhaul the 1968 Act by:

- Establishing a National Pesticide Management Authority and State counterparts
- Replacing the current system of registration
- Promoting organic/bio-pesticide adoption
- Introducing compensation funds for victims of counterfeit pesticides
- Ensuring transparent pesticide data (adverse effects, alternatives).

The bill also proposes tighter control on pesticide marketing and advertisements.

4.4 Laws on Health and the Environment

Other relevant mechanisms:

- Environmental Protection Act (1986), enforced by CPCB/SPCBs, governs hazardous chemical pollution.
- Water Act (1974) restricts pesticide discharge into water bodies.
- NGT (2010) adjudicates environmental harm from pollution incidents involving pesticides.
- Public Liability Insurance Act (1991) and others provide civil redress in case of chemical mishandling.

5. Case Studies

5.1 Endosulfan in Kerala

Used extensively on cashew orchards and crops, aerial spraying of endosulfan (1980s–2000s) led to genetic defects, cancers, and widespread ecological harm. Between 1998 and 2001, state and national permanent bans were imposed in response to court rulings and NHRC recommendations. Residues persist in soil decades later[12].

5.2 Neonicotinoids and Pollinators

A 2025 study at GB Pant University linked neonicotinoid exposure to declines in honeybee health and pollinator populations—reaffirming biodiversity concerns and raising alarm about global crop security.

5.3 Paraquat Poisoning

The Visakhapatnam 2023 autopsy series found paraquat in 39.4% of fatal poisonings, underscoring its lethality. The Times of India reports that despite global restrictions, India still permits limited uses.

6. Obstacles to Implementation

6.1 Regulatory Enforcement Gaps

Despite the legal architecture, there are systemic weaknesses:

1. Substandard and counterfeit pesticides pose a threat to farmer safety due to inadequate sales point enforcement.
2. Continuing use of banned/restricted chemicals in some regions.
3. Farmer ignorance of toxicity and safe handling—56% of farmers in UP and 59% in Karnataka lack awareness[13]. PPE usage remains low (~30–60% report non-use).
4. Inefficient testing infrastructure, especially at the local and state levels, and delayed residue monitoring in food.

6.2 Socio-Economic and Agricultural Pressures

Farmer preference for quick-acting chemicals, government subsidies, and aggressive pesticide marketing have perpetuated chemical reliance. Climate variability has also intensified pest pressures, leading to overuse.

6.3 Funding and Governance

Budgetary limitations: only ₹ 55 million dedicated to sustainable farming compared to ₹ 20 billion in fertilizer subsidies. Regulatory agencies often lack transparency and face bureaucratic bottlenecks.

7. Measures Taken & The Way Forward

7.1 Regulatory Tightening

India has steadily restricted or banned various pesticides (e.g., carbofuran, chlorpyrifos). The draft Pesticide Management Bill signals potential structural reforms[14].

7.2 Integrated & Natural Farming Adoption

States like Andhra Pradesh are actively promoting natural and organic farming. In 2024, ~700,000 farmers in AP switched to natural methods with promised soil restoration and resistance to climate extremes[15].

7.3 Bio-Pesticide Advocacy and IPM

Agricultural research supports integrated strategies that combine biological agents, crop rotation, and judicious pesticide use. Scaling IPM remains critical to reducing chemical loads.

7.4 Awareness & Capacity Building

Educational programs, extension services, and pesticide dealer training are essential. Studies underscore the need for proper PPE usage and safe handling among farmers.

7.5 Strengthening Infrastructure

Expanding and upgrading pesticide testing labs, using digital systems for residue monitoring, and enforcing label compliance are key steps forward.

8. Conclusion

Pesticides remain central to India's agricultural productivity—but at a mounting cost to human health, ecosystem integrity, and environmental safety. While the regulatory framework is extensive, critical gaps in enforcement, farmer awareness, and resource allocation persist.

- To mitigate these harms, India must:
- Accelerate the Pesticide Management Bill
- Strengthen environmental and health monitoring systems
- Expand IPM and organic/natural farming
- Put money into farmer training and safer handling methods.
- Phase out toxic and hazardous compounds

With coordinated action from central and state governments, civil society, and farming

communities, India can transition toward a more sustainable, resilient, and health-conscious agricultural model—one that balances economic gains with ecological stewardship and public welfare.

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