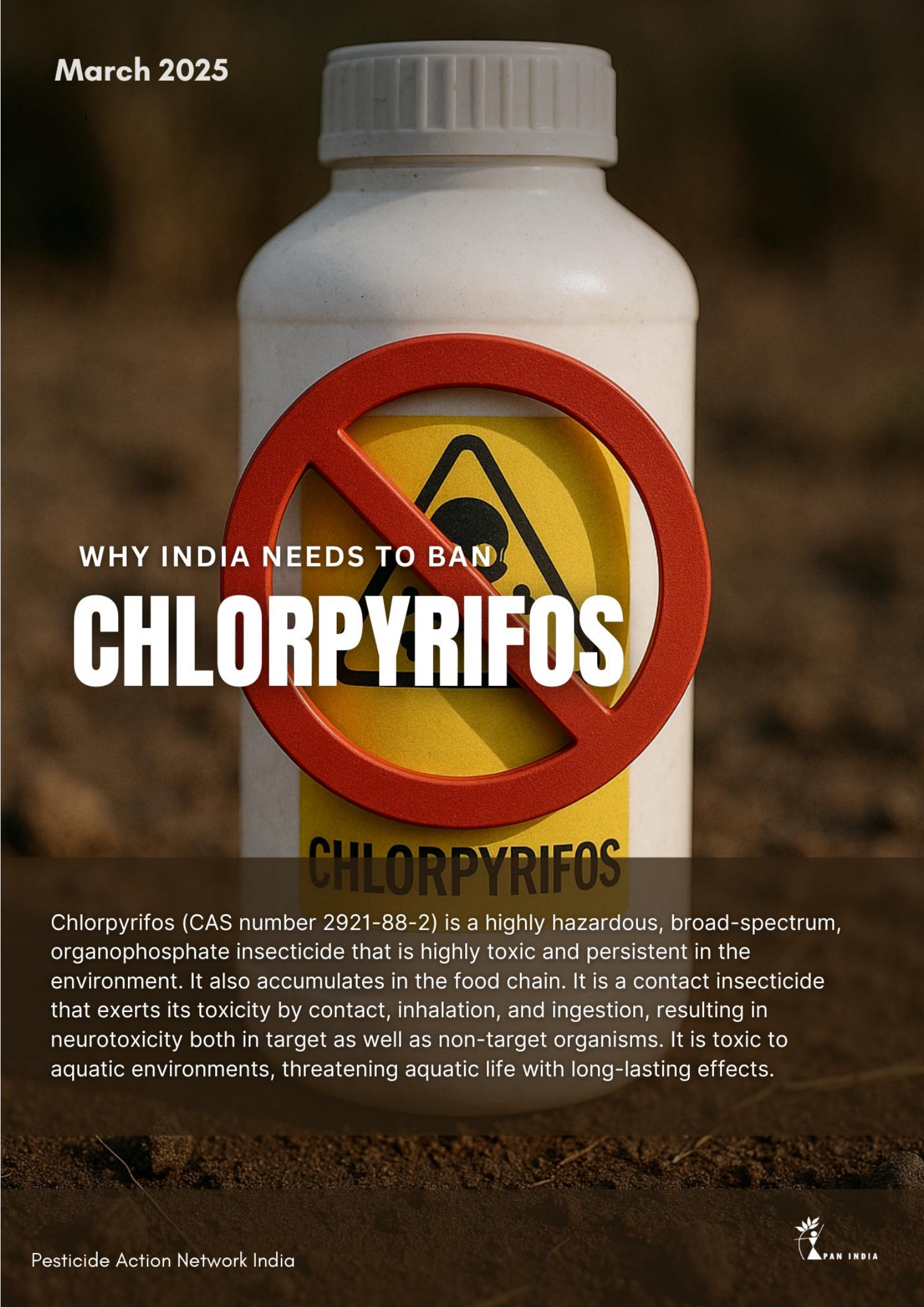
March 2025



WHY INDIA NEEDS TO BAN

CHLORPYRIFOS

Chlorpyrifos (CAS number 2921-88-2) is a highly hazardous, broad-spectrum, organophosphate insecticide that is highly toxic and persistent in the environment. It also accumulates in the food chain. It is a contact insecticide that exerts its toxicity by contact, inhalation, and ingestion, resulting in neurotoxicity both in target as well as non-target organisms. It is toxic to aquatic environments, threatening aquatic life with long-lasting effects.

Pesticide Action Network India

PAN INDIA

WHY INDIA NEED TO BAN CHLORPYRIFOS

March 2025

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About PAN India

PAN INDIA

Pesticide Action Network India (PAN India) is a non-profit, public interest, research and advocacy organisation formed in 2013. Its objective is to help communities and governments reduce dependence on toxic agrochemicals for pest control in agriculture, household as well as public health and to increase the use of sustainable alternatives. PAN India is working to empower farming communities to keep away from toxic pesticides and agrochemicals, and to take up non-chemical methods of farming practices based on agroecology.

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INTRODUCTION

Chlorpyrifos (CAS number 2921-88-2) is a highly hazardous, broad-spectrum, organophosphate insecticide that is highly toxic and persistent in the environment. It also accumulates in the food chain. It is a contact insecticide that exerts its toxicity by contact, inhalation, and ingestion, resulting in neurotoxicity both in target as well as non-target organisms. It is toxic to aquatic environments, threatening aquatic life with long-lasting effects. The World Health Organization classified chlorpyrifos as a moderately hazardous (Class II) pesticide based on acute toxicity[1].

Chlorpyrifos is known to cause respiratory paralysis and death, endocrine disruption, neurodevelopmental impacts, and fetal damage leading to neurodevelopmental disorders. Studies highlight that chlorpyrifos is implicated in various adverse effects in children, including derailed development, brain damage, impaired immune function, hormone disruption, triggering obesity, diabetes, cancer, and reproductive problems later in life. Chlorpyrifos is reported in many occupational as well as non-occupational poisonings. Residues of chlorpyrifos have been reported in human cord blood and meconium, cervical fluid, sperm fluid, breast milk, and maternal and infant hair. Further, residues have also been reported in food commodities[2].

It affects the normal functioning of the nervous system of insects upon contact. Chlorpyrifos affects the nervous system by inhibiting the breakdown of the neurotransmitter acetylcholine (ACh) (Smegal, 2000). Chlorpyrifos activity results in the accumulation of ACh in the synaptic cleft and causes overstimulation of the neuronal cells, which leads to neurotoxicity and eventually death (Karanth, 2000; USDHHS, 1997). Studies have shown that the mode of action of chlorpyrifos is similar both in target organisms and in non-target organisms. It can interact with the enzyme cholinesterase, carboxylesterases, and A-esterases in mammals.

Chlorpyrifos can cause cholinesterase inhibition in humans. This can over stimulate the nervous system, causing nausea, dizziness, confusion, and at very high exposures (e.g., accidents or major spills), respiratory paralysis and death (USEPA, 1999), as well as a range of chronic health impacts, such as endocrine disruption and neurodevelopmental impacts (Hazarika, et al., 2020; Bruke, et al., 2017). It is known to cause fetal damage, leading to neurodevelopmental disorders. Chlorpyrifos is implicated in various hazards in children, such as derailed development, brain damage, impaired immune function, hormone disruption, triggering obesity, diabetes, cancer, and reproductive problems later in life.

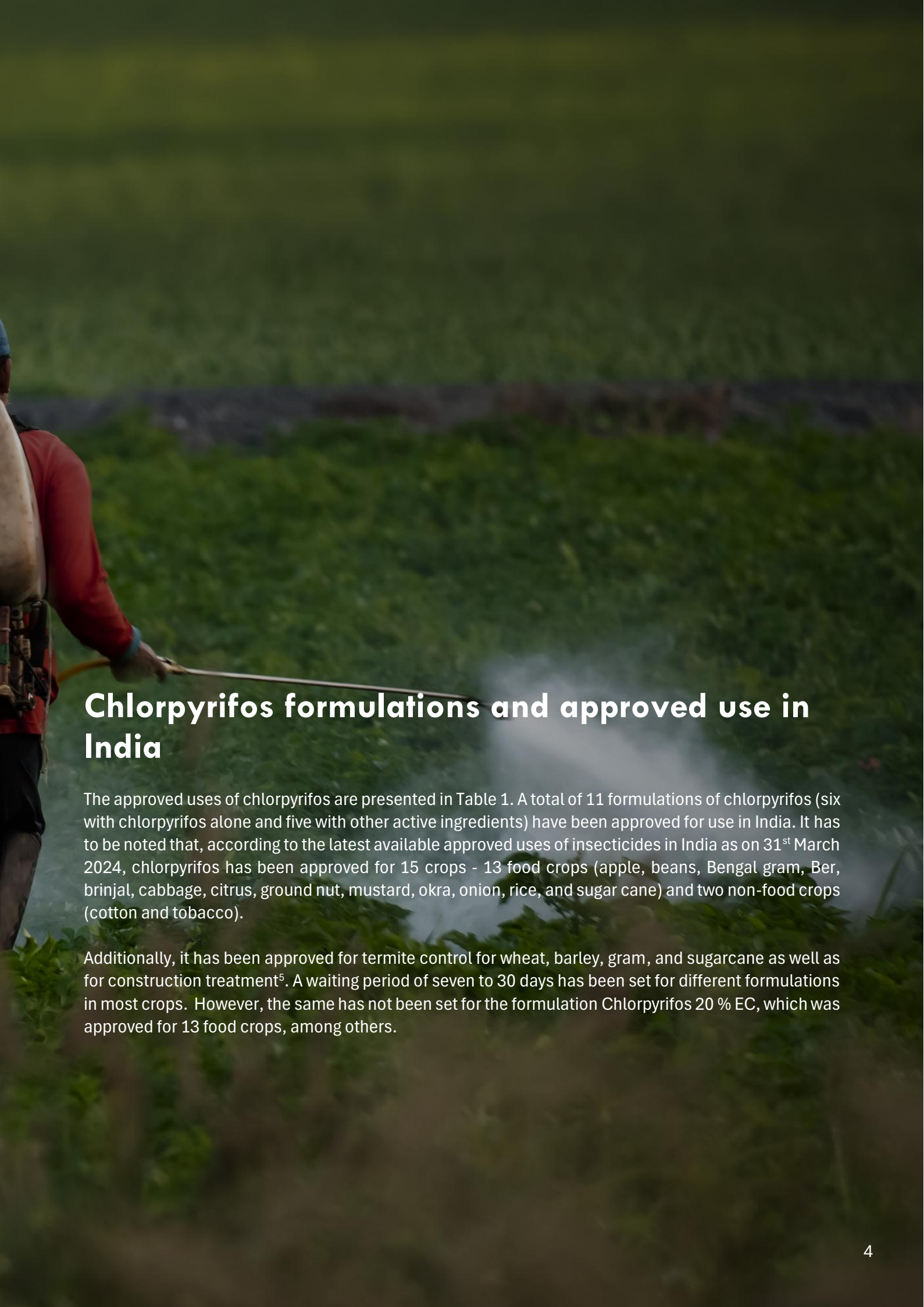
Chlorpyrifos is a dangerous chemical and is toxic if swallowed as well as fatal if inhaled (acute toxicity). It is very toxic to aquatic life with long-lasting effects. The acute toxicity classification of the World Health Organization (WHO) classified chlorpyrifos as a Class II - moderately hazardous pesticide. However, Pesticide[4] Action Network (PAN) considers it a Highly Hazardous Pesticide (HHP) as it meets the reproductive toxicity criterion, and is a PAN Bad Actor[5] chemical. Moreover, it has been identified as one of the 20 most Highly Hazardous Pesticides that cause harm to children.


CHLORPYRIFOS

Chlorpyrifos regulation in India

Chlorpyrifos was registered in 1977 and approved for use in agriculture as well as non-agricultural applications. Chlorpyrifos is one of the most commonly used and recommended insecticides in India (Bhushan, C. et al, 2013). In the State of Bihar, chlorpyrifos has been banned for use on green gram. The State Government of Kerala has restricted the use of chlorpyrifos. The Indian government has banned the use of Chlorpyrifos on Ber, Citrus, and Tobacco (S.O. 4294(E) dated 3rd October, 2023).

The Anupam Varma Committee constituted by the Agriculture Department in 2013 reviewed 66 pesticides banned elsewhere and still used in India recommended use of chlorpyrifos to be continued and to be reviewed in 2018. A subcommittee constituted by the Registration Committee had reviewed the continued use of 27 pesticides as recommended by the Dr. Anupam Verma Committee in 2015. This subcommittee concluded that all 27 pesticides, including chlorpyrifos, may be banned in India. The subcommittee arrived at this recommendation after considering information with respect to safety concerns, submission of requisite data by pesticide companies, availability of information in the public domain, ban status of pesticides in other countries, and availability of alternatives. On chlorpyrifos, the decision of the subcommittee was as follows: ***"incomplete data submitted for toxicity and bio efficacy, ecotoxic and health hazards to children and infants, product is an organophosphate and neurotoxic. There are reports of genotoxicity and health hazards. Also, alternatives are available. Therefore, its use in agriculture may be banned except for use in desert locust"***[3]**.** The subcommittee had listed several alternatives to chlorpyrifos for its registered uses, which include a number of chemical and non-chemical alternatives. The Registration Committee approved the report of the Sub Committee on the 27 pesticides and submitted the same to the Department of Agriculture for further action, and consequently, the Ministry of Agriculture and Farmers Welfare issued a draft notification on banning the 27 pesticides, including chlorpyrifos, on 14th May 2020. This draft notification pointed out that the "***Central Government is satisfied that the use of twenty-seven insecticides as specified in the schedule to this Notification is likely to involve risk to human beings and animals and to render it expedient or necessary to take immediate action".*** The government appointed a couple of committees to consider submissions from stakeholders –primarily pesticide companies- on this matter, and later in 2023, the government watered down the important regulatory decision of banning the 27 pesticides and banned only four pesticides among the 27 list. Chlorpyrifos is allowed for continuous use, but three crops - Ber, citrus, and tobacco – are omitted from approved use[4].



Chlorpyrifos formulations and approved use in India

The approved uses of chlorpyrifos are presented in Table 1. A total of 11 formulations of chlorpyrifos (six with chlorpyrifos alone and five with other active ingredients) have been approved for use in India. It has to be noted that, according to the latest available approved uses of insecticides in India as on 31st March 2024, chlorpyrifos has been approved for 15 crops - 13 food crops (apple, beans, Bengal gram, Ber, brinjal, cabbage, citrus, ground nut, mustard, okra, onion, rice, and sugar cane) and two non-food crops (cotton and tobacco).

Additionally, it has been approved for termite control for wheat, barley, gram, and sugarcane as well as for construction treatment[5]. A waiting period of seven to 30 days has been set for different formulations in most crops. However, the same has not been set for the formulation Chlorpyrifos 20 % EC, which was approved for 13 food crops, among others.

Table 1. Approved uses of Chlorpyrifos in India (as on 30/11/24)

#	Formulations	Crops	Target pests	Waiting period
1	Chlorpyrifos 10 % Granules	Rice	Stemborer	30 days
			Leaf folder	
			Gall midge	
2	Chlorpyriphos 75 % w/w WG	Rice	Yellow stem borer	15 days
3	Chlorpyrifos 19% ME	Rice	Stem Borer	30 days
4	Chlorpyrifos 20 % EC	Rice	Leaf folder, gall midge, stem borer	-
			Hispa	-
			Whorl maggot	-
		Beans	Pod borer, black bug	-
		Gram	Cut worm	-
		Sugarcane	Blackbug	-
				-
			Early shoot & stalk borer	-
			Pyrilla	-
		Cotton	Aphid	-
			Bollworm	-
			Whitefly	-
			Cutworm	-
		Groundnut	Aphid	-
			Root grub	-
		Mustard	Aphid	-
				-
		Brinjal	Shoot& fruit borer	-
		Cabbage	Diamond back moth	-
		Onion	Root grub	-
		Apple	Aphid	-
		Ber	Leaf hopper	-

		Citrus	Black citrus fly	-
			Aphid	-
		Non-cropped & cropped area and soil treatment.	Termites	-
		Tobacco	Ground beetle	-
5	Chlorpyrifos 50 % EC	Rice	Stemborer, leaffolder	15 days
		Cotton	Bollworms	30 days
		Non agricultural use	Termites	-
6	Chlorpyrifos 01.50 % DP	Rice	Stem borer, Green leaf hopper, Leaf folder, Gall midge, Grass hopper	7 days
			Brown plant hopper	
		Bengal gram	Pod borer (Helicoverpa armigera)	7 days
			Chlorpyrifos in combination with other active Ingredients	
7	Chlorpyrifos 50 % + Cypermethrin 05 % EC	Rice	Stem borer, Leaf folder	15 days
		Cotton	Aphid, Jassids, Thrips,Whitefly, Spodoptera litura, Spotted bollworm, Pink bollworm, American bollworm	15 days
		Brinjal	Shoot & Fruit Borer	7 days
		Cabbage	Diamond Back Moth	5 days
		Okra	Fruit borer (Earias vitella)	10 days
8	Chlorpyriphos 16 % + Alphacypermethrin 01 % EC	Cotton	Spotted bollworm, Pink bollworm, American bollworm	15 days
9	METHOXYFENOZIDE 5% + CHLORPYRIPHOS 25% SE	Bengal gram	Pod borer (Helicoverpa armigera)	15 days
10	Bifenthrin 03 % + Chlorpyriphos 30 % w/w EC	Rice	Stem borer, Leaf folder	21 days
11	Acetamiprid 00.40 % + Chlorpyriphos 20 % EC	Rice	Stem Borer, Brown plant hopper & White backed plant hopper	10 days

Global regulation on Chlorpyrifos

Globally, chlorpyrifos is completely banned in 44 nations. Many countries have brought severe restrictions on the production, sale, use, import, and/or export of chlorpyrifos, and some countries are reviewing the use of chlorpyrifos, particularly due to health and environmental concerns. The European Union nominated it for inclusion under the Stockholm Convention on Persistent Organic Pollutants (POPs) for global phase-out in 2021, and the POPs Review Committee found in January 2022 that it meets the Convention's criteria for a POP. The twentieth meeting of the Persistent Organic Pollutants Review Committee (POPRC) that took place from 23 to 27 September 2024 concluded that it meets all criteria warranting global phase out and decided to recommend listing it under Annex A to the Stockholm Convention[6].

The POPRC's Risk Management Evaluation of Chlorpyrifos has emphasized opportunities for reduction of HHPs. It states, "The Global Framework on Chemicals (GFC) was adopted and Resolution V/11 on HHPs was endorsed at the International Conference on Chemicals Management, ICCM5, in September 2023, and addresses pesticides that meet the FAO criteria for HHPs. More specifically, Target A7 of the GFC requests that by 2035, stakeholders have taken effective measures to phase out HHP in agriculture where the risks have not been managed and where safer and affordable alternatives are available; and to promote transition to and make available those alternatives. As to Resolution V/11, the ICCM endorsed the formation of a global alliance on HHP; it requests inter alia to support low- and middle-income countries in their efforts to strengthen national regulatory frameworks and phase out HHP in agriculture where the risks have not been managed and where safer and affordable alternatives are available; and to promote transition to and make available those alternatives[7].

Major findings from the Risk Management Evaluation for Chlorpyrifos from the Report of the Persistent Organic Pollutants Review Committee is summarized as follows.

POPRC-19/3 concluded that chlorpyrifos is likely to cause significant adverse effects on human health and the environment due to its long-range environmental transport. The European Food Safety Authority's assessment points that "chlorpyrifos may be considered to meet "Criterion 4" of the FAO's Highly Hazardous Pesticide (HHP) criteria (FAO 2016): i.e., meets the criteria of reproductive toxicity Categories 1A and 1B of the Globally Harmonized System on Classification and Labelling of Chemicals (GHS)". Chlorpyrifos use has been reported in agriculture, household and residential settings, forestry and construction sectors as well as public health and locust control operations. Chlorpyrifos is a semi-volatile chemical. It can be released into the environment during the manufacturing process and use. Chlorpyrifos application contributes direct release into the environment and is further dispersed into various environmental compartments – soil, water, and air. It has the potential to contaminate water resources through spray drift and runoff from the site of application.

The POPRC (2024) risk assessment evaluation of Chorpyrifos notes that "prohibition of production, use, import and export by listing in Annex A without exemptions is the most effective control measure to prevent harm to human health and the environment. Several countries in a wide range of climates, economic development levels, and specific chlorpyrifos applications have successfully implemented this to date".

Statistics of chlorpyrifos in India

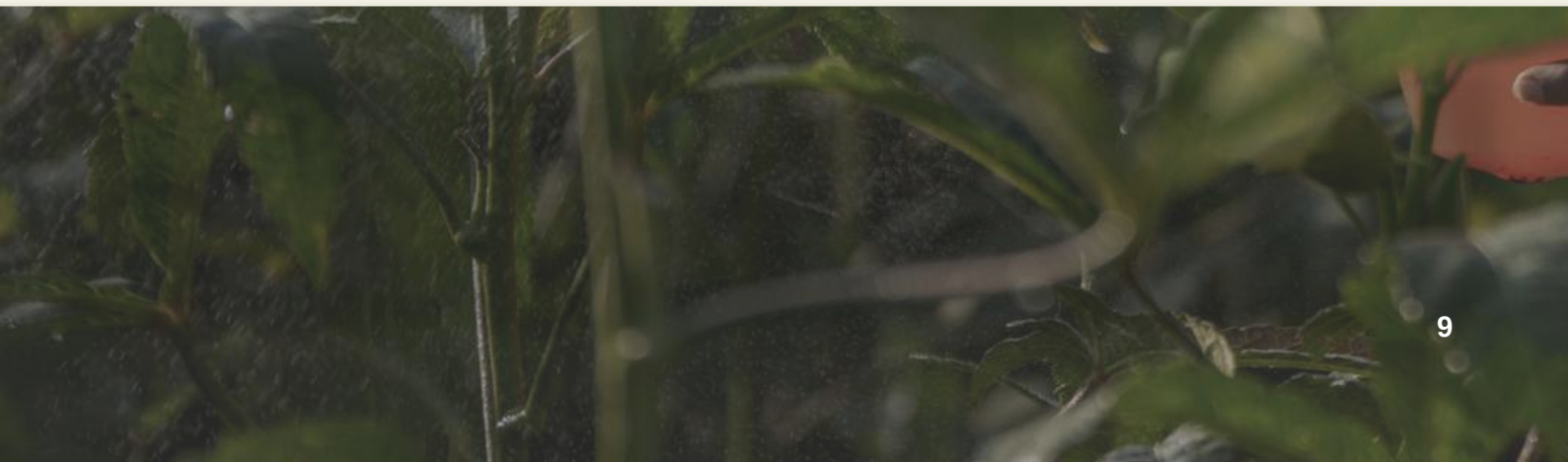
Five-year data on chlorpyrifos production and consumption as available from official sources are presented table 2 and 3. The gap between production and consumption data indicates possible export of a considerable proportion of chlorpyrifos; however, statistical data is not available for that.

Table 2. Production of Chlorpyrifos in India

#	Year	Production of chlorpyrifos (Metric ton)	Total production of pesticides (37 pesticides)	Percentage of production
1	2019-20	6496	191755	3.39
2	2020-21	8529	255090	3.34
3	2021-22	7494	297783	2.52
4	2022-23	8454	258130	3.28
5	2023-24	7789	280108	2.78

Table 3. Consumption of Chlorpyrifos in India

#	Year	Consumption of chlorpyrifos (Metric ton)	Total consumption of pesticides (293 pesticides)	Percentage of Consumption
1	2019-20	1430.62	24679.32	5.80
2	2020-21	1036.69	20697.24	5.00
3	2021-22	1050.06	23386.45	4.49
4	2022-23	1368.58	21981.98	6.63
5	2023-24	1416.22	22004.40	6.44



Recommended use of Chlorpyrifos in India

Pesticide use recommendations given by State Agriculture Departments/Universities, as well as pesticide manufacturers, covered more crops than their approved uses, indicating non-compliance with the national regulation, as well as promoting illegal use. Chlorpyrifos formulations were found to be recommended for several non-approved uses, including in food crops. Use of pesticides for non-approved crops has implications for food safety. Any use beyond the approved ones would result in farm produce not being adequately monitored for pesticide residues and thus posing a risk to consumers, in addition to environmental damage.

Use of chlorpyrifos as observed from a field study in India

A 2022 PAN India report gives insights into the field use of chlorpyrifos in India. A field study conducted in seven Indian states, Andhra Pradesh, Jharkhand, Himachal Pradesh, Karnataka, Tamil Nadu, Telangana, and West Bengal, reported chlorpyrifos use. About 79% of respondents reported the use of chlorpyrifos insecticides in 23 crops. State-wise analysis shows that all the respondents interviewed, from Andhra Pradesh, Himachal Pradesh, Karnataka, and West Bengal, have been using this insecticide, whereas in Jharkhand, Tamilnadu and Telangana, 75%, 48.14%, and 40% of the respondents, respectively, have been using it. Many respondents reported mixing of biopesticides, fungicides, and other pesticides, and micronutrients, as well as adhesives to improve stickability to plants, while applying chlorpyrifos.

According to the field data, chlorpyrifos is applied about four times during a crop season on average, especially in vegetables; it is applied at 15-day intervals. A 2020 report titled 'Toxic Blooms: Impacts of Pesticides on Children in the Floriculture Industry in Tamil Nadu', India had revealed extensive use of chlorpyrifos and other hazardous pesticides in jasmine fields in Tamil Nadu. Use of chlorpyrifos in jasmine is a non-approved use in India[8], which means it is an unauthorized use. This report points out that the use of chlorpyrifos is happening in violation of national regulations as well as the International Code of Conduct on Pesticides Management; and recommends banning the use of Chlorpyrifos by promoting non-chemical alternatives based on the principle of agroecology.

Chlorpyrifos Residues in Agriculture Commodities, Environmental Samples, And Breast Milk in India

The annual progress report of the monitoring of pesticides at the national level in India revealed that residues of chlorpyrifos (among a number of other pesticides) have been detected in a number of samples of farm produce across India during 2017-18 (FSSAI, 2019). Of the 29 commodities in which residues of chlorpyrifos were detected, only 10 were approved uses. A great majority of the residues were found in commodity/crops for which chlorpyrifos was not approved, indicating widespread non-approved use in the country. Chlorpyrifos residues were reported in water samples as well.

The Government of Kerala has been conducting regular pesticide residue monitoring of Agri produce and food products within the state as part of the Safe to Eat Scheme for a decade. It reports pesticide residues detected above the permissible limit. An analysis conducted by the author based on the residue monitoring reports for the year 2023 and 2024[9,10,11,12] shows widespread contamination of food materials with chlorpyrifos, among others. The reports revealed the presence of chlorpyrifos residues in 66 market and farm gate samples of vegetables, fruits, spices, and other food items. For all the samples, the residue level was far higher than the maximum residue limit (MRL) prescribed by the Food Safety and Standards Authority of India (FSSAI). Further, among these samples, only two are marked as approved/recommended use for chlorpyrifos in India, while the remaining 97% of samples have been reported as non-recommended/non-approved pesticides.

There were 34 commodities in which pesticide residues were found which include Amaranthus (red), apple, beans, bitter gourd, bottle gourd, broccoli, cabbage, capsicum (red and yellow), cardamom, carrot, celery, coriander & pudina leaves, coriander powder, cucumber, cumin & cumin powder, curry leaves, dry fennel leaves, dry fenugreek leaves, fennel seeds, French beans/cowpea, grapes (black and green), green chilli, ivy gourd, Kashmiri chilli, mint leaves, okra, pea, pomegranate, pumpkin, red spinach, salad cucumber, snake gourd and tomato. It is important to note that chlorpyrifos has been approved for 12 food crops.

Table 4 Commodities in which residues of chlorpyrifos have been detected in monitoring of pesticide residues at the national level 2017-2018

Pesticides	Approved crops	Commodities in which residues were detected
Chlorpyrifos	Rice,/paddy, beans, gram, cotton, ground nut, mustard, brinjal, cabbage, onion, apple, citrus, tobacco, Bengal gram, and ber.	Cauliflower, coriander leaves, green peas, pointer gourd, pigeon pea, green gram, capsicum, rice, okra, bitter gourd, cabbage, green chilli, apple, wheat, tomato, spinach, beans, cowpea, cucumber, red gram, beetroot, mustard leaves, radish, basmathi rice, fenugreek leaves, broccoli, black gram, and board bean. And also in water samples

Source: Compiled from the Survey report, Status of Pesticide Residues in India Monitoring of pesticide Residues at National Level, 2017-18.

Residues of chlorpyrifos detected in breast milk from Punjab

A 2014 report, "Monitoring of Pesticide Residues in Human Breast Milk from Punjab, India and Its Correlation with Health Associated Parameters", showed the presence of chlorpyrifos, among other pesticides, in breast milk. This study analyzed 127 milk samples, and residues were found in 25% of the samples (Anupama & Pooni, 2014). A study conducted in Bhopal, India, Sangi et al. (2003) reported that chlorpyrifos was found in breast milk at high levels, resulting in intake of 41 mg/kg/day in infants, which is 41 times higher than the level recommended by the WHO[13].

Residues of chlorpyrifos in human blood samples

A study was conducted by Mathur et al. (2005) reported chlorpyrifos residues in 85% of samples tested from four villages in Punjab, India.[14].

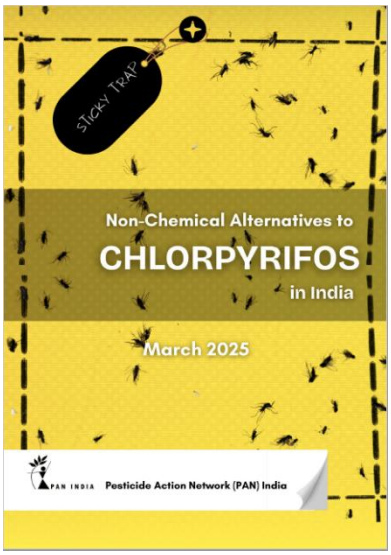
Chlorpyrifos Poisoning in India

Chlorpyrifos has been reported in many poisonings – both occupational/unintentional poisonings and self-poisonings - in India. A 2019 study conducted in Rajasthan, India, that surveyed the medical history of 50 farmers using chlorpyrifos and other pesticides found complaints of itchiness of the skin, redness of the eyes, muscle pains, dry throat, excessive sweating, and headaches[15].

Pawaret al. (2015) conducted a nine-year retrospective study of poisoning cases at the regional forensic science laboratory (RFSL) in Nashik, India detected a total of 5725 cases positively and out of which 131 fatalities were due to chlorpyrifos poisoning. They reported an increasing trend in the use of chlorpyrifos self-poisoning[16]. A 2005 study highlighted that chlorpyrifos was one of the three most used organophosphate pesticides for self-poisonings/suicide[17].

Peshin et al. (2013) performed a retrospective study between 1999 and 2012 showing that chlorpyrifos was among the pesticides which was commonly ingested as poison[18]. A 2007 study on 116 poisoning cases in Osmania General Hospital, Telangana, noted that chlorpyrifos, among others, showed more severe mortality in poisoning[19].

Alternatives to Chlorpyrifos



A number of alternatives to Chlorpyrifos are available in India. A subcommittee that reviewed continued use of chlorpyrifos in India in 2020 had listed several alternatives for the crop-pest combination approved for its use. Sustainable ecological solutions to replace chlorpyrifos include the use of bio-pesticides and numerous cultural, mechanical, and biological solutions to pest control, as well as natural sprays that can be used depending on the pest and the situation, which rely on the utilization of agroecological practices.

Pesticide Action Network India has compiled a list of non-chemical alternatives to chlorpyrifos in India, based on information provided in major uses of approved bio pesticides in India and practices and methods listed in crop production guides/packages of practices developed by various State agriculture Universities and Departments (Available in this link: https://pan-india.org/wp- content/uploads/2025/04/Non-Chemical Alternatives-to-Chlorpyrifos_PAN-India_March-2025.pdf).

It provides viable non-chemical alternatives applicable for almost all the crops for which chlorpyrifos is currently approved for use in India. Apparently, there are thousands of farmers across India who grow various crops with non-chemical, organic, and agroecology methods, for which chlorpyrifos is approved for in the country.

Conclusion

Chlorpyrifos is a dangerous chemical acknowledged to present acute and chronic adverse health and environmental effects. It has been reported in both occupational and self-poisonings in the country. It is approved for 15 crops and non-agricultural usage in India. Residues of chlorpyrifos have been detected in several agricultural produce, food items, water samples, and breast milk in India, indicating widespread contamination. Available statistical data from official sources point to chlorpyrifos having nearly 3% share in production and about 6.44% share in consumption in India, indicating that it will not affect agricultural production in the country. Moreover, a number of viable non-chemical alternatives are available. It has been banned in 44 countries, and many countries are working towards stringent regulation. Persistent Organic Pollutants Review Committee (POPRC) of the Stockholm Convention concluded in 2024 that chlorpyrifos meets all criteria warranting global phase out and recommend to list it under Annex A to the Stockholm Convention as a prohibition of production, use, import and export by listing in Annex A without exemptions is the most effective control measure to prevent harm to human health and the environment.

Recommendation

Given that the inherent potential and adverse effects of chlorpyrifos as evident from both national and international assessments, also that several viable affordable and practical alternatives are available PAN India recommends urgently banning the production, use, import and export of chlorpyrifos in India.

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