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Permitted Does Not Imply Safe

Why a legal limit is not the same as a safe dose, and how to read India's pesticide limits for drinking water against the world's

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FOR WATER UTILITIES, PUBLIC-HEALTH AGENCIES, STANDARD SETTERS, JOURNALISTS, FARMER AND FARMWORKER ORGANISATIONS, AND ANYONE READING A WATER TEST

ABSTRACT

If my water is within the limit, is it safe? Why does the European Union allow one tenth of a microgram of malathion in a litre of drinking water while India allows 190? And who checks? This working paper answers those three questions by setting India's 18 pesticide limits for drinking water (IS 10500:2012) beside those of the World Health Organization, the European Union and the United States, each read in the original. It makes three claims. First, a permissible limit is not the same as a safe dose: two different kinds of number share the word 'limit'. Health-based limits divide a tolerable daily intake by assumptions about a 60 kg adult drinking 2 litres a day; the European limit is a purity rule that applies the same 0.1 µg/L to every pesticide, whatever its toxicity. Second, India is looser than Europe on 14 of its 18 pesticides, by up to 1,900 times, and matches or beats Europe only on four persistent organochlorines of the past; for ten of the 18 the WHO sets no guideline value, often because it judges them unlikely to occur, a judgment India's own measurements contradict. Third, a limit is only as real as the laboratory that can see it: India's drinking-water mission tests pesticides at state laboratories only, and the national pollution board reports 'below detection limit' without saying what the limit is. Every limit can be read with four plain questions, and the paper sets them out.

KEYWORDS

pesticides; drinking water; standards; IS 10500; WHO guidelines; European Union; EPA; permissible limit; detection limit; mixtures; PFAS; tail-end; India; Tailwinds

COMPANION PAGE

Pesticide Central

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Argument

If my water is within the limit, is it safe? Why does the European Union allow one tenth of a microgram of malathion in a litre of drinking water while India allows 190, nearly two thousand times as much? And who checks? These are the questions a lay reader asks of a water test, and the number printed beside each pesticide answers none of them on its own.

This paper makes three claims. First, a permissible limit is not the same as a safe dose. The word 'limit' covers two different kinds of number: a health-based value, computed from toxicology and a set of assumptions about who is drinking, and a purity rule, which says that pesticides do not belong in drinking water at all. Second, India's limits are strict on the chemicals of the past and loose on the chemicals of the present: India is looser than Europe on 14 of its 18 pesticides and matches or beats Europe only on four persistent organochlorines. Third, a limit is only as real as the laboratory that can see it. Where no laboratory looks, or where a laboratory reports 'below detection' without stating what it can detect, the limit protects no one.

The comparison rests on four standards read in the original: India's IS 10500:2012 (Bureau of Indian Standards 2012), the WHO guidelines for drinking-water quality (WHO 2022), the European Union's drinking water directive (European Union 2020), and the United States' national primary drinking water regulations (US EPA 2026a). All values are in micrograms per litre (µg/L).

1

Two kinds of number share one word

A health-based limit begins with a tolerable daily intake: the amount of a substance that can be ingested every day for a lifetime 'without appreciable health risk, and with a margin of safety' (WHO 2022). The WHO converts that intake into a concentration in water by multiplying it by body weight and by the fraction of the intake allotted to drinking water, then dividing by daily water consumption. The defaults are an adult of 60 kg drinking 2 litres a day, with 20 percent of the intake allotted to water, but the choices are made chemical by chemical. Among the pesticides in this paper the allocation is 20 percent for atrazine, 10 percent for chlorpyrifos, 2,4-D and isoproturon, and 1 percent for aldrin with dieldrin, DDT and lindane. The value for DDT is set for a child of 10 kg drinking 1 litre a day, and the value for alachlor comes from a cancer model rather than a tolerable intake (WHO 2022). The limit is therefore a person as much as a chemical: it is set for someone of a given weight, drinking a given amount, whose food and surroundings bring the rest of the dose.

The European limit is a different kind of number. The directive sets 0.10 µg/L for each individual pesticide and 0.50 µg/L for all pesticides together, and a stricter 0.030 µg/L for aldrin, dieldrin, heptachlor and heptachlor epoxide (European Union 2020). The same 0.10 applies to a herbicide of low toxicity and to an organophosphate insecticide. It does not claim that 0.11 µg/L is harmful; it says that drinking water should be close to free of pesticides, and that their presence signals a failure upstream.

India, the WHO and the United States set health-based numbers; Europe sets a purity rule. Comparing them is still useful, because the gap between them is the size of the bet each country makes on its assumptions. Where India allows 1,900 times the European value, it is relying on its toxicology, its 60 kg adult and its 2 litres being right. The two kinds are easily confused, even by specialists: a 2026 peer-reviewed study of groundwater in Greater Noida gives the WHO guideline for chlorpyrifos as 0.1 µg/L, the European purity value, where the WHO sets 30 (Mathur et al. 2026; WHO 2022).

2

What the numbers mean

A microgram per litre is one part per billion. One part per billion is about one second in 31.7 years. The European limit, 0.1 µg/L, is one gram of a pesticide dissolved evenly in ten million litres of water, about four Olympic swimming pools. India's limit for malathion, 190 µg/L, is one gram in about 5,300 litres, a little over five 1,000-litre rooftop tanks. India's limit for chlorpyrifos, 30 µg/L, is one gram in about 33 such tanks.

Daily doses make the limits concrete. An adult drinking 2 litres a day of water at India's malathion limit takes in 380 micrograms of malathion a day. A child of 10 kg drinking 1 litre, the WHO's default for a child (WHO 2022), takes in three times as much per kilogram of body weight as the 60 kg adult the limit was set for. These are statements about the arithmetic of the limit, not about harm: whether 380 micrograms a day harms anyone depends on the toxicology the limit was meant to encode.

3

Four standards, one pesticide at a time

Table 1 sets India's 18 limits beside the other three standards. Three patterns stand out.

PESTICIDE	INDIA, IS 10500 (µg/L)	WHO GUIDELINE (µg/L)	EUROPEAN UNION (µg/L)	UNITED STATES, EPA (µg/L)	INDIA AGAINST THE EU VALUE
Malathion	190	None; occurs well below health concern	0.1	None	1,900 times
Butachlor	125	Not covered	0.1	None	1,250 times
Chlorpyrifos	30	30	0.1	None	300 times
2,4-D	30	30	0.1	70	300 times
Alachlor	20	20	0.1	2	200 times
Isoproturon	9	9	0.1	None	90 times
Ethion	3	Not covered	0.1	None	30 times
Atrazine	2	100	0.1	3	20 times
Lindane (gamma-HCH)	2	2	0.1	0.2	20 times
Phorate	2	None; unlikely to occur	0.1	None	20 times
DDT and metabolites	1	1	0.1	None	10 times
Monocrotophos	1	None; withdrawn in many countries	0.1	None	10 times
Endosulfan	0.4	None; occurs well below health concern	0.1	None	4 times
Methyl parathion	0.3	None; occurs well below health concern	0.1	None	3 times
Aldrin and dieldrin	0.03	0.03	0.03	None	Equal
Beta-HCH	0.04	None; unlikely to occur	0.1	None	2.5 times stricter

PESTICIDE	INDIA, IS 10500 (µg/L)	WHO GUIDELINE (µg/L)	EUROPEAN UNION (µg/L)	UNITED STATES, EPA (µg/L)	INDIA AGAINST THE EU VALUE
Delta-HCH	0.04	None; unlikely to occur	0.1	None	2.5 times stricter
Alpha-HCH	0.01	None; unlikely to occur	0.1	None	10 times stricter
Glyphosate (not in IS 10500)	None	None; occurs well below health concern	0.1	700	No Indian limit

First, India follows the WHO wherever the WHO has a number. The standard says so: its pesticide limits were 'specified based on WHO guidelines, wherever available', and where none existed, 'the standards available from other countries have been examined and incorporated, taking in view the Indian conditions' (Bureau of Indian Standards 2012). Seven of India's values equal the WHO's current guideline values exactly: alachlor, aldrin with dieldrin, chlorpyrifos, 2,4-D, DDT, isoproturon and lindane. Atrazine is the exception, and it is instructive. India's 2 µg/L is the WHO's own earlier value: the 1993 guidelines set 0.002 mg/L, the 2008 edition that India's standard drew on kept it (WHO 2008), and the WHO has since raised it to 100 µg/L (WHO 2022). On atrazine, India kept the old number after the WHO moved.

Second, for ten of India's 18 pesticides the WHO sets no guideline value at all. For malathion, endosulfan and methyl parathion it judges that they occur in drinking water 'at concentrations well below those of health concern'; for the hexachlorocyclohexanes and phorate it judges them 'unlikely to occur in drinking-water'; monocrotophos 'has been withdrawn from use in many countries' (WHO 2022). Butachlor and ethion do not appear in the guidelines at all. For these, India borrowed from elsewhere or set its own, and the standard does not say how.

Third, the United States sets federal limits for only four of India's 18: alachlor, atrazine, 2,4-D and lindane (US EPA 2026a). The United States has no federal drinking-water limit for chlorpyrifos, malathion, DDT or endosulfan. Absence from a standard is not the same as absence from water.

4

Strict on the past, loose on the present

Against the European value, India is stricter on three pesticides, equal on one and looser on fourteen. All four where India matches or beats Europe are persistent organochlorines listed under the Stockholm Convention: alpha-, beta- and delta-HCH, and aldrin with dieldrin. The fourteen where India is looser include the chemicals sprayed on Indian fields today: malathion at 1,900 times the European value, butachlor at 1,250 times, chlorpyrifos and 2,4-D at 300 times, alachlor at 200 times, isoproturon at 90 times, and atrazine at 20 times.

The WHO's occurrence judgments carry the same tilt. A guideline is withheld when a chemical is judged unlikely to occur, and that judgment rests on where measurement has been done. India's own measurements disagree. Groundwater in Amravati, Maharashtra, carried alpha-HCH at 0.39 µg/L, 39 times India's limit (Lari et al. 2014). In the Hooghly basin, 93.7 percent of river samples carried more than 0.5 µg/L of total pesticides, the European limit for all pesticides together, in 2014 to 2016 (Mondal et al. 2018). 'Unlikely to occur' is a statement about the places that were measured.

5

The assumptions fail at the tail

Every health-based limit assumes a person, and the person is not the one most exposed. The WHO itself notes that daily water intake 'can vary significantly in different parts of the world, seasonally and particularly where consumers are involved in manual labour in hot climates' (WHO 2022). A farm labourer in an Indian summer is the person the guidelines describe as the exception. A child drinks three times the adult's dose per kilogram at the same concentration. The fraction allotted to water assumes that food and surroundings bring the rest of a tolerable intake; for a household that mixes and sprays pesticides, the field can bring more than the rest.

Limits are also set one chemical at a time, and water does not arrive that way. The Hooghly study detected 19 pesticides in the basin's rivers (Mondal et al. 2018). India's standard has no limit for total pesticides; Europe's 0.50 µg/L is the only one of the four standards that counts the mixture. A glass of water can meet every individual limit and still carry a dozen residues at once. A limit set for a 60 kg adult, drinking 2 litres, exposed to one chemical, is a limit for the middle of the distribution. The people at its tail are the ones it was not drawn for.

6

A limit nobody can see

A limit protects no one unless a laboratory can measure below it. India's limit for alpha-HCH is 0.01 µg/L. A laboratory that cannot detect 0.01 µg/L cannot say whether water meets it, and a report of 'not detected' from such a laboratory is a non-measurement, not a clean result.

The record shows both failures. The Jal Jeevan Mission's framework assigns total pesticide residue and every individual pesticide to state laboratories only, marking each 'No' for district and for sub-divisional or block laboratories (Ministry of Jal Shakti n.d.). The laboratories closest to the villages are not expected to test pesticides at all. When the Central Pollution Control Board reported to the National Green Tribunal on Punjab, it stated that 12 pesticides at 43 groundwater stations were 'Below Detection Limit (BDL) in the State during 2019 – 2023', and nowhere stated what the detection limit was (Central Pollution Control Board 2024). The limits in IS 10500 are exact to the hundredth of a microgram. The reporting that is meant to enforce them is not.

7

PFAS and industrial pollutants: the limits India has not written

Pesticides are not the only chemicals the standards treat unequally. The United States now regulates PFOA and PFOS, two of the synthetic 'forever chemicals', at 4.0 nanograms per litre each, and requires quarterly sampling wherever they exceed a trigger level; compliance is due by April 2029 (US EPA 2026b). In May 2026 the EPA proposed to keep those limits while letting systems apply for two more years, to 2031, and separately proposed to rescind its limits for PFHxS, PFNA, HFPO-DA and their mixtures (US EPA 2026c). The European Union's limit of 0.10 µg/L for the sum of 20 PFAS applies from 12 January 2026 (European Union 2020).

Four nanograms per litre is four parts per trillion, about four seconds in 7,900 years. One gram of PFOA would bring 250 million litres, about 100 Olympic pools, to the US limit. The US value is 25 times stricter than Europe's value for any single pesticide and 47,500 times stricter than India's limit for malathion. India's drinking-water standard, its bottled-water regulation and the Jal Jeevan Mission's framework contain no PFAS parameter at all (Bureau of Indian Standards 2012). The United States is arguing over how fast to reach four parts per trillion; India has not begun the argument. Whether other countries of the Global South have begun it is a question this series will take up. A country without a limit has no exceedances to report, and so no evidence that it needs one.

Industrial pollutants show the same pattern from a different angle. For most of them, India's numbers match the WHO's: 0.5 µg/L for PCBs, 0.1 µg/L for polyaromatic hydrocarbons, 10 µg/L for lead and 3 µg/L for cadmium (Bureau of Indian Standards 2012; WHO 2022). The gaps lie elsewhere. Arsenic, which the Jal Jeevan Mission names first among the natural contaminants of rural groundwater, is held to 10 µg/L but relaxed to 50 µg/L 'in the absence of alternate source', so the households with the fewest options receive the weakest protection. PCBs, polyaromatic hydrocarbons, cadmium and cyanide are tested only at state laboratories (Ministry of Jal Shakti n.d.). And for pharmaceutical waste, the government told Parliament in 2021 that active pharmaceutical ingredients are 'not a notified parameter' for common effluent treatment plants, and that an expert committee had not accepted a standard for antibiotic residues because 'no other country in the world implemented these standards' (Lok Sabha 2021).

How to read a limit

Four plain questions turn any limit into something a reader can judge.

1. **What kind of number is it?** A health-based value, which estimates a dose, or a purity rule, which says pesticides should not be there at all. Europe's 0.1 is a purity rule; India's, the WHO's and the United States' numbers are health-based.
2. **Whom was it set for?** A 60 kg adult drinking 2 litres a day, unless the standard says otherwise. A child, a pregnant woman, or a labourer drinking more in the heat sits outside that assumption.
3. **Can the laboratory see it?** A result means something only if the detection limit is stated and is below the permissible limit. 'Not detected' without a detection limit is no result.
4. **Is it one chemical or many?** Water carries mixtures. A test that meets every single limit says nothing about the sum unless a total is measured.

What would settle the question is modest. Publish the detection limit beside every 'below detection' result. Extend pesticide testing to district laboratories in the districts that spray the most. Report a total for all pesticides measured, as Europe does. Add limits for widely used chemicals that the standard omits; glyphosate has no limit in IS 10500, although the WHO, Europe and the United States all address it. And state, for each limit, where it came from and for whom it was set. None of this changes a single number in the standard. It makes the numbers mean what they claim to mean.

Privacy and use

This paper uses published standards and peer-reviewed or official measurements only, at the level of districts and river basins. No well, farm or household is identified. The comparisons with the European value are arithmetic, not judgments of harm: a value above the European limit is not evidence of injury, and a value below India's limit is not evidence of safety.

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Limits of this paper

The paper compares the numbers in four standards; it does not reassess their toxicology. It does not cover limits for packaged water or food residues, or state-level standards. The WHO values are those of the fourth edition with the first and second addenda (WHO 2022); India's standard was built on the third edition of 2008, and some differences may reflect revisions since then. The measurements cited are examples drawn from the companion map of India's waters, not a survey.

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