SOWING HARM

The Multifaceted Impact of Pesticides in Four Countries

PAN ASIA PACIFIC

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This publication was published by PAN Asia Pacific.

e ISBN 978-983-9381-79-5

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List of Abbreviation

2,4-D	2,4-Dichlorophenoxyacetic acid
3-PBA	3-Phenoxybenzoic acid
AChE	Acetylcholinesterase
BARCIK	Bangladesh Resource Center for Indigenous Knowledge
BBC	British Broadcasting Corporation
BMC	BioMed Central
CCI	Climate Change Institute
CGFED	Research Centre for Gender, Family and Environment in Development
CPAM	Community based Pesticide Action Monitoring
CO_2	Carbon dioxide
CO_2e	Carbon dioxide equivalent
CSO	Civil Society Organisation
DDE	Dichlorodiphenyldichloroethylene
DDT	Dichloro-diphenyl-trichloroethane
EEC	European Economic Commission
EU	European Union
FAO	Food and Agriculture Organisation
GAP	Good Agriculture Practice
GHG	Greenhouse gases
GSA	Green and Sustainable Agriculture
GSAF	Green and Sustainable Agriculture Framework
GTB	Guru Teg Bahadur
HCB	Hexachlorobenzene
HCH	Hexachlorocyclohexane
HHP	Highly Hazardous Pesticide
HQ	Hazard quotient
ICC	Institute of Climate Change
IPM	Integrated pest management
LYCH	Lambda-cyhalothrin
MAF	Ministry of Agriculture and Forestry
MARD	Minister of Agriculture and Rural Development
MRL	Maximum residue level
MU	Mehendiganj Upazila

NIAS	National Institute of Advanced Studies
NPUW	No Pesticide Use Week
OAPP	Occupational acute pesticide poisoning
OC	Organochlorine
OP	Organophosphate
PANAP	Pesticide Action Network Asia Pacific
PAN	Pesticide Action Network
PChE	Pseudocholinesteras
PNP	Para-nitrophenol
POC	Protect Our Children
POP	Persistent Organic Pollutant
PPE	Personal Protective Equipment
SAEDA	Sustainable Agriculture & Environment Development Association
SHISUK	Shikkha Shastha Unnayan Karzakram
SU	Savar Upazila
SVI	Social Vulnerability Index
TCPY	3,5,6-trichloro-2-pyridinol
UAPP	Unintentional acute pesticide poisoning
UCMS	University College of Medical Sciences
UN	United Nations
USA	United States of America
VND	Vietnamese Dong

1.
EXECUTIVE SUMMARY AND RECOMMENDATIONS

Pesticides are widely used in agriculture in Bangladesh, India, Laos and Vietnam to manage harmful pests and reduce production losses or product damage, in the mistaken belief that pesticides are necessary to grow food, and despite evidence to the contrary that sufficient, healthy food can be grown without them.

Farmers who load, mix, and spray pesticides run the risk of coming into contact with these substances from drift, spills, and splashes as well as direct spray contact, but also when engaged in non-pesticide-related tasks. Women and children, who work manually in pesticide-treated fields run the risk of serious exposures by direct spraying, drifting chemicals from nearby fields, or coming into contact with pesticide residues on the crop, in the soil or airborne dust. Famers' families are also exposed by spray and vapour drift from the fields, by washing pesticide-soaked work clothing, children playing in the fields that have been sprayed, or picking sprayed flowers or cotton, or even just playing on the ground around their houses which has become contaminated by drift from the fields. Or in their homes: analysis of dust samples in houses in Vietnam found 47 different pesticides, including carbendazim, carbofuran, chlorfluazuron, chlorpyrifos, cyhalothrin, cypermethrin, hexaconazole, permethrin and DDT. Produce from sprayed crops frequently contains residues, and these are ingested by everyone. All of these exposures – both respiratory, dermal and ingested – can result in acute and/or chronic health impacts.

Health Impacts

Acute pesticide poisoning continues to be a major problem in the four countries. The number of studies and the information available is very inadequate, but what is available shows that the incidence is actually increasing in two of the countries, with only slight decreases in the other two, since the publication

of the first estimations of unintentional[1] acute pesticide poisoning (UAPP) by Boedeker et al. in 2020.[2] Laos, in particular, suffers from a shortage of studies on acute poisoning, and the only available studies have the incidence increasing to over 90%. Most information is available for India, and there the incidence has increased to 73.63%. In Bangladesh, there appears to be a slight decrease in incidence, to 46%. However, local media have reported a number of deaths of farmers who collapsed in their fields whilst spraying; there is no record of the number of farmers who fell ill whilst spraying but did not die. In Vietnam, again recent data is not showing any significant decrease in acute pesticide poisoning since the publication of the 57.35% incidence by Boedeker et al. (2020) with two subsequent surveys arriving at an overall rate of 55.72%.

Occupational acute pesticide poisoning (OAPP) appears to be worse for some crops than for others: in India it is cardamon with a 100% incidence in some studies in Kerala; in Laos it is maize with a 92% incidence; in Bangladesh it is summer vegetables with an incidence of 60%. In Vietnam no one crop stands out. Child poisoning is a particularly serious problem in the floriculture industry in Tamil Nadu, with the only available study reporting a 87.5% incidence.

There is a significant body of highly reputable work detailing the chronic health effects that can result from exposure to pesticides. This exposure usually takes the form of ongoing exposure to low levels of pesticides and the incidence rates of OAPP are testament to that exposure. These effects include numerous cancers (breast, prostate, bladder, colon, lung, and pancreatic cancers, and leukaemia and non-Hodgkin's lymphoma), reduced nervous system functioning, disturbed neurodevelopment of children, diabetes, asthma, decreased male and female fertility, spontaneous abortion, birth defects and Parkinson's disease. One recent study in the US[3] put pesticides on a par with cigarette smoking for some types of cancer causation. However, whilst it is known that

1. The term unintentional is used to separate these largely occupational poisonings from intentional (suicidal) poisonings. This report focuses on occupational poisoning and hence uses the term occupational acute pesticide poisoning (OAPP).
2. Boedeker W, Watts M, Clausing P, Marquez E. 2020. The global distribution of acute unintentional pesticide poisoning: estimations based on a systematic review. *BMC Public health* 20:1875.
3. Gerken J, Vincent GT, Zapata D, Barron IG, Zapata I. 2024. Comprehensive assessment of pesticide use patterns and increased cancer risk. *Front Cancer Control Soc* 2:1368086.

pesticides can cause a wide range of chronic health effects, it is exceptionally difficult to link particular pesticides with chronic health conditions in the field, because of the often long latency period between exposure and manifestation of the disease, and the myriad genetic, environmental and other aspects that can contribute to chronic conditions – not least the wide range of pesticides a person might have been exposed to during the latency period. Some studies of OAPP also note the existence of chronic conditions amongst exposed farmers; although this is useful, it falls short of proof of casual link. And is often used to exclude farmers from studies of acute effects, even though acute exposure may have caused those chronic effects in the first place. In Bangladesh, surveys for acute poisoning noted diabetes, hypertension, asthma and other respiratory problems, tuberculosis, poor vision, urine control problems, reduction of sexual urge, and physical weakness. In India, breast cancer in younger women is linked to pesticide exposure, whilst one survey of OAPP also found asthma, hypertension, diabetes, cancer, immune suppression, hormone disruption, and reproductive abnormalities. In Vietnam, reduced sperm count and motility and abnormal sperm shape were recorded amongst farmers with OAPP.

Very little information is available on the impact of pesticides on women as most surveys do not differentiate between men and women, or intentionally select only male farmers. Apart from one survey of cardamom pickers in Kerala, only the field surveys carried out by PAN Asia Pacific and its partner CSOs adequately sample for women. This is perhaps based on the view that only males are farmers, only males spray and so only males are exposed. This is far from the truth. In the indigenous tribal areas of Bangladesh there are many farms maintained by indigenous women; in India, cultural operations like weeding are largely carried out by women, especially in paddy fields where large quantities of systemic pesticides have been used. In West Bengal, where there is heavy pesticide usage in the tea plantations, women carrying babies on their backs, and with small children alongside pick recently sprayed foliage. In Vietnam, with men migrating in search of work, there is a 'feminisation' of the rural workforce and women now constitute the majority of the it, including using pesticides. Disaggregation of data reveals that male and female workers are not always equally affected by pesticides. In Kerala, women cardamom pickers were found to have a higher proportion of moderate poisoning than were the male pickers. In Vietnam men were found to be experiencing higher incidence of a number

of symptoms (headache, excessive sweating, dizziness and vomiting), whilst women experienced a higher incidence of hand tremors and blurred vision.

Where a number of different pesticides are being used, it is very difficult to identify the exact one/s causing the poisoning. Unfortunately, the Bangladesh media reports of farmers who died whilst they are spraying, or shortly afterwards, did not identify the pesticides they were using. In India, two workers died whilst spraying a mixture of quinalphos and cypermethrin. But, overwhelmingly, the pesticides most implicated in adverse health effects in the four countries are organophosphate, carbamate and pyrethroid insecticides. In Laos, finger-prick tests for acetylcholinesterase revealed that 76.9% of those sampled were at significant risk from exposure to organophosphate and carbamate insecticides.[4] The currently used pesticides in these classes, of most concern are:

- organophosphate: chlorpyrifos, diazinon, dimethoate, malathion, monocrotophos quinalphos;
- carbamate: carbofuran, carbosulfan, carbaryl;
- pyrethroid: cypermethrin, lambda-cyhalothrin.

But there are others too: fipronil, imidacloprid, permethrin, phorate, profenofos, thiamethoxam, and herbicides such as 2,4-D, atrazine, paraquat, glyphosate. And many more are identified as posing a risk in these countries in the 2023 Four-Country Review of Pesticide Poisoning in Asia.[5] Lambda-cyhalothrin is of particular concern as it has been known to cause hundreds of poisoning in many countries.[6] Cypermethrin is also a particular problem, especially if it is used in combination with chlorpyrifos.

Residues in Food

High levels of residues have been found in many food types across all four countries, in particular of organophosphate and pyrethroid insecticides, no

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4. Hughes D, Vo TV, Turnbull N, Sycareun V, Jordan S. 2022. Study in Press. Data taken from presentation by. Pesticide uses and health impacts on farmers in Thailand, Vietnam, and Lao DPR. Ancient Capital Conference on Science and technology, Hue University, August 2022.
5. Watts MA. 2023. *Acute Pesticide Poisoning in Asia: A Four-Country Review.* PAN Asia Pacific, Penang.
6. Watts M. 2017. SHPF Lambda-cyhalothrin emulsifiable concentrate 50 g/L: Comments by PAN International on the CRC Task Group Report October 2017.

doubt reflecting their high usage. These high levels of residues result from farmers using more than the recommended amount (up to 5–6 times, in Bangladesh), using adulterated formulas, and/or not adhering to the required withholding period between last application and harvest. In Laos, a survey found that 59% of vegetable farmers in Xieng Khouang province overuse pesticides leading to high levels of residues. In Bangladesh, 93.3% of summer vegetable growers did not even consider a withholding period; perhaps because most (70%) were unaware of health risks from eating pesticide-contaminated vegetables. So concerned were the authorities in Bangladesh about residues of toxic pesticides in mangoes that in 2019 the police were deployed, by a High Court order, to prevent the overuse of pesticides. Rejection of export cardamom and basmati rice from India, by Saudi Arabia and the European Union, are evidence that other countries find the residues levels in food too high.

Numerous surveys in Bangladesh have found residues to be widespread, including at levels above the allowable MRLs and particularly in vegetables. Organophosphate and pyrethroid residues (cypermethrin, lambda-cyhalothrin) were especially common.

Cardamom from the Idduki district in Kerala, India, were found to contain residues of 15 different pesticides, mostly organophosphate or pyrethroid, and mostly banned in many countries. One study found quinalphos in cardamom at 25 times the MRL.[7] Lindane, DDT, endosulfan, cypermethrin, cyhalothrin, permethrin, chlorpyrifos, ethion, profenofos and fipronil were found in cow milk in India, with levels of fipronil, lindane, DDT and ethion posing risks for children. Other pesticides found in food in India include malathion and triazophos.

In Laos, 42% of people consuming vegetables from the market had unacceptable levels of cholinesterase inhibition (caused by organophosphate and carbamate insecticides) – more than did farmers (37%). Of the 422 schoolchildren tested for organophosphates and carbamates, 33% had unacceptable levels of residues, higher than farmers and other consumers. Other residues found in surveys included glyphosate and pyrethroids. Taken

7. MRL = Maximum Residue Limit, a threshold set by governments for a legally allowable level of residue of a particular pesticide in a particular food item.

together, there is powerful evidence that residues in food are a serious health problem across Laos.

In Vietnam, nearly 50% of 570 fresh food samples were found to contain pesticide residues, with 3.5% above MRLs and 10.2% not permitted for that use. Some contained seven different pesticides. Other surveys found residues in a variety of vegetables and in rice. Again, the most common residues were organophosphates, carbamates, pyrethroids (cypermethrin, permethrin), carbendazim, imidacloprid, difenoconazole and acetamiprid, and a number of fungicides.

Residues in the Environment

When such overuse of pesticides occurs as to result in acute and chronic health effects and significant residues in food, not surprisingly it also results in residues in the environment that can affect all organisms from human, to wildlife, to livestock, to companion animals, to beneficial insects that are vital for pollination and managing pests, to the very tiny microorganisms that keep the soil healthy and on which plants depend for the uptake of nutrients through their roots. A survey of farmers in Bangladesh found that more than half of them knew that excessive use of pesticides was polluting surface waters and destroying beneficial insects. Soil samples there contained diazinon, carbofuran and carbaryl in vegetable and paddy fields sometimes exceeding the EEC[8] allowable level. In India, in 2014, soils in the cardamom plantations of the Idduki area were contaminated with endosulfan, DDT, chlorpyrifos, quinalphos and ethion; earlier in 2011–2012 they also contained profenophos, lambda-cyhalothrin, bifenthrin, imidacloprid and indoxacarb. More recently, soils in apple and mango orchards in Himachal Pradesh contained residues of DDT, HCH, endosulfan, chlorpyrifos, cypermethrin, cyfluthrin, dicofol and chlorothalonil. In Laos, soils contained carbendazim, glyphosate, paraquat, dicofol and cypermethrin. And in Vietnam, in 2018, isoprothiolane, chlorpyrifos and propiconazole were found in paddy rice field soil and irrigation ditch sediments in the Red River delta.

In Bangladesh, numerous pesticides have been found in waterways, pond water, water from paddy fields, lakes, rivers – commonly, carbaryl, chlorpyrifos,

8. European Economic Commission (European Union).

carbofuran, cypermethrin, diazinon, and malathion. One review noted that 25% of pesticides being used might pollute the sea. In India, pesticides found in groundwater included DDT and HCH, even after a decade's ban. Current use pesticides found in groundwater included malathion, atrazine, diazinon, methyl parathion, lindane, chlorpyrifos, butachlor and alachlor. In surface waters, metabolites or isomers of HCH, DDT, endosulfan, malathion, atrazine, and butachlor, were found in more than 90% of river water samples, while malathion, lindane, and methyl parathion were detected in around 50% of samples. Chlorpyrifos and diazinon were also detected in surface waters. In Laos, paraquat, cypermethrin, chlorpyrifos, imidacloprid, atrazine and the breakdown products of DDT, dieldrin, heptachlor and lindane have all been found in sediment samples, and atrazine contamination in a village water supply. In Vietnam, the primary contaminants of water are quinalphos, isoprothiolane, diazinon, fenitrothion, imidacloprid, endosulfan, fenobucarb, trichlorfon and dichlorvos.

Climate Change

There is very little information available on pesticides and climate change, anywhere, let alone in the four countries. Even though it is known that the manufacture of one kilogram of synthetic pesticide requires about 10 times more energy than one kilogram of nitrogen fertilizer, the World Bank's report on Climate Smart agriculture, which talks extensively about fertilisers, says only this about pesticides: disease-resistant varieties reduce greenhouse gas emissions by reducing the use of synthetic pesticides (fungicides). That is an admission that synthetic pesticides contribute to climate change.

Pesticides are fundamental to supporting the intensive agriculture propped up by synthetic fertilisers and especially nitrogen-based ones that create weak, pest- and disease-prone plants. The widespread use of herbicides reduces carbon sequestration in soils. The World Bank's report on Climate-Smart agriculture states that pesticides are applied to 66% of agricultural land in Bangladesh – and therefore, conversely, 34% is managed without them. In Vietnam, it has been calculated that the use of pesticides on citrus trees in Bac Tan Uyen results in greenhouse gas emissions of 3,239 tons of CO_2e/year.

Government Action on Pesticides

The governments of all four countries have taken some actions to manage pesticides – primarily enacting laws and regulations to manage them and banning some of the worst pesticides. However, the high level of acute pesticide poisoning, together with the significant occurrence of residues in food and the environment indicates that there is a huge amount more that is needed to be done. In Bangladesh, Laos and Vietnam pesticides that are not registered in the county have been found in use or as residues in food or the environment, indicating inadequate regulatory, surveillance and compliance regimes. In India, pesticides are commonly used for crops/pests for which they are not approved. Bangladesh was proactive in banning most organochlorine insecticides in the 1970s and 1980s but failure to follow this up with training in IPM or agroecology has left farmers relying on the highly toxic organophosphate insecticides with the resultant poisoning problems.

Vietnam has banned at least 44 current use pesticides, and is working towards the 'gradual removal of toxic pesticides'. The level of OAPP in the country suggest that the process needs to be speeded up. Laos has banned at least 39 current use pesticides, but it is rather hamstrung by having a mountainous country with massive land borders across which illegal pesticides are regularly smuggled, with the countries of origin failing to take any responsibility to curb the illicit trade. It would be greatly assisted by regional bans on such pesticides. In the absence of this, greater international and national effort to reduce the desire for such pesticides by training farmers in cost-effective agroecological approaches is essential.

Laos has taken some good actions to promote sustainable agriculture and has endorsed a Strategic Plan for National Organic Agriculture Development. Vietnam has also issued a decree on organic agriculture and promulgated standards, paving the way for its development. But in all four countries there is a lack of training and other assistance for farmers in effective low-risk methods of pest management.

CSOs Work to Curb Pesticide Problems

CSOs in all four countries have been very active undertaking community monitoring of pesticide use practices and acute poisoning, producing reports, raising awareness about the dangers of pesticides and the advantages of agroecological alternatives, and campaigning to ban pesticides. Their work is often conducted within a framework of cooperative projects with PANAP, including through commemorating World Environment Day, the Protect Our Children Campaign, the 16-Day Action Campaign for Rural Women and Ecological Agriculture, and the Pesticide-Free Week Campaign.

Recommendations

Health impacts

- Drastically increase the number of well-designed surveys of occupational poisoning across a number of different crops, especially in Laos, Bangladesh and Vietnam, but also in India, and all other countries in South and South East Asia, including identifying the pesticides being used.
- Stop children working in fields in which pesticides have been applied.
- Much greater effort is needed to identify chronic health conditions being experienced by farmers and their communities as a result of exposure to pesticides. Surveys on acute pesticide poisoning should not discard participants with chronic conditions: rather those conditions should be recorded in both those exposed to pesticides and in control subjects not exposed to pesticides.
- All field surveys should include both male and female farmers and workers and should disaggregate the date, even down to particular symptoms.
- Immediately ban all organophosphate insecticides; these highly toxic pesticides cannot be used safely under the conditions of use common in South and South East Asian countries.
- Immediately ban lambda-cyhalothrin and cypermethrin.
- Immediately ban the carbamates carbofuran and carbosulfan, both recommended by the Chemical Review Committee for listing under the Rotterdam Convention.

- Phase out the other pesticides implicated in poisonings, here and in Watts (2023)[9]. See the list of pesticides suggested to be phased out.
- Work to establish regional regulation of pesticides to prevent the cross boundary smuggling of illegal pesticides.
- Dramatically ramp up efforts nationally and internationally to help farmers implement agroecological alternatives: there is no point replacing these pesticides with others that will also cause poisonings.

Food residues

- Banning the pesticides that are causing poisoning will dramatically reduce the levels of those residues in food.
- Governments should increase their residue testing in the four countries, work with farmers whose produce has high residues to reduce the levels, remove produce with residues above MRLs from the market and report their findings to the public.
- Because simply replacing these pesticides with others will only result in different residues in food, it is imperative that there is national and international action to assist farmers to replace their pesticides use with agroecological approaches to growing.

Environment

- Increased monitoring for pesticides in the environment.
- Work with farmers to reduce the excessive use of pesticides that results in environmental contamination.
- Governments must recognise the role of pesticides in climate change and assist farmers to implement agroecological farming which not only reduces climate change emissions but assists them to develop better climate resilience in their cropping systems.
- Microfinance for agroecology instead of pesticides.
- Increase resources for CSOs to continue their work to reduce the damage caused by toxic pesticides and in implementing agroecological alternatives
- Greater recognition by governments of the positive role CSOs are playing in assisting farmers to farm better and more productively.

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9. Watts MA. 2023. *Acute pesticide Poisoning in Asia: a Four-Country Review*. PAN Asia Pacific, Penang.

2.
OVERVIEW

Pesticides are widely used in agriculture in many countries, including in South and South-East Asia, to manage harmful pests and reduce production losses or product damage. The power of the pesticide industry over many years has resulted in the mistaken belief that pesticides are necessary to grow food to feed the burgeoning billions of people,[10] despite evidence to the contrary that sufficient, healthy food can be grown without them.[11] The risk of pesticides to people and the environment caused by their use in agriculture has been significantly ignored, under-reported, down-played, and otherwise discarded. Information on the extent of unintentional pesticide poisoning of farmers and their communities is systemically disregarded and discredited.[12] Residues in the environment and food are ignored. The impact of pesticides on climate change is largely unaddressed in mainstream scientific and political reporting.

10. Bayer Global. Why do we need pesticides. https://www.bayer.com/en/agriculture/article/why-do-we-need-pesticides
11. Badgley C, Moghtader J, Quintero E, Zakem E, Chappelli MJ, Avilés-Vázquez K, Samulon A, Perfecto I. 2006. Organic agriculture and the global food supply. *Renew Agric Food Sys* 22(2):86-108.
12. The paper [Boedeker W, Watts M, Clausing P, Marquez E. 2020. The global distribution of acute unintentional pesticide poisoning: estimations based on a systematic review. *BMC Public health* 20:1875] was retracted by the journal four years after publication, for spurious unsupported reasons using vague unreferenced 'data' (all of which was scientifically refuted), in a process that was lacking transparency and was based on a complaint by the pesticide industry and one anonymous 'reader'. https://bmcpublichealth.biomedcentral.com/articles/10.1186/s12889-024-20318-x
    Retraction Watch published this commentary on the process https://retractionwatch.com/2024/10/14/journal-pulls-pesticide-article-a-year-after-authors-engaged-lawyer-to-fight-retraction-decision/ which included a link to the authors original response to the proposal to retract the article https://bmcpublichealth.biomedcentral.com/articles/10.1186/s12889-021-11941-z
    The full rebuttal of the retraction can be found at https://retractionwatch.com/wp-content/uploads/2023/11/retraction-BMC-PH-final-080523.pdf because it was not published by the journal even though they published the original letter of complaint.

Farmers who load, mix, and spray pesticides run the risk of coming into contact with these substances from drift, spills, and splashes as well as direct spray contact from leaking sprayers or when protective gear is lacking, defective or inadequate. Farmers may also come into contact with pesticides even when they are engaged in non-pesticide-related tasks. People, including pregnant women and children, who work manually in pesticide-treated areas run the risk of being seriously exposed by direct spraying, drifting chemicals from nearby fields, or coming into contact with pesticide residues on the crop, in the soil or in airborne dust. They are usually exposed to pesticides through the skin and respiratory systems. During routine pesticide handling, the face and hands – as well as other body parts not covered by adequate protective clothing – are subject to dermal exposure.[13] Even when protective clothing is used, pesticides can still penetrate it and result in harm to the farmer.[14]

Famers' families are also exposed by spray and vapour drift from the fields, by washing pesticide-soaked work clothing, children playing in the fields that have been sprayed, or picking sprayed flowers or cotton, or even just playing on the ground around their houses which has become contaminated by drift from the fields. The tea plantations in West Bengal are highly addicted to chemical pesticides,[15] and as many mothers have no place to leave their children when they work picking tea, they carry them on their backs. Soon the child is also picking tea with its small nimble fingers, handling recently sprayed foliage. Children are also exposed on the way to school and at school where there are nearby fields from which spray can drift.[16]

13. Damalas C, Koutroubas S. 2016. Farmers' exposure to pesticides: toxicity types and ways of prevention. Toxics 4(1):1. https://doi.org/10.3390/toxics4010001
14. Garrigou A, Laurent C, Berthet A, Colosio C, Jas N, Daubas-Letourneux V, Jackson Filho JM, Jouzel JN, Samuel O, Baldi I, Lebailly P, Galey L, Goutille F, Judon N. 2020. Critical review of the role of PPE in the prevention of risks related to agricultural pesticide use. *Safety Sci* 123:104527.
15. Team MP. 2024. State proposes district committees to monitor pesticide use in small tea farms. July 17. Millenium Post. https://www.millenniumpost.in/bengal/state-proposes-district-committees-to-monitor-pesticide-use-in-small-tea-farms-572117
16. CGFED, SRD, PANAP. 2020. Schoolchildren's Exposure to Pesticides in Vietnam: A Study in Three Districts. PAN Asia Pacific, Penang. https://panap.net/2020/12/vietnamese-schoolchildren-exposed-to-highly-hazardous-pesticides-study-shows/

Other people who live and/or work near fields that are sprayed, even if not themselves engaged in farming work can be exposed to pesticides through drift. Exposures also occur in urban areas when pesticides, and principally herbicides, are used to spray parks, gardens, roadsides, in schools and homes. Household and public space use of insecticides adds another route of exposure and layer of risk.

When crops have been sprayed, the produce frequently contains residues, and these are ingested by everyone – residues are generally highest in spices, fruit and vegetables and grains, but can also be found in the dairy, meat, fish, tea, etc.

All of these exposures – both respiratory, dermal and ingested – can result in residues in people's bodies, as well as acute poisoning and chronic health effects.

Pesticides affect every part of the environmental and residues can be found in soils, rivers and creeks, the marine environment, air, rain, fog, snow, animals, birds, fish, insects: every environmental medium and all living creatures.

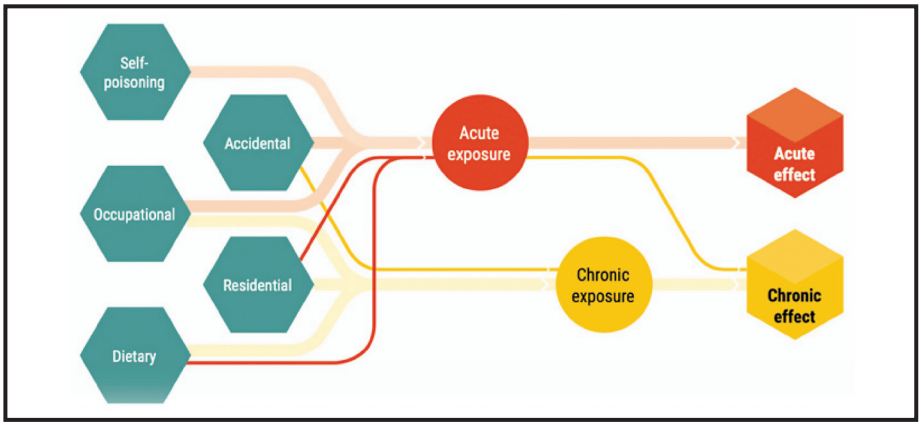
A report from the Intergovernmental Panel on Climate Change finds that about 30% of global emissions leading to climate change are attributable to agricultural activities, including pesticide use.[17] About 99% of all synthetic chemicals – including pesticides – are derived from fossil fuels. The manufacture of one kilogram of pesticide requires about 10 times more energy than one kilogram of nitrogen fertiliser. Fumigant pesticides increase nitrous oxide production in soils seven to eight-fold. Rising temperatures and altered rain patterns are leading to decreased crop resilience, leaving them more vulnerable to pests, leading to increased pesticide application rates, which in turn exacerbates the problem through loss of beneficial insects. Agroecology, which minimizes or eliminates synthetic fertiliser and pesticide use while increasing the resilience of farming systems to climate change, is a real solution that addresses all aspects of this vicious cycle.[18] Interestingly, the Food and Agriculture Organisation (FAO), the

17. Californians for Pesticide Reform. Undated. Pesticides and Climate Change. https://www.pesticidereform.org/climate-change/
18. Sharma A, Reeves M, Washburn C. 2023. *Pesticides and Climate Change: A Vicious Cycle*. PAN North America. https://www.panna.org/wp-content/uploads/2023/02/202308ClimateChangeEng.pdf

UN agency charged with global oversight of agriculture and food production, did not mention pesticides (although it did mention synthetic fertilisers) in its 2021 analytical brief "Emissions due to Agriculture",[19] even though pesticides are the most energy intensive of all farm inputs.[20]

Whilst pesticides are often considered both necessary and a quick, easy and inexpensive solution for controlling weeds, pests, and diseases, their use comes at significant costs to people (including those not using them), and the environment – costs which are never taken into account in determining that pesticides are "necessary" and "affordable". Those who promote pesticides and those who sell them never pay these costs.

Figure 2.1: Human health effects of pesticides can show up in the short term (acute) or after a long period (chronic) and may be the result of activities leading to both acute and chronic exposure. Shown are the most common routes of poisoning (less likely options are indicated by thinner arrows).



Source: UNEP 2021[21]

19. FAO. 2021. *Emissions due to agriculture. Global, regional and country trends 2000-2018*. FAOSTAT Analytical Brief 18. Food and Agriculture Organisation of the United Nations, Rome. https://openknowledge.fao.org/server/api/core/bitstreams/cc09fbbc-eb1d-436b-a88a-bed42a1f12f3/content
20. Safa M, Watts, M. 2013. Energy inputs in pest control using pesticides in New Zealand. *Int Pest Manag* Rev 3:99-126.
21. UNEP. 2021. *Environmental and Health Impacts of Pesticides and Fertilizers and Ways of Minimizing Them*. United Nations Environment Programme, Nairobi. https://www.unep.org/resources/report/environmental-and-health-impacts-pesticides-and-fertilizers-and-ways-minimizing

3.
METHODOLOGY

This was a secondary research project, with PAN partner organisations in the four countries obtaining information on the impacts of pesticides on human health, food, the environment and climate change from various sources, including published studies, local and community surveys, media reports, websites or relevant organisations and agencies, statistical data, and government policies, regulations and reports, and collating this into individual country reports. Much of the material contained in local media reports never finds its way into peer-reviewed published papers or government reports, and hence is an invaluable source of information on what is really going on with pesticides.

These country reports are here consolidated into a regional report, with additional material added where it has been found, largely from peer-reviewed published studies obtained from google searches. Data is analysed and collated, focusing as much as possible on recent data.

Country estimates that were part of the Global Estimate of Unintentional Acute Pesticide Poisoning published in 2020 have been included here, despite the very recent retraction (after this report was commenced) of the article by its publisher, BMC Public Health – see Footnote 12.

Limitations

Challenges encountered included the lack of research and studies relevant to these areas of investigation. In Vietnam, most information was mainly obtained from media and the websites of Government agencies. Whilst there is good information on unintentional acute pesticide poisoning (UAPP) in India, there is very little for other countries, particularly Laos. Often incidents that are reported in local media are not recorded officially, nor do they make their way into peer-reviewed published papers, especially in Laos and Vietnam.

4.
IMPACTS ON HUMAN HEALTH

4.1 Acute Poisoning

Bangladesh

The systematic review of unintentional acute pesticide poisoning by Boedeker et al. (2020)[22] estimated a 55.64% incidence of non-fatal UAPP among the farming/occupational population in Bangladesh, based on studies from 2006–2018.

Since that publication, only three studies could be found on AOPP in Bangladesh: Diyana et al. 2022 reported an incidence of 21.21%,[23] Kobashi et al. (2021) reported an incidence of 14% (although this study was based on comparing use of PPE rather than on measuring acute health effects),[24] and Islam et al. 2023 reported an incidence of 60% among summer vegetable growers in Dhanbari and Madhupur upazilas in Tangail district.[25]

In 2019, local media reported[26] a number of deaths related to pesticide use, fatalities not discussed in the mainstream media or in the citizen space.

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22. Boedeker W, Watts M, Clausing P, Marquez E. 2020. The global distribution of acute unintentional pesticide poisoning: estimations based on a systematic review. Retracted. *BMC Public health* 20:1875.
23. Diyana A, Rajendran D, Watts M, Rengam S, Alviar S. 2022. *Field Survey: Use and Impacts of Pesticides in Four Countries in Asia*. PAN Asia Pacific, Penang.
24. Kobashi Y, Haque SE, Nishikawa Y, Morita T, Nagami H, Sakisaka K, Mubassara S, Tsubokura M. 2021. The increase in frequency of protective behavior against pesticide poisoning in Narail, Bangladesh through use of an easy paper checklist; an interventional study. *Int J Environmental Res Public Health* 18(17).
25. Islam A, Samiha A, Amin MR, Rokonuzzaman M, Hossain MS. Patterns of insecticide uses and its impact on the health of the farmers in Tangail district of Bangladesh. *Ann Bangladesh Agric* 27(1):31-39.
26. Gowhar Nayeem Wara. 21/10/2019. Farmers are pouring into the land. daily Prothom Alo, Dhaka, Bangladesh. https://en.prothomalo.com/bangladesh/

On 3 March 2019, Md. Tarek Hossain of the village Monpura under Kachua of Chandpur district died from pesticide spraying. Farmer Abdul Majid from Vatara village of Sherpur sub-district of Bogura District died in hospital on 9 September 2019 after spraying pesticides in his fields. Abdus Salam of village Padmabila Mollahpara of Sathia sub-district of Pabna District died from pesticide spray on 16 September 2019. Farmer Nurul Islam of Jamuria village of Ghatail sub-district of Tangail District died from pesticide spraying on 9th October 2019. There is no record of the farmers that fell ill while spraying but did not die. Nor of the pesticides being used.

From 31 May to 30 June 2012, 14 children fell ill after eating litchi in the northern Dinajpur district of Bangladesh; 13 of them died. In 2015, 11 children died after eating litchi again in Dinajpur Medical College Hospital over 21 days from 29 May to 18 June. Media published some reports and four sub-editorial articles were published in 'dailies'. But the Government denied the pesticide poisoning and claimed that the children died because they consumed litchi on empty stomachs. A study published in the American Journal of Tropical Medicine and Hygiene[27] linked the children's deaths to exposure to pesticide residues in the litchi, particularly endosulfan.[28]

India

> Malliga: Not many days go by without headaches or skin irritations. Some of us even have nausea or breathing difficulties. Each [cardamom] season leaves us with bad hands. Look at my hands; my fingertips hurt. We come for this work because we have no alternatives. These marunthu [pesticides], they give us headaches, skin rashes, nausea and God knows what else.[29]

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27. Islam MS, Raihan A, Hossain MS, Sazzard AK, Dawlat K, Hasan M, Akter S, Rahman M, Luby SP, Heffelfinger JD, Gurley ES. 2017. Outbreak of sudden death with acute encephalitis syndrome among children associated with exposure to lychee orchards in northern Bangladesh, 2012. *Am J Trop Med Hyg* 97(3):949-57.
28. The information was collected from different articles by Pavel Partha, published in Bangladeshi Newspaper and information collected from Daily Prothomalo, 14 July 2015 and BBC-Bengali 25 July 2017. https://www.bbc.com/bengali/news-40713240
29. Krishna A. 2024. Tales Behind a Spice: Toxified Terrain and Tortured Bodies in the Making of Indian Small Cardamom. *Global Environ* 17(2):281-310 https://doi.org/10.3828/whpge.63837646622492

A descriptive cross-sectional study for identifying the severity of occupational acute pesticide poisoning (OAPP), was conducted in 2018 by the Department of Public Health and Community Medicine, Central University of Kerala, among Idukki (Kerala) cardamom plantation workers.[30] A total of 300 pesticide applicators with a minimum of one year experience (79.3% males) were selected from 30 randomly selected cardamom plantations in Udumbanchola Taluk. The study concluded that the prevalence of OAPP was 100% as all the pesticide applicators reported at least one symptom. Mild poisoning was more prevalent (80.7%), followed by moderate (18.7%) and severe (0.60%). A decrease in duration and frequency of spraying, use of a motor pump sprayer, safe storage and disposal of pesticides, and proper personal hygiene were found to reduce the severity of OAPP. All the pesticide applicators in cardamom plantations of Idukki are at risk of OAPP. Organophosphates were the most common pesticides used (51%), followed by pyrethroids (35.7%). Most of the participants avoided using personal protective equipment, (PPE) when spraying: 65.3% because of discomfort; about 25.0% due to the cost; and 10.0% were simply not aware of it. Most of those that did wear some form of PPE, but relied upon local measures rather than standard equipment, and nobody wore all the appropriate PPE.

A recent local survey conducted in six panchayats in Kuttanad (Alappuzha, Kerala), of 28 families, randomly sampled, found that acute poisoning symptoms were common among people.[31] 86% of the sampled population were field workers and had direct exposure while spraying. The field workers also consume food and water while they are still in the sprayed fields, increasing the risk of exposure to the pesticides. The other 14 % would have non-occupational exposure: they are residing close to the paddy fields and are utilizing contaminated well water and canal water.

Recently, a news report revealed the deaths of two farm workers from upper Kuttanad who fainted in the paddy field while spraying pesticides. The investigation found that the reason for these deaths was excessive inhalation of vapour from a mixture of quinalphos and cypermethrin (trade name

30. Reshma H, Jayalakshmi R. 2020. Prevalence of acute pesticide poisoning among pesticide applicators in cardamom plantations: A cross-sectional study from Idukki District, Kerala. *Ind J Occup Environ Med* 24(3):188.
31. Krishnan. A. S. 2024. The Hidden Toll: Pesticides ad human health impacts in Kerala's agriculture. [unpublished manuscript]

Viraat). This pesticide mixture was being used without legal prescription from Krishibhavan.[32]

BBC news reported in 2017[33] that the government in the western state of Maharashtra had ordered a probe after suspected pesticide poisoning killed at least 50 farmers. Of these, 19 were reported from Yavatmal district, a major cotton-growing area.

A study of pesticide applicators in rice fields of low lying areas in Kerala found 38.9% of applicators reported itchy skin, one of the more frequently reported symptoms of acute poisoning. The most commonly used pesticide (58 %) was 2,4-D. Other pesticides reported to be used were monocrotophos, methyl parathion and paraquat dichloride, which have been banned or restricted respectively for rice crops. The main categories of pesticides used were herbicides, followed by insecticides and fungicides.[34]

In India, cultural operations like weeding are mainly done by women labourers especially in paddy fields, where large quantities of systemic pesticides are used. Acute symptoms like skin allergies, headache, vomiting and breathing difficulties are common among the field labourers which was evident from the random field survey.[35]

The systematic review of unintentional acute pesticide poisoning (UAPP) by Boedeker et al. (2020),[36] estimated a 62% incidence of non-fatal UAPP among the farming/occupational population in India, as well as unintentional 6,488 fatalities (including in non-occupational settings such as children at home). That was based on studies carried out between 2006 and 2018. More recent studies,

32. Government body implementing state government programmes for crops in the state.
33. BBC. 2017. Indian farmers falling prey to pesticides. October 5. https://www.bbc.com/news/world-asia-india-41510730
34. Jomichen J. 2014. Pesticide use behaviour and potential health risks among pesticide applicators in Kuttanad area, Kerala, India. Dissertation, Sree Chitra Tirunal Institute for Medical Sciences & Technology, Thiruvananthapuram.
35. Krishnan. A. S. 2024. The Hidden Toll: Pesticides ad human health impacts in Kerala's agriculture. [unpublished manuscript]
36. Boedeker W, Watts M, Clausing P, Marquez E. 2020. The global distribution of acute unintentional pesticide poisoning: estimations based on a systematic review. *BMC Public health* 20:1875.

between 2017 and 2021, showed that this has actually increased to a 73.63% incidence and 7,950 deaths in 2021. These new studies involved apple orchard workers in the Kinnaur District of Himachal Pradesh in the western Himalayan region where 85% of the workers reported acute poisoning symptoms;[37] pesticide applicators in cardamon plantations in Idduki district in Kerala where 100% reported symptoms, as referred to above;[38] agricultural workers in an unspecified area of whom 52.1% experienced the most common symptom of poisoning (headache);[39] children working in the floriculture industry in Tamil Nadu of whom 87.5% experienced poisoning symptoms;[40] and farmworkers in the Rangareddy district of Telangana of whom 95.5% reported symptoms.[41] In the Yavatmal district of Maharashtra, 39.4% of farmers growing cotton, dal and soybean reported symptoms, and in the Wayanad district of Kerala, 38.9% of farmers growing a variety of crops reported symptoms.[42]

Laos

Located in the centre of the Southeast Asian peninsula, Laos is a small landlocked country that borders China, Thailand, Vietnam, Myanmar, and Cambodia. In 2020, the population was approximately seven million. Most of the nation is made up of mountains and dense forests. Laos is a predominantly agricultural country: up to 70% of the workforce was still employed in agriculture in 2020. Although

37. Kumari D, Sebastian AJ, John S. 2019. Pesticide handling practices and health risks among the apple orchard workers in Western Indian Himalayan region. *Human Ecol Risk Assess: An Int* J 27(1):15-29.
38. Reshma H, Jayalakshmi R. 2020. Prevalence of acute pesticide poisoning among pesticide applicators in cardamom plantations: A cross-sectional study from Idukki District, Kerala. *Indian J Occup Environ Med* 24(3):188-93.
39. Thakur R, Jumade P, Waghmare R, Shobha J, Abhishek J. Perceptions, practices and health hazards, of agricultural workers from rural central India with regard to pesticide use - a cross sectional study. *J Evol Med Dental Sci* 9(47):3528-32.
40. Pamintuan M, Rengam S. 2020. *Toxic Blooms: Impacts of Pesticides on Children in the Floriculture Industry in Tamil Nadu, India.* SRED, PAN India, PAN Asia Pacific. PAN Asia Pacific, Penang.
41. Lari S, Yamagani P, Pandiyan A, Vanka J, Naidu M, Kumar BS, Jee B, Jonnalagadda PR. 2023. The impact of the use of personal-protective-equipment on the minimization of effects of exposure to pesticides among farm-workers in India. *Front Pub Health* 11:1075448.
42. Diyana A, Rajendran D, Watts M, Rengam S, Alviar S. 2022. *Field Survey: Use and Impacts of Pesticides in Four Countries in Asia*. PAN Asia Pacific, Penang.

the proportion of farmers is high, agricultural productivity is relatively low due to the geography, mode of production and limited technology; most Laotian farmers are smallholders with an average farm size of only about 2.4 hectares per household.[43] According to the Statista website, in 2020 the agricultural sector contributed only 16 percent to the national economy.

In Laos, pesticide use increased by 56% each year in the decade to 2012, with 59% of sampled vegetable farmers in Laos reportedly 'overusing' pesticides in the sense of applying levels in excess of a profit-maximizing rate.[44] A study by Hughes et al. (2022)[45] using finger-prick tests to determine blood levels of acetylcholinesterase (AChE) identified that 76.9% of those sampled in Laos were at significant risk from exposure to organophosphate and carbamate insecticides.

The systematic review of unintentional acute pesticide poisoning by Boedeker et al. (2020),[46] estimated a 39% incidence of non-fatal UAPP among the farming/occupational population in Laos.

However, in 2021, Shattuck et al. found in their survey of maize farmers a 92% prevalence of OAPP symptoms, which included vomiting, skin rashes and burns, hard skin on hands, dizziness, faintness, difficulty breathing and "lung problems", eye irritation, headache, impotence, tiredness, numb lips, dry mouth, bitter taste in mouth, loss of consciousness, etc. And, according to an article published by AGRILINKS in 2022, in a survey of 103 farmers, LURAS found that

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43. Xiong M, Moustier P, UMR MoiSA, CIRAD. 2022. Resilience of food systems in Laos in the face of Covid19, with a focus on Agroecological Food System in Xiengkhouang province https://institut-agro.docressources.fr/index.php?lvl=notice_display&id=99800&lang_sel=en_UK&opac_view=-1
44. Hughes D, Thongkum W, Tudpor K, Turnbull N, Yukalang N, Sychareun V, Vo TV, Win LL, Watkins A, Jordan S. 2021. Pesticides use and health impacts on farmers in Thailand, Vietnam, and Lao PDR: Protocol for a survey of knowledge, behaviours and blood acetyl cholinesterase concentrations. *PLOS One* 16(9):e0258134.
45. Hughes D, Vo TV, Turnbull N, Sycareun V, Jordan S. 2022. Study in Press. Data taken from presentation by authors. Pesticide uses and health impacts on farmers in Thailand, Vietnam, and Lao DPR. Ancient Capital Conference on Science and Technology, Hue University, August 2022.
46. Boedeker W, Watts M, Clausing P, Marquez E. 2020. The global distribution of acute unintentional pesticide poisoning: estimations based on a systematic review. Retracted. *BMC Public health* 20:1875.

over 90% reported at least one symptom of acute exposure following pesticide application, including headache, dizziness, rash, nausea, vomiting and difficulty breathing. Meanwhile, blood samples from the public show that, on average, about one-third of individuals sampled had "unacceptable" residue levels, well above those considered dangerous to one's health by WHO. Levels for school children are a particular cause for concern.[47]

Vietnam

Vietnam is one of the highest users of pesticides in the region – 16.2 kg/ha of cultivated land compared with Thailand's 8.4 kg, Cambodia's 2.9 kg and Laos's 0.1 kg. It has 1,820 active ingredients in 4,537 commercial products.[48]

Dang et al. (2017)[49] reported that, "according to the Treatment Department of the Ministry of Health, there were over 3,000 cases of pesticide poisoning, nearly 3,000 victims and over 100 people died in the first half of 2011". However, no reference is given and there is no indication how many of these were intentional poisonings.

A study conducted by Hoang Trong Hanh et al. (2021)[50] surveyed all patients hospitalised in the Emergency Resuscitation Department of Hue Central Hospital from January to December 2019. Among the 307 patients with poisoning cases, 48 were poisoned by the herbicide paraquat and organophosphorus insecticides. The cross-sectional study utilised a questionnaire to gather information from medical records and by interviewing patients or their relatives. Results indicated

47. Neely B. 2022. Sustainable Maize Production for Human Health and Biodiversity in Laos. *AGRILINKS*. USAID. https://agrilinks.org/post/sustainable-maize-production-human-health-and-biodiversity-laos
48. Dam QA. 2024. Reducing dependency on pesticides – A sustainable path to improving food safety in Vietnam. The University of Sydney, Vietnam Institute. https://www.sydneyvietnaminstitute.org/en/news-and-events/news/2024/07/24/reducing-dependency-on-pesticides---a-sustainable-path-to-improv.html
49. Dang HV, Nguyen LT, Tran HT, Nguyen HT, Dang AK, Ly VD, Frazzoli C. 2017. Risk factors for non-communicable diseases in Vietnam: a focus on pesticides. *Front Environ Sci* 5. https://doi.org/10.3389/fenvs.2017.00058
50. Hoang H, Nguyen VP, Nguyen XK, Tran TH, Hoang CT, Hoang D 2021. Situation of acute poisoning in the Intensive Care Department of Hue Central Hospital. *J Clin Med* 70:79-82. https://jcmhch.com.vn/upload/files/Tapchi/70/Bai%2011%20-%20Hoàng%20Tr%E1%BB%8Dng%20Hanh.pdf

that acute poisoning constituted 6.62% of emergency cases. The highest rate of acute poisoning was observed in the 26–35 age group, comprising 28.66% of cases. Poisoning was more prevalent among males, aged 26–35, manual labourers, and those living in rural areas. Again, there is no indication how much of this poisoning was accidental/occupational rather than intentional.

In 2018, the Institute of Occupational and Environmental Health conducted a periodic qualitative test of pesticide residues in blood. There were 67 test subjects (32 men, 35 women) who were all students at a class at the Community Learning Center in four suburban districts of Hanoi: Soc Son, Dong Anh, Me Linh, Hoai Duc. The results revealed that of the 67 participants, only 35 were at a safe level of pesticide exposure. The remaining 32 individuals were at a risk level, with one person falling into the highest risk category. Notably, most of the participants were not directly involved in agricultural production.[51]

PANAP and its community partners in Vietnam have carried out a number of studies on acute pesticide poisoning over the years since the first one in 2015. They are summarised in the table below:

Study	Year	Sample Size	Population	Morbidity	Symptom Range
RCRD et al. 2015[1]	2014	335	farmers	82.00%	any
Rengam et al. 2018[2]	2015–2017	534	farmers	84.00%	any
CGFED et al. 2020[3]	2018	140 100	children children + teachers	91.40% 36.20%	any vomiting
CGFED et al. 2020b[4]	2018	200	farmers	72.40%	any
Diyana et al. 2022[5]	2019	Hai Hau: 52 Thuan Chau: 51	farmers farmers	26.92% 78.00%	any any
Average			**farmers & workers children**	**68.66% 63.80%**	

51. Thai Binh. 2018. Alarm: 31 out of 67 people in Hanoi tested had pesticide residue in their blood. 2018-07-27. https://suckhoedoisong.vn/bao-dong-xet-nghiem-67-nguoi-o-ha-noi-thi-31-nguoi-ton-du-thuoc-bao-ve-thuc-vat-trong-mau-169146780.htm

Limitations

The study of children and teachers was for only a single symptom – vomiting – so the morbidity for children is likely to be higher than the average here, as this is not generally one of the most common symptoms of acute pesticide poisoning. Additionally, it included teachers who are less likely to be affected by the pesticides than are the children.

The systematic review of unintentional acute pesticide poisoning (UAPP) by Boedeker et al. (2020),[52] estimated a 57.35% incidence of non-fatal UAPP among the farming / occupational population in Vietnam, using data from 2006-2018. Recent data is not showing any significant decrease in acute pesticide poisoning, with Diyana et al. (2022) reporting two surveys, with 26.92% and 78% incidence, both with small sample sizes.

4.2 Chronic Health Effects

One of the implications of acute pesticide poisoning, apart from the loss of life, livelihood and well-being, is that it can be indicative of exposures that may lead to chronic outcomes (Boedeker et al. 2020) – see Vietnam below for an example of this.

Pesticides cause cancer, one of the most common types being breast cancer (Pathak 2022).[53] Breast cancer is linked to organophosphate insecticides such as parathion and malathion that affect cellular growth and multiplication (Pathak 2022), but also to many other pesticides including organochlorine insecticides, synthetic pyrethroid insecticides, and numerous herbicides and fungicides through a variety of mechanisms that include endocrine disruption, tumour promotion, disturbance of mammary gland development, etc (Watts

52. Boedeker W, Watts M, Clausing P, Marquez E. 2020. The global distribution of acute unintentional pesticide poisoning: estimations based on a systematic review. Retracted. *BMC Public health* 20:1875.
53. Pathak VM, Verma VK, Rawat BS, Kaur B, Babu N, Sharma A, Dewali S, Yadav M, Kumari R, Singh S, Mohapatra A, Pandey V, Rana N, Cunill JM. 2022. Current status of pesticide effects on environment, human health and its eco-friendly management as bioremediation: A comprehensive review. *Front Microbiol* 13:962619.

2007).[54] Other cancers for which there is evidence of a link to pesticides include prostate and childhood leukaemia.[55] Positive associations have been found between non-Hodgkin's lymphoma and DDT, organophosphates and malathion according to the UN Environment Programme.[56] But a study recently published in the journal *Frontiers in Cancer Control and Society* goes much further and the authors state that:

> Our findings demonstrated an association between pesticide use and increased incidence of leukemia; non-Hodgkin's lymphoma; bladder, colon, lung, and pancreatic cancer; and all cancers combined that are comparable to smoking for some cancer types.[57]

Pesticide use is on a par with smoking for cancer causation. The study, based in the US, used country-wide agricultural pesticide use data along with cancer incidence and covariant data (such as smoking, the Social Vulnerability Index (SVI), agricultural land use, and total population).

Besides cancer, chronic exposure to pesticides can also result in reduced nervous system functioning, disturbed neurodevelopment of children, diabetes, asthma, decreased male and female fertility, spontaneous abortion, birth defects and Parkinson's disease, among others. Positive associations have also been found between Parkinson's disease and herbicides, insecticides including diazinon, malathion, and fungicides; and between diabetes and DDT, DDE, HCB.[58]

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54. Watts MA. 2007. *Pesticides & Breast Cancer: A Wake Up Call*. PANAP, Penang.
55. UNEP. 2021. *Environmental and Health Impacts of Pesticides and Fertilizers and Ways of Minimizing Them*. United Nations Environment Programme, Nairobi. https://www.unep.org/resources/report/environmental-and-health-impacts-pesticides-and-fertilizers-and-ways-minimizing
56. UNEP. 2021. *Environmental and Health Impacts of Pesticides and Fertilizers and Ways of Minimizing Them*. United Nations Environment Programme, Nairobi. https://www.unep.org/resources/report/environmental-and-health-impacts-pesticides-and-fertilizers-and-ways-minimizing
57. Gerken J, Vincent GT, Zapata D, Barron IG, Zapata I. 2024. Comprehensive assessment of pesticide use patterns and increased cancer risk. *Front Cancer Control Soc* 2:1368086.
58. UNEP. 2021. *Environmental and Health Impacts of Pesticides and Fertilizers and Ways of Minimizing Them*. United Nations Environment Programme, Nairobi. https://www.unep.org/resources/report/environmental-and-health-impacts-pesticides-and-fertilizers-and-ways-minimizing

Whilst it is known that pesticides can cause a wide range of chronic health effects, it is exceptionally difficult to link particular pesticides with chronic health conditions in the field, because of the often long latency period between exposure and manifestation of the disease, and the myriad genetic, environmental and other aspects that can contribute to chronic conditions – not least the wide range of pesticides a person night have been exposed to during the latency period. Some studies of acute poisoning also note the existence of chronic conditions amongst exposed farmers; although this is useful, it falls short of proof of a connection. And is often used to exclude farmers from studies of acute effects, even though acute exposure may have caused those chronic effects in the first place.

Bangladesh

Bhattacharjee et al. (2013)[59] conducted a survey on the impacts of pesticide exposure on paddy farmers health and, besides the acute symptoms of poisoning in more than 27% (just for the most frequently reported symptom, not any symptom), they also noted that 12.1% of the farmers were suffering from diabetes, hypertension, asthma or tuberculosis.

In a study on insecticide use and the impact on the health of framers, in Tangail District of Bangladesh, in addition to the acute symptoms of poisoning farmers were found to be experiencing poor vision, urine control problems, reduction of sexual urge, asthma, physical weakness and breathing problems.[60]

India

One recent study in India found that that exposure to OC pesticides could be an important modifiable risk factor for breast cancer, especially in younger women, noting the increasing trend of breast cancer in younger women in India. The study, carried out by UCMS and GTB Hospital in Delhi in 2015–2016,

59. Bhattacharjee S, Chowdhury MA, Fakhruddin AN, Alam MK. 2013. Impacts of pesticide exposure on paddy farmers' health. *Jahangirnagar Uni Environ Bull* 2:18-25.
60. Islam A, Samiha A, Amin MR, Rokonuzzaman M, Hossain MS. Patterns of insecticide uses and its impact on the health of the farmers in Tangail district of Bangladesh. *Ann Bangladesh Agric* 27(1):31-9.

was of 42 women breast cancer patients, less than 40 years age, and 42 age-matched controls. All subjects were evaluated for exposure to organochlorine compounds by performing assays in blood samples for pesticides such as DDT and its metabolites DDD and DDE, dieldrin, aldrin, methoxychlor, heptachlor, α-endosulfan, β-endosulfan, and hexachlorocyclohexane (HCH) and its isomers (α, β, and γ). The results showed that the young women with breast cancer had significantly higher serum levels of all the organochlorine compounds except aldrin, p,p'-DDT, and methoxychlor. The authors concluded there was a statistically significant association between exposure to organochlorine pesticides and risk of breast cancer in young women.[61]

Based on an exhaustive review of epidemiological and laboratory studies, Gray et al. (2017)[62] concluded that an overall comparison of the association between disease risk and DDT use in developed countries (where DDT has been banned for several decades) and in developing countries (where DDT use is still prevalent) supports the premise that exposures to DDT, especially in the early developmental stage, are associated with an increased risk of breast cancer.

One study of the impact of pesticides on farmer's health in Western Odisha reported 58% of the 100 farmers experienced symptoms of acute pesticide poisoning, but also seven had paralysis, 13 had cancer and five had a neurological disorder.[63] In a study by Kumari et al. (2021)[64] of the health effects of pesticides on apple orchard workers in the Western Himalayan region, whilst 85% reported acute symptoms workers also reported asthma, hypertension, diabetes, cancer and other conditions (immune suppression, hormone disruption, and reproductive abnormalities). In an earlier paper

61. Kaur N, Swain SK, Banerjee BD, Sharma T, Krishnalata T. 2019. Organochlorine pesticide exposure as a risk factor for breast cancer in young Indian women: A case-control study. *South Asian J Cancer* 8(4):212-4.
62. Gray JM, Rasanayagam S, Engel C, Rizzo J. 2017. State of the evidence 2017: An update on the connection between breast cancer and the environment. *Environ Health* 16:94.
63. Seth P, Mahananda MR. 2016. Impact of pesticides on farmer's health of Western Odisha. *Int J Environ Agric Res* 2(12):101-7.
64. Kumari D, Sebastian AJ, John S. 2019. Pesticide handling practices and health risks among the apple orchard workers in Western Indian Himalayan region. *Human Ecol Risk Assess. https://doi.org/10.1080/10807039.2019.1689353*

on acute pesticide poisoning Kumari & John (2018)[65] also reported asthma and hypertension.

Laos

One article on pesticides in Laos referred to potential chronic health risks from exposure to pesticides: chronic neurodevelopmental impairment, cancer, reproductive dysfunction, and possibly dysfunction of the immune and endocrine systems.[66]

Vietnam

Statistics from the Ministry of Health (2015) estimated that over 11 million people across Vietnam are regularly exposed to pesticides and around 2.1 million had chronic poisoning.[67]

Nguyen Hong Lap and colleagues (2024)[68] conducted a study to evaluate the sperm quality of 184 individuals in An Giang province, Mekong Delta. Of these participants, 116 had been exposed to organophosphate insecticides, while 68 had not. Results indicated that symptoms experienced within 1–2 days of spraying included dizziness (18.1%), headache (19%), red eyes (43.1%), itching, redness, and burning skin (38.8%), and cough, shortness of breath, and chest pain (19.8%). The exposure group had abnormal indicators such

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65. Kumari D, John S. 2018. Safety and occupational health hazards of agricultural workers handling pesticides: A case study. In: Siddiqui NA, Tauseef SM, Bansal K, Eds. *Advances in Health and Environment Safety: Select Proceedings of HSFEA 2016*. Springer Singapore; 2018. p.75-82.
66. Hughes D, Thonkum W, Tudpor K, Turnbull N, Yukalang N, Sychareun V, Vo TV, Win LL, Watkins A, Jordan S. 2021. Pesticides use and health impacts on farmers in Thailand, Vietnam, and Lao PDR: Protocol for a survey of knowledge, behaviours and blood acetyl cholinesterase concentrations. *PLoS One* 16(9):e0258134.
67. Ministry of Health, Government of Vietnam. https://moh.gov.vn/web/phong-chong-benh-nghe-nghiep/thong-tin-hoat-dong/-/asset_publisher/xjpQsFUZRw4q/content/benh-nhiem-oc-hoa-chat-tru-sau-nguy-co-phong-va-ieu-tri?inheritRedirect=false&gidzl=YPfAFVetPmA9WKao-Ybl0ek0HZVbB61Km8P9PxCdCbV0tXeqjdPX0C7U7-pUm8sC7beqVD6D0c1y7-3DW2W
68. Nguyen HL, Ngo QD, Nguyen VC, Nguyen KT, Lam VN, Nguyen ND, Tran TT, Tran QH. 2024. Evaluation of sperm quality of people spraying organophosphorus pesticides in An Giang province. *Vietnam Med J* 539(3):38-42.

as sperm density of 14.7%, total sperm count of 13.8%, progressive motility of 62.9%, and abnormal sperm shape that was 26.7% higher than the non-exposure group. Pearson's test analysis found an inverse relationship between pseudocholinesterase (PChE) and semen parameters, except for sperm immobility, which had a negative correlation ($p < 0.001$). The results reflect that exposure to OP pesticides is associated with reduced PChE and sperm quality, providing evidence of the risks of pesticide exposure.

4.3 Gender

Shammi et al. (2017)[69] noted the "largely non-existence" of reviews of occupational health and safety of women and children handling pesticides in Bangladesh.

In a study on cardamom plantation workers in Kerala, gender was found to be significantly affecting the severity of OAPP. It was found that females had a higher proportion of occurrence of moderate poisoning compared to males.[70] An in-dept report[71] on the gendered aspects of cardamon plantation work revealed that:

> Historically, cardamom plantations have been workplaces primarily for women from the lower castes. This practice stems from the colonial legacy of the kangani[72] system of labour recruitment, which continues to be the reason why hundreds of lower-caste women work on cardamom plantations in the Cardamom Hills.

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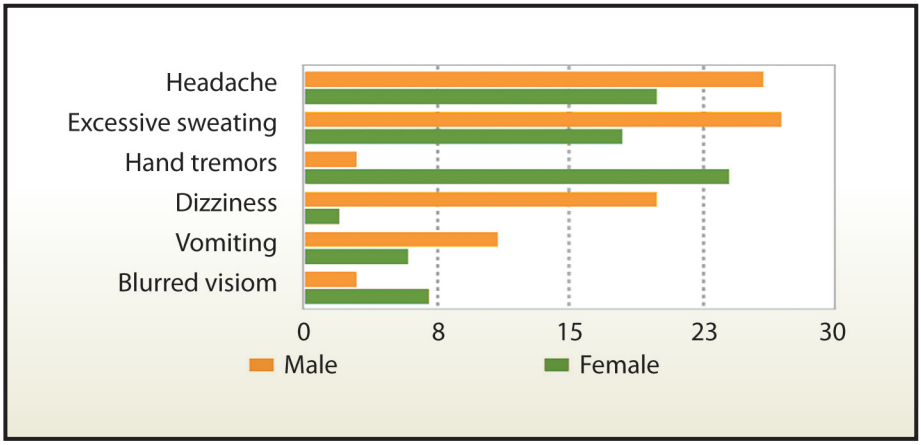
69. Shammi M, Sultana A, Hasan N, Rahman MM, Islam MS, Bodrud-Coza M, Uddin MK. 2020. Pesticide exposures towards health and environmental hazard in Bangladesh: A case study on farmers' perception. *J Saudi Soc Agric Sci* 19:161-73.
70. Reshma H, Jayalakshmi R. 2020. Prevalence of acute pesticide poisoning among pesticide applicators in cardamom plantations: A cross-sectional study from Idukki District, Kerala. *Ind J Occup Environ Med* 24(3):188. https://doi.org/10.4103/ijoem.ijoem_72_19
71. Krishna A. 2024. Tales Behind a Spice: Toxified Terrain and Tortured Bodies in the Making of Indian Small Cardamom. *Global Environ* 17(2):281-310 https://doi.org/10.3828/whpge.63837646622492
72. The kangani is typically a male from a higher caste, a 'left-over' from the British colonial system of indentured labour on the plantations which began in Ceylon and relied on the owner hiring a male from a dominant caste to recruit lower-caste workers. See Krishna 2024.

The work is intergenerational, with Malliga (quoted previously with regard to OAPP) being the fourth generation in her family to pick cardamom. Picking cardamom is regarded as 'women's work' because it requires diligence, patience and nimble fingers – and they work einght hours a day, six or seven days a week. Pesticide spraying (by males usually) occurs every 7–15 days or so, so the women are constantly exposed to pesticides on the plants and the pods they are picking. They say the stench of chemicals is ever present and they can identify which one has been sprayed by the smell (quinalphos), irritation of their hands (lambda-cyhalothrin) or the headaches (phorate).

In Vietnam, rural women constitute the majority of the agricultural workforce, undertaking various tasks in crop and livestock farming, including the use of pesticides. A 2022 CGFED participatory action research approach (CPAM) study conducted in Hai Hau, Nam Dinh[73], revealed the following gender differences in pesticide poisoning symptoms:

Figure 4.1: Common Symptoms of Poisoning by Gender



Source: CGFED 2022 [74]

73. CGFED. 2022. Current status of pesticide use and exposure in the community – Latest results from CPAM 2022 study. http://cgfed.org.vn/thuc-trang-su-dung-va-phoi-nhiem-hoa-chat-tru-sau-tai-cong-dong-ket-qua-moi-nhat-tu-nghien-cuu-cpam-2022/
74. CGFED. 2022. Use and exposure of pesticides in the community – Newest results from CPAM 2022. http://cgfed.org.vn/

Currently, many localities in Vietnam are experiencing "rural aging and feminisation of farmers" due to men migrating in search of work, placing an even greater burden of labour and disease risks on women and children.

4.4 The Pesticides Implicated in Adverse Health Effects

Bangladesh

Organophosphates are in widespread use in Bangladesh.[75] A study conducted by Samiha et al. (2022)[76] in the four districts of Rajshahi, Noagaon, Chapainawabganj and Natore under Barind areas of Bangladesh during 2020, of 30 farmers per district, found that the main insecticides used were:

- thiamethoxam (20%) + chlorantraniliprole (20%)
- chlorpyrifos (20%)
- chlorpyrifos (50%) + cypermethrin (5%)
- acephate (45%) + imidacloprid (25%)
- cartap (50%)
- carbofuran (3% or 5%)

Other insecticides used by more than 20% of rice farmers were profenofos, carbaryl, thiamethoxam, carbosulfan, pymetrozine and diazinon.

The analysis by Watts (2023)[77] of the pesticides being used in Bangladesh identified a number of pesticides as most likely to be contributing to OAPP in that country, including:

- abamectin
- chlorpyrifos
- imidacloprid
- thiamethoxam
- carbofuran
- cypermethrin
- lambda-cyhalothrin
- cartap
- diazinon
- malathion

75. Rahman A, Kaium A, Khan MS, Islam MA, Begum N, Prodhan MD, Hossain A, Mustafiz SS, Chowdhury MT. 2021. Residue level and health risk assessment of organophosphorus pesticides in country bean and bitter gourd collected from Cumilla, Bangladesh. *Food Res* 5(6):238-246.
76. Samiha A, Islam A, Hossain MS, Amin MR, Bari MN. 2022. Insect pest status and insecticide use in T. aman rice cultivation under Barind areas of Bangladesh. *Ecol J* 4(2):137-43.
77. Watts M. 2023. *Acute Pesticide Poisoning in Asia: A Four Country Review*. PAN Asia Pacific, Penang.

India

Referring to cardamon production in Kerala:[78]

> Interviewer: Can you name me some of these marunthu [pesticides]?
> Malliga: Agent (lambda-cyhalothrin), Porate (phorate), Kurudan (carbofuran), Ekkalax (quinalphos), Thurish (potassium phosphonate).

In 2016, organophosphates were the most commonly reported chemical family in different literature causing acute pesticide poisoning in India.[79]

A more recent study of cardamon plantation workers in Kerala, in which 100% suffered symptoms of OAPP, found organophosphates to be the most commonly used pesticides (51%), followed by pyrethroids (35.7%).[80]

Quinalphos and cypermethrin caused the deaths of two farmworkers (see section on acute poisoning, India) in upper Kuttanad who fainted in the paddy field while spraying pesticides.[81]

In a study of pesticide applicators in rice fields of low lying areas in Kerala where 38.9% of applicators reported symptoms of acute poisoning, the most frequently used pesticide (58%) was 2,4-D; other pesticides being used were monocrotophos, methyl parathion and paraquat dichloride.[82]

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78. Krishna A. 2024. Tales Behind a Spice: Toxified Terrain and Tortured Bodies in the Making of Indian Small Cardamom. *Global Environ* 17(2):281-310 https://doi.org/10.3828/whpge.63837646622492
79. Kumar S, Kaushik G, Villarreal-Chiu JF. 2016. Scenario of organophosphate pollution and toxicity in India: A review. *Environ Sci Pollut Res Int* 23:9480-91.
80. Reshma H, Jayalakshmi R. 2020. Prevalence of acute pesticide poisoning among pesticide applicators in cardamom plantations: A cross-sectional study from Idukki District, Kerala. *Ind J Occup Environ Med* 24(3):188. https://doi.org/10.4103/ijoem.ijoem_72_19
81. Government body implementing state government programmes for crops in the state.
82. Jomichen J. 2014. Pesticide use behaviour and potential health risks among pesticide applicators in Kuttanad area, Kerala, India. Dissertation, Sree Chitra Tirunal Institute for Medical Sciences & Technology, Thiruvananthapuram.

In the analysis by Watts (2023)[83] of the pesticides being used in India, the following were identified as most likely to be causing OAPP:

- acephate
- cypermethrin
- dimethoate
- fipronil
- monocrotophos
- profenofos
- chlorpyrifos
- diafenthiuron
- ethion
- imidacloprid
- quinalphos
- lambda-cyhalothrin

Laos

The most commonly used insecticides are chlorpyrifos, diazinon, fipronil, deltamethrin, abamectin and imidacloprid, according to a report by FAO in 2023.[84]

A study by Hughes et al. (2022)[85] using finger-prick tests to determine blood levels of acetylcholinesterase (AChE) identified that 76.9% of those sampled in Laos were at significant risk from exposure to organophosphate and carbamate insecticides.

Paraquat, atrazine and glyphosate have all been found in widespread use in Laos, and the following have been identified as some of the pesticides most likely to be causing OAPP:[86]

- 2,4-D
- chlorpyrifos
- glyphosate
- cypermethrin
- atrazine
- paraquat
- organophosphates
- carbamates

83. Watts M. 2023. *Acute Pesticide Poisoning in Asia: A Four Country Review*. PAN Asia Pacific, Penang.
84. FAO. 2023. *Special report − 2022 FAO/WFP Crop and Food Security Assessment Mission (CFSAM) to the Lao People's Democratic Republic. 7 March 2023.* Food and Agriculture Organization of the United Nations, Rome. https://doi.org/10.4060/cc4748en
85. Hughes D, Vo TV, Turnbull N, Sycareun V, Jordan S. 2022. Study in Press. Data taken from presentation by. Pesticide uses and health impacts on farmers in Thailand, Vietnam, and Lao DPR. Ancient Capital Conference on Science and technology, Hue University, August 2022.
86. Watts M. 2023. *Acute Pesticide Poisoning in Asia: A Four Country Review*. PAN Asia Pacific, Penang.

Vietnam

In 2022, CGFED collaborated with the Wonjin Institute of Occupational and Environmental Health (Korea) to conduct a study on the impact of pesticides on the environment and people in Hai Cuong commune, Hai Hau district, Nam Dinh province.[87] The study collected 150 samples of patches (10 sets x 15 patches/set/person), 40 urine samples from families of 30 farmers who directly used pesticides and families of people living near areas where pesticides were used. The results showed that 32 of the 48 pesticides found in samples are banned or not approved by the EU (67%). 84% of these are highly hazardous pesticides. Seven of the pesticides found in the samples are banned by Vietnam.

Type	Compounds
Fungicides	carbendazim, dimethomorph, hexaconazole, thiabendazole, tricyclazole
Herbicides	diuron, quizalofop-ethyl
Organochloride insecticides	**DDT**
Pyrethroid insecticides	allethrin, cyhalothrin, cypermethrin, deltamethrin, etofenprox, permethrin, phenothrin-trans
Organophosphate insecticides	**chlorpyrifos**, diazinon, **methamidophos**, mevinphos, **parathion**, quinalphos, phenthoate, sulfotep, **triazophos**
Carbamate insecticides	**aldicarb**, carbendazim, **carbofuran**
Neonicotinoids	clothianidin, dinotefuran, imidacloprid, thiamethoxam
Other insecticides	chlorfluazuron, lufenuron, propargite, pymetrozine, spirodiclofen

Notes:
- Red: PAN International List of Highly Hazardous Pesticides (March 2021)
- Bold: Banned in Vietnam
- Underline: Pesticide detected in urine

87. Wonjin, CGFED. 2022. *Environmental impacts of pesticides on farmers and their families (A study from Hai Cuong commune, Hai Hau district, Nam Dinh province).* https://drive.google.com/file/d/15sHFTm-KGFpH7VoJWBX54NbziL87NYW9/view?usp=drivesdk

Many active ingredients of insecticides (including permethrin and cypermethrin) were detected in the dust samples. Insecticides used in the home to control harmful insects, such as mosquitos, could be the source for house dust contamination.

Vietnamese children's pesticide exposure level is much higher than that of children from the US and Korea. Levels of 3-PBA (metabolite of pyrethroid insecticides), PNP (from parathion) and TCPY (from chlorpyriphos) were highest in the children group. Children's pesticide exposure level was similar to that of farmer family members.[88]

Wonjin Institute also collaborated with the Institute of Climate Change (ICC, under An Giang University) to study the impacts of pesticides on environment and people, in the districts of Cho Moi, Tri Ton and Thoai Son, An Giang province in 2022. The study collected 164 urine samples from farmers and their families. The results showed that 10 of the 16 pesticides found in urine and crops are banned or not approved by the EU (63%). Most of these are highly hazardous pesticides (8 or 80%).[89]

Type	Compounds
Fungicides	flusilazole, hexaconazole, propiconazole, tricyclazole
Organophosphate insecticides	**chlorpyrifos**, diazinon, malathion, **parathion**
Other insecticides	lufenuron
Neonicotinoids	clothianidin

Notes:
- Red: Pesticide Action Network (PAN) International List of Highly Hazardous Pesticides (March 2021)
- Bold: Banned List in Vietnam
- Underline: Pesticide detected in Urine

88. Wonjin, CGFED. 2022. *Environmental impacts of pesticides on farmers and their families (A study from Hai Cuong commune, Hai Hau district, Nam Dinh province)*. https://drive.google.com/file/d/15sHFTm-KGFpH7VoJWBX54NbziL87NYW9/view?usp=drivesdk
89. Wonjin, CCI 2022. *Environmental impacts of pesticides on farmers and their families (A study from Cho Moi, Tri Ton and Thoai Son district, An Giang province*). https://drive.google.com/file/d/15sHFTm-KGFpH7VoJWBX54NbziL87NYW9/view?usp=drivesdk

The analysis by Watts (2023)[90] identified the following pesticides likely to be involved in OAPP in Vietnam:

- abamectin
- chlorpyrifos
- difenoconazole
- fipronil
- hexaconazole
- indoxacarb
- paraquat
- propiconazole
- buprofezin
- cypermethrin
- emamectin benzoate
- glyphosate
- imidacloprid
- isoprothiolane
- permethrin

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90. Watts M. 2023. *Acute Pesticide Poisoning in Asia: A Four Country Review*. PAN Asia Pacific, Penang.

5.
FOOD CROPS

There are two main issues with regard to food crops:

- that of residues in the food and the subsequent risks for both health and economics/trade;
- that of impact on the growth of crops.

Residues in food often result from using more than the recommended amount on a crop, using adulterated formulas or not adhering to the required withholding period before harvesting.[91] A study conducted by Islam et al. (2023)[92] in Bangladesh found that 93.3% of summer vegetable growers did not consider the pre-harvest interval. Rahman et al. (2021)[93] refer to the use of organophosphates in Bangladesh at 5–6 times the recommended dosage in one crop per growing season. Perhaps that is because, as Illah et al. (2023)[94] found in their survey of six districts in Bangladesh, "70% of respondents were unaware of the health problems caused by consumption of pesticide-laden vegetables".

91. Rahman A, Kaium A, Khan MSI, Islam MA, Begum N, Prodhan MDH, Hossain A, Mustafiz SSB, Chowdhury MTI. 2021. Residue level and health risk assessment of organophosphorus pesticides in country bean and bitter gourd collected from Cumilla, Bangladesh. *Food Res* 5(6):238-46.
92. Islam A, Samiha A, Amin MR, Rokonuzzaman M, Hossain MS. 2023. Patterns of insecticide uses and its impact on the health of the farmers in Tangail district of Bangladesh. *Ann Bangladesh Agric* 27(1):31-9.
93. Rahman A, Kaium A, Khan MSI, Islam MA, Begum N, Prodhan MDH, Hossain A, Mustafiz SSB, Chowdhury MTI. 2021. Residue level and health risk assessment of organophosphorus pesticides in country bean and bitter gourd collected from Cumilla, Bangladesh. *Food Res* 5(6):238-46.
94. Shahidullah AK, Islam A, Rahman M. 2023. Knowledge, attitude, and practice of pesticide use by vegetable growers in Bangladesh: a health literacy perspective in relation to non-communicable diseases. *Front Sustain Food Sys* 7:1199871.

Some authorities, such as the EU, will prevent the entry of a shipment of food if it is found to have residues higher than the permitted MRL; and a number of food residue analyses in Bangladesh have found pesticides residues higher than the MRL in the EU (Sarker et al. 2021).[95] India has had consignments of cardamom rejected by Saudia Arabia because of residues, and other food consignments rejected by EU and USA for the same reason, including a 35% loss of basmati rice trade with EU.[96] Hence, residues in food can be a barrier to trade.[97]

Bangladesh

The extensive use of pesticides in Bangladesh, especially in major mango-growing regions like Rajshahi, Natore, and Naogaon, poses significant threats to food safety. Despite a High Court order to deploy police to curb this harmful practice, pesticide use continues unabated. This is largely due to a lack of awareness among farmers about the adverse effects of these chemicals. Many growers believe that increasing pesticide use is the only way to protect their crops from pests and diseases, which not only raises production costs and their risk of poisoning, but also leads to high levels of toxic residues in the food supply.[98]

Because organophosphate insecticides are in such widespread use in Bangladesh, Rahman et al. (2021)[99] tested country beans and bitter gourds collected from five markets in the district of Cumilla, for residues of seven organophosphates (acephate, chlorpyrifos, diazinon, dimethoate, fenitrothion,

95. Sarker A, Islam T, Rahman S, Nandi R, Kim JE. 2021. Uncertainty of pesticides in foodstuffs, associated environmental and health risks to humans – a critical case of Bangladesh with respect to global food policy. *Environ Sci Pol Res* 28(39):54448-65.
96. Kuruvila A, Devi PI, George T, Murugamn M, Sabu SS. 2022. Product standards, farmers' practices and global trade: a critical analysis with respect to pesticide residue levels in Indian small cardamom. *Agric Econ Res Rev* 35:75-87.
97. ITC News. 20 Dec 2022. Replacing chemical pesticides in Lao PDR with natural alternatives. International Trade Centre. https://www.intracen.org/news-and-events/news/replacing-chemical-pesticides-in-lao-pdr-with-natural-alternatives
98. The Daily Star. 2019. Overuse of pesticides in mangoes. Apr 23rd. https://www.thedailystar.net/editorial/news/overuse-pesticides-mangoes-1733164
99. Rahman A, Kaium A, Khan MSI, Islam MA, Begum N, Prodhan MDH, Hossain A, Mustafiz SSB, Chowdhury MTI. 2021. Residue level and health risk assessment of organophosphorus pesticides in country bean and bitter gourd collected from Cumilla, Bangladesh. *Food Res* 5(6):238-46.

malathion and quinalphos), and then carried out a health risk assessment. Of the 40 samples of country bean, two contained multiple residues, and seven contained a single residue. Of the 40 samples of bitter gourd, one sample contained multiple residues and three samples contained a single residue. Diazinon was the most commonly detected residue, followed by dimethoate and chlorpyrifos. Short- and long-term risk assessment results showed that the intake risks of country bean and bitter gourd were 'acceptable'.

Also in 2021, Ahmed et al.[100] detected acephate, diazinon, fenitrothion and chlorpyrifos residues, above the EU MRLs, in 21.5% of 80 samples of eggplant and tomatoes collected from local markets in four different regions (Bogura, Narsingdi, Jeshore and Cumilla).

A review published in 2021 by Barman et al.[101] noted cartap residues, above the MRL, in brinjal in Chuadanga. It also reported that 21.8% of brinjal, yard long bean, bitter gourd, snake gourd, pointed gourd, okra, tomato, hyacinth bean and cabbage collected between 2010 to 2011 from several districts of Bangladesh were contaminated, with 18.26% above the MRL; and 27.4% samples of country bean, green chili, tomato, eggplants, red amaranth contained residues of which 89.2% exceeded MRL. Endosulfan was detected in cabbage and potatoes during the period 2009 to 2012. Ethion has been detected in Lady's finger, fenvalerate in country bean, linuron in eggplant, parathion in tomato and brinjal, phenthoate in eggplant, and cypermethrin in yard long bean.

Another review published in 2021[102] reported lambda-cyhalothrin in lady's finger, Indian spinach,

100. Ahmed MS, Begum A, Prodham MD, Afroze M, Sarker D. 2021. Organophosphorus pesticide residues detected in eggplant and tomato samples collected from different regions of Bangladesh. *Asian Australas J Food Saf Secur* 5(1):27-31.
101. Barmon SC, Chaki BM, Wu Y. 2021. Pesticide use in Bangladesh: a review on potential impacts. *Asian J Environ Ecol* 16(4):224-41.
102. Sarker A, Islam T, Rahman S, Nandi R, Kim JE. 2021. Uncertainty of pesticides in foodstuffs, associated environmental and health risks to humans – a critical case of Bangladesh with respect to global food policy. *Environ Sci Pol Res* 28(39):54448-65.

and bean; alpha-cypermethrin in lady's finger, Indian spinach, red spinach; cypermethrin in eggplant, summer country bean, okra, brinjal; permethrin and aldrin in fish and vegetable samples; earlier (2009) findings of DDT and heptachlor in dried fish; and more recent (2016, 2019) findings of DDT in fish and poultry meat.

In 2023, Umama Begum Ruba and colleagues published a systematic review of the environmental impacts of pesticides in Bangladesh,[103] in which they also summarised studies on residues of pesticides in food:

- A 2019 study conducted in the local market of Dhaka city found concentrations of dimethoate in coriander and lettuce that exceeded the EU permissible limit.
- Again in 2019, concentrations of dimethoate in tomatoes in the Rajshahi district were above MRLs.
- An earlier study (2014) found acephate and fenitrothion in brinjal in Gazipur district above MRLs.
- In 2014, the concentration of ethion in lady's finger in Gazipur district exceeded MRLs.
- Significant concentrations of chlorpyrifos, diazinon, and carbaryl were found in Dhaka city brinjal and tomatoes (2007, 2010).
- A 2017 study in Dhaka revealed that dimethoate and quinalphos were above MRLs in some country bean samples.
- Substantial amounts of mancozeb and imidacloprid in cucumber and spinach, respectively, indicate significant chemical contamination in those respective vegetables in Mymensingh (2015).
- In 2014, in Narsingdi, diazinon, quinalphos, malathion, cypermethrin, fenitrothion, fenvalerate, and propiconazole, were detected in field crops with some above MRLs.
- In 2019, 12% of the analysed cabbage in Dhaka was contaminated with residues of diazinon and chlorpyrifos, with all detected concentrations above the EU MRLs.
- Aldrin and permethrin were detected in fish samples of catla, a South Asian carp (*Catla catla*).

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103. Ruba UB, Chakma K, Ali MP, Khan AU, Talucder MS. 2023. Environmental pollution from injudicious application of pesticides: Bangladesh context. *J Agroforestry Environ* 16(1):40-9.

- In 2015, pesticide contamination was found in 60% of tomatoes and 50% of brinjals from the Narayanganj district, with all levels exceeding the EU MRLs; diazinon was the most prevalent pesticide identified.
- A 2019 study in the retail market of Savar found pesticide residue contamination in 12.3% of bitter gourds, above the EU MRL.

A second systematic review of vegetable contamination in Bangladesh published in 2023, (Khatun et al. 2023),[104] analysed the data over the preceding decade and concluded that:

- More than 29% of vegetables samples were contaminated with pesticides.
- 73% of the contaminated samples exceeded the MRLs.
- The most commonly contaminated vegetables were cucumber (51%), tomato (41%), cauliflower (31%), miscellaneous vegetables (36%), eggplant (29%), beans (23%), cabbage (18%), and gourds.
- The hazard quotient (HQ>1) was observed for adolescents and adults in tomato, eggplant, beans, cauliflower, cabbage, cucumber, lady's finger, lettuce, and coriander.
- The most used pesticides were chlorpyrifos, dimethoate, diazinon, malathion, and quinalphos.
- The highest HQ was observed for cypermethrin in beans.

India

A 2009 study showed that pesticide use in cardamom plantations in Idukki was one of the world's highest, with farmers using an average of 27 kg of pesticides per hectare, whereas the average use of pesticides in India as a whole was only 0.5 kg per hectare for all crops. Cardamoms collected from the Cardamom Hill Reserve were found to contain high levels of residues of triazophos, quinalphos and endosulfan. A 2010 study conducted by the National Institute of Advanced Studies (NIAS) corroborates this with residues of quinalphos 25 times the MRL, and high levels of endosulfan.[105]

104. Khatun P, Islam A, Sachi S, Islam MZ, Islam P. 2023. Pesticides in vegetable production in Bangladesh: A systemic review of contamination levels and associated health risks in the last decade. *Toxicol Reports* 11:199-211.
105. Misra SS. 2011. Kerala gets cautious. DownToEarth. https://www.downtoearth.org.in/environment/kerala-gets-cautious-33029

Kuruvila et al. (2022)[106] reported that of the 38 pesticides being sprayed on cardamom, 15 were found as residues in the pods, with two – lambda-cyhalothrin and quinalphos – being above the MRLs.

Residues Found in Cardamom from Idduki District

Pesticide	Type	HHP Status[6]	No. of Countries Banned[7]
acephate	organophosphate insecticide	+	43
alpha-cypermethrin	pyrethroid insecticide	+	29
bifenthrin	pyrethroid insecticide	+	30
carbendazim	benzimidazole fungicide	+	41
chlorpyrifos	organophosphate insecticide	+	44*
difenoconazole	triazole fungicide		**
ethion	organophosphate insecticide	+	35
imidacloprid	neonicotinoid insecticide	+	29
indoxacarb	oxadiazine insecticide	+	29
lambda-cyhalothrin	pyrethroid insecticide	+	**
metalaxyl	acylalanine fungicide		1**
methomyl	carbamate insecticide	+	50
profenophos	organophosphate insecticide	+	39
quinalphos	OP insecticide	+	32
thiamethoxam	Neonicotinoid insecticide	+	28

Source: Kuruvila et al. 2022.

* Proposed for global ban under Stockholm Convention.
** EU approval expires in 2026

The good news is that there is a highly positive trend for cardamom growers in Kerala to use biopesticides, with most planters now using them (Nafeesa et al. 2021).[107]

106. Kuruvila A, Devi PI, George T, Murugamn M, Sabu SS. 2022. Product standards, farmers' practices and global trade: a critical analysis with respect to pesticide residue levels in Indian small cardamom. *Agric Econ Res Rev* 35:75-87.
107. Nafeesa M, Murugan M, Remya JS, Preethy TT, Abraham JK. 2024. Pesticide scenario and reduction strategies in Indian cardamom farming – present and future perspectives. *Current Sci* 126(8):894-902.

But it is not just cardamom: in November 2023 the EU sounded the alarm about the levels of pesticides in turmeric coming from India: chlorpyrifos was found in a sample tested in Germany.[108]

A study in Rajasthan in 2017–2018 found residues in wheat, gram and mustard samples, of chlorpyrifos, malathion, profenofos and triazophos, with 14 samples above the MRL and 59 below.[109]

Analysis of cow milk samples from five different peri-urban locations (Bangalore, Bhubaneswar, Guwahati, Ludhiana and Udaipur) revealed residues of lindane, DDT, endosulfan, fipronil, cypermethrin, cyhalothrin, permethrin, chlorpyrifos, ethion and profenophos in cow milk, with levels of fipronil, lindane, DDT and ethion posing risks for children.[110]

A case study was conducted in Assam to determine the phytotoxicity of malathion and Tatafen (a formulation of fenvalerate) to *Solanum melongena* (eggplant), which is an essential vegetable used all over India. The results affirmed that seedling growth, relative water content, fresh and dry weight were reduced and that a steady phytotoxicity response by the higher concentration of both insecticides was more prominent at an early stage of treatment, when the insecticides are applied in large quantities.[111]

108. Kulkarni C. 2023. Danger looms as pesticides reign supreme on India's farms. November 19. *Deccan Herald*. https://www.deccanherald.com/india/danger-looms-as-pesticides-reign-supreme-on-india-s-farms-2776637
109. Sharma N, Dutta S. Analysis of pesticide residues on crops with related health impact on farmers in agriculture field of Sikrai Tehsil, Dausa District, Rajasthan, India. *Int J Current Microbiol Appl* Sci 8(05):161-9.
110. Gill JP, Bedi JS, Fairoze MN, Hazarika RA, Gaurav A, Satpathy SK, Charhan AS, Lindahl J, Grace D, Kumar A, Kakkar M. 2020. Pesticide residues in peri-urban milk from India and risk assessment: A multicenter study. *Sci Reports* 10:8054. https://doi.org/10.1038/s41598-020-65030-z
111. Yengkokpam P, Mazumder PB. 2020. Phytotoxicity of malathion (PM) and tatafen (PTF) towards Solanum melongena L. cv. Longai: a case study. *Plant Phys Rep* 25:149-56.

In 2013, an inspection in Food Corporation of India godowns in Kerala (Thiruvananthapuram and Kozhikode) found that the stored grains contained malathion in high quantities. Malathion is commonly used in grain storage areas to control stored pests.[112]

Laos

Pesticide use in Laos has been associated with negative impacts on food, both in terms of food safety and food security. The increased commercialisation of agriculture in the country has led to a significant increase in pesticide imports, reaching 2.3 million kilograms in 2019.[113] This has resulted in dangerously high levels of pesticide use, particularly in maize production, which attracts the use of controversial and often banned herbicides such as paraquat, glyphosate, atrazine, and 2,4-D.[114] A study conducted in Xiengkhouang province found that 59% of vegetable farmers overuse pesticides, leading to high levels of pesticide residues in both local and imported food products.[115]

A report published in 2022[116] drew attention to the increasing safety concerns for both fresh and processed foods in Laos, pointing to misuse and overuse of pesticides, importation of banned pesticides, leading to pesticide poisoning of farmworkers and local communities, contamination of the environment, and to food contamination above tolerable levels, which in turn leads to "increased risk of serious illness (cancer, etc.)".

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112. The Hindu. 2013. Pesticide residue found in rice. August 24. https://www.thehindu.com/news/cities/Thiruvananthapuram/pesticide-residue-found-in-rice/article5055545.ece
113. Rassapong S, Syfongxay C, Phanthanivong I, Syhalal B, Phimmahthut S, Manyvong T, Keothingkham B, Hongsibsong S, Shattuck A, Bartlett A. 2018. Pesticide Use in Lao PDR: Health and Environmental Impacts. Lao Upland Rural Advisory Service (LURAS). http://www.laofab.org
114. Neely, B. 2022. Sustainable Maize Production for Human Health and Biodiversity in Laos. February 17. AGRILINKS, USAID. https://agrilinks.org/post/sustainable-maize-production-human-health-and-biodiversity-laos
115. Rassapong S, Syfongxay C, Phanthanivong I, Syhalal B, Phimmahthut S, Manyvong T, Keothingkham B, Hongsibsong S, Shattuck A, Bartlett A. 2018. Pesticide Use in Lao PDR: Health and Environmental Impacts. Lao Upland Rural Advisory Service (LURAS). http://www.laofab.org
116. FAO, European Union, CIRAD. 2022. *Food Systems Profile – The Lao People's Democratic Republic. Catalysing the sustainable and inclusive transformation of food systems.* Rome, Brussels and Montpellier, France. https://doi.org/10.4060/cc0302en

This is not just a problem for farmers and workers: testing of food for residues in Xiengkhouang province and in the Vientiane capital revealed that a higher percentage of people consuming vegetables from the market (45%) had unacceptable levels of cholinesterase inhibition than did farmers (35%). 52.4% of samples of fresh fruit and vegetables contained organophosphate and carbamate residues, with the highest incidence (54%) in Xiengkhouang province and the lowest (27%) in Houaphan province. Of the 422 schoolchildren tested for organophosphates and carbamates, 33% had unacceptable levels of residues, higher than farmers and other consumers. These children were exposed either through residues in food or from living near fields where the pesticides are used. In a second, smaller study of 20 farmers, students, and government officials, 85% had organophosphate and 25% glyphosate residues. A consistent finding in these surveys is that higher-income groups – i.e., those with access to food markets – had higher levels of residues, indicating that a major problem with a contaminated food supply is the result of pesticides overuse. The problem appears to be nationwide, with unacceptable levels of organophosphates found in students in Vientiane capital as well as Xiengkhouang province. However, there was no indication of the pesticides that may have been involved in these findings other than that they would have been organophosphates and/or carbamates, and pyrethroids, and no testing for herbicides apart from the one study on glyphosate.[117]

Vietnam

A survey of fresh food safety at three wholesale agricultural and food markets in Ho Chi Minh City revealed that 271 out of 570 vegetable and fruit samples (47.54%) contained pesticide residues (Bao Phuong 2022).[118] Of these, 198

117. Rassapong S, Syfongxay C, Phanthanivong I, Syhalal B, Phimmahthut S, Manyvong T, Keothingkham B, Hongsibsong S, Shattuck A, Bartlett A. 2018. Pesticide Use in Lao PDR: Health and Environmental Impacts. Lao Upland Rural Advisory Service (LURAS). http://www.laofab.org
118. Bao Phuong. 2022. Shocked by food safety at wholesale markets: There are enough pesticides and heavy metals. July 19. https://vietnamnet.vn/tp-hcm-choang-voi-do-an-toan-thuc-pham-cho-dau-moi-co-du-thuoc-tru-sau-kim-loai-nang-2040960.html

samples were within the allowable limit, 58 samples (10.2%) were not listed as allowed, and 20 samples (3.5%) exceeded the permissible limit. The test results indicated that vegetable and fruit products were contaminated with multiple pesticides simultaneously, with some containing up to seven different actives.

- Carbendazim residues on spinach, tomatoes, Chinese cabbage, Chinese spinach, Malabar spinach, basil, and amaranth.
- Permethrin on spinach, Chinese cabbage, and water spinach, while cypermethrin was found on Chinese cabbage, white radish, basil and water spinach.
- imidacloprid on Chinese cabbage and tomatoes.

A study conducted in Da Nang City from 2018 to 2021 found pesticide residues in 872 vegetable and fruit samples.[119] The results revealed that 1.38% of the samples (12 out of 872) exceeded the MRL. Common pesticide active ingredients detected in agricultural products included cypermethrin, permethrin, imidacloprid, carbendazim, difenoconazole, and acetamiprid. These substances were frequently found in vegetables and fruits such as celery, tomatoes, carrots, oranges, Thai longan, apples and rambutan, etc.

A separate survey conducted between 2015 and 2016 at the 108 Central Military Hospital examined the presence of organophosphate and carbamate pesticide residues in vegetables, tubers, and fruits supplied to their kitchens. The results indicated the highest positive rate in beans (14.28%), followed by sweet cabbage (13.7%), chrysanthemum greens (11.54%), mustard greens (10%), water spinach (9.28%), Malabar spinach, cabbage (7.14% each), carrots (6.79%), tomatoes (6.25%), squash (6.15%), potatoes (5.33%), and bean sprouts (4.11%).[120]

Cypermethrin and permethrin were detected in jute plant, longevity spinach, pumpkin buds, sweet leaf, Vietnamese balm, and vine spinach in 28

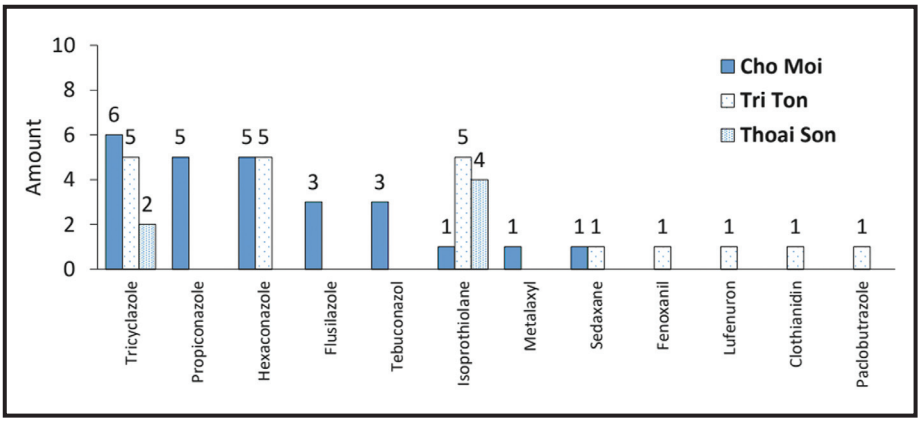
119 https://www.ccatvstp-haiduong.com/2022/06/01/thuc-pham-o-nhiem-hoa-chat-bao-ve-thuc-vat-va-nhung-dieu-can-biet

120. Hang PT, Kha LM. 2018. Survey on the presence of pesticide residues in vegetables, tubers, and fruits provided in the kitchens of the 108 Central Military Hospital in 2015-2016. *J 108 - Clin Med Pharm* 13(2). https://tcydls108.benhvien108.vn/index.php/YDLS/article/view/321

vegetable samples collected by CGFED in the study "Impact of pesticides on the environment, farmers and their families" in Hai Cuong commune, Hai Hau district, Nam Dinh province in 2022.[121]

Pesticides were also found in 30 rice samples collected by CCI and Wonjin in 2022 (see Figure 5.1).[122]

Figure 5.1: Pesticide compounds detected on rice samples



121. Wonjin, CGFED. 2022. Environmental impacts of pesticides on farmers and their families: A study from Hai Cuong commune, Hai Hau district, Nam Dinh province. https://drive.google.com/file/d/15sHFTm-KGFpH7VoJWBX54NbziL87NYW9/view?usp=drivesdk

122. Wonjin, CCI. 2022: Environmental impacts of pesticides on farmers and their families (A study from Cho Moi, Tri Ton and Thoai Son district, An Giang province). https://drive.google.com/file/d/15sHFTm-KGFpH7VoJWBX54NbziL87NYW9/view?usp=drivesdk

6.
IMPACTS ON THE ENVIRONMENT

6.1 Soil

Bangladesh

In a survey of farmers in two areas of Bangladesh (Savar Upazila (SU) and Mehendiganj Upazila MU)), Shammi et al. (2020)[123] found that about 83% farmers in SU and 24% in MU reported surface water pollution resulting from pesticides, that excessive use of pesticides was destroying beneficial insects, and that 67% farmers of SU and 26% farmers of MU thought that environmental quality was deteriorating.

An analysis of 21 soil samples from vegetable and paddy fields in the coastal district Feni found three had residues of diazinon, two had carbofuran and two had carbaryl at concentrations ranging from 0.01 to 3.21 µg/kg, but no organochlorine residues,[124] whereas an earlier sampling of soils in the Narshingdi district found DDT (0.726 µg/kg) and DDE (0.563 µg/kg), with organophosphate, carbamate and pyrethroid residues below quantification levels (Uddin et al. 2016).[125]

However, a recent analysis from the Lakshmipur district in 2020 discovered the prevalence of carbofuran (1.851 µg/kg), carbaryl (1.047 µg/kg) and diazinon

123. Shammi M, Sultana A, Hasan N, Rahman MM, Islam MS, Bodrud-Coza M, Uddin MK. 2020. Pesticide exposures towards health and environmental hazard in Bangladesh: A case study on farmers' perception. *J Saudi Soc Agric Sci* 19:161-73.
124. Uddin MA, Rahman MH, Nesha M, Choudhury MA, Fardous Z, Rahman MA. 2018. Studies on pesticide residues in soils of some selected spots of coastal region of Bangladesh. *Nuclear Sci Applic* 27(1&2):13-17.
125. Uddin MA, Chowdhury MA, Fardous Z, Hasanuzzaman M. 2016. Quantification of pesticide residues in some soils of Narshingdi area. *Bangladesh J Sci Res* 29(2):75-8.

(0.759 µg/kg) in soil sediments collected from ponds and canals, that exceeded the EEC recommended limit of 0.1 µg/kg, indicating a major hazard.[126]

The 2021 review of residues in Bangladesh by Barmon et al. (2021)[127] also noted the occurrence of diazinon, carbofuran and carbaryl residues in a variety of soils, including from ponds, canals, vegetable fields and paddy fields.

In 2023, Umama Begum Ruba and colleagues published a systematic review of the environmental impacts of pesticides in Bangladesh,[128] stating that the intensive use of pesticides harms soil health, destroying soil microorganisms, with long-term applications disrupting biochemical equilibrium and nitrogen fixation, and inhibiting the activity of soil enzymes.

Because most organochlorines were banned in Bangladesh in 1993 due to their environmental persistence, there is little evidence of them in the environment there now.[129]

India

An environmental study conducted in Idukki district, Kerala, detected a number of pesticides in the soils of cardamom plantations including endosulfan and its metabolites, DDT and its metabolites, chlorpyrifos, quinalphos and ethion, and the authors stated that "the probability of contamination of the soil in the cardamom plantations by any of these pesticides is as high as 82%". The highest levels were for endosulfan sulphate and chlorpyrifos.[130]

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126. Uddin MA, Chowdhury N, Rahman MA, Rashid MH, Chowdhury MA, Fardous Z. 2020. Identification and quantification of soil pesticides in coastal Lakshmipur District of Bangladesh. *J Asiat Soc Bangladesh* 46(2):191-200.
127. Barmon SC, Chaki BM, Wu Y. 2021. Pesticide use in Bangladesh: a review on potential impacts. *Asian J Environ Ecol* 16(4):224-41.
128. Ruba UB, Chakma K, Ali MP, Khan AU, Talucder MS. 2023. Environmental pollution from injudicious application of pesticides: Bangladesh context. *J Agroforestry Environ* 16(1):40-9.
129. Barmon SC, Chaki BM, Wu Y. 2021. Pesticide use in Bangladesh: a review on potential impacts. *Asian J Environ Ecol* 16(4):224-41.
130. Jacob S, Resmi G, Mathew PK. 2014. Environmental pollution due to pesticide application in cardamom hills of Idukki, District, Kerala, India. *J Energy Res Environ Technol* 2(1):54-62.

An earlier two-year study was also conducted at the cardamom plantations of Idukki district to assess the nature and extent of pesticide residues in soils. The analysis of 50 samples each collected during the years 2011 and 2012 revealed the presence of pesticides in as many as 74% and 60% samples, respectively. The pesticides detected were p,p'-DDT, p,p'-DDD, p,p'-DDE, endosulfan sulphate, alpha-endosulfan, beta-endosulfan, ethion, quinalphos, profenophos, chlorpyriphos, lambda-cyhalothrin, bifenthrin, cypermethrin, imidacloprid and indoxacarb.[131]

Organochlorine residues were found in soils in vegetable growing areas in Bihar in 2012 – endosulfan, HCH, DDT – together with chlorpyrifos, cypermethrin, quinalphos, dimethoate, deltamethrin and fenvalerate.[132]

More than 90 % of soil samples from four different climatic zones of the state of Himachal Pradesh were found to contain residues, including DDT, HCH, endosulfan, chlorpyrifos, cypermethrin, cyfluthrin, dicofol and chlorothalonil in apple and mango orchard soils.[133]

Laos

According to Rassapong et al. (2018),[134] a government report documented residues of carbendazim, glyphosate, paraquat, dicofol and cypermethrin in soil samples from six locations of Tonpherng and Phaoudom districts. The levels of glyphosate and paraquat were regarded as being high.

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131. Beevi SN, Paul A, George T, Mathew TB, Kumar NP, Xavier G, Kumar GTP, Rajith R, Ravi KP, Kumar SV. 2014. Pesticide residues in soils under cardamom cultivation in Kerala, India. *Pest Res J* 26:35-41.
132. Sah SB, Gupta RN, Patel DK, Kumar T, Kumari M, Singh SP. 2021. Pesticide residues in soil samples from vegetable growing area of Bihar. *Int J Chem Studies* 9(1):1001-4.
133. Brar SP, Sharma ID. 2019. Soil pesticide residues in orchard based land use systems across different agro-climatic zones of Himachal Pradesh. *Int J Curr Microbiol App Sci* 8(4):1250-63.
134. Rassapong S, Syfongxay C, Phanthanivong I, Syhalal B, Phimmahthut S, Manyvong T, Keothingkham B, Hongsibsong S, Shattuck A, Bartlett A. 2018. *Pesticide Use in Lao PDR: health and Environmental Impacts*. Lao Upland Rural Advisory Service (LURAS). http://www.laofab.org

Vietnam

In Vietnam, the problem of environmental pollution caused by residual pesticides is primarily attributed to the widespread use of persistent organic pollutants (POPs), particularly DDT and hexachlorocyclohexane (HCH). Preliminary statistical data collected by Provincial People's Committees and the General Department of Environment within the framework of the National Plan for the Prevention and Treatment of Pesticide Pollution (Decision No. 1946/QD-TTg) indicate that as of June 2013, there were approximately 1,652 (suspected) sites of environmental pollution caused by residual pesticides nationwide. All of these recorded locations had stored various types of pesticides during their operations, including POPs (mainly DDT and HCH).[135] According to the studies cited in this report, the pesticides that were commonly being used in Vietnamese agriculture include paraquat (Nimaxon 20SL, Gfaxone 20SL), diquat, atrazine (Mizin 80WP), glyphosate (Dosate 480SC, Lyrin 480DD), 2,4-D (Anco 600DD) herbicides; organophosphate insecticides; DDT and other organochlorine insecticides.

In 2018, isoprothiolane, chlorpyrifos and propiconazole were found in paddy rice field soil and irrigation ditch sediments in the Red River delta. Azoxystrobin was also found in the sediment.[136]

Findings from the study conducted jointly by CGFED and Wonjin Institute in 2022 showed a total of 47 different pesticides were detected in 30 dust samples collected from 30 households in Hai Cuong commune, Hai Hau district, Nam Dinh province, including chlorpyrifos, DDT and carbofuran. People living in these houses are at risk of frequent exposure to these toxic chemicals through the respiratory tract – see Figure 6.1.

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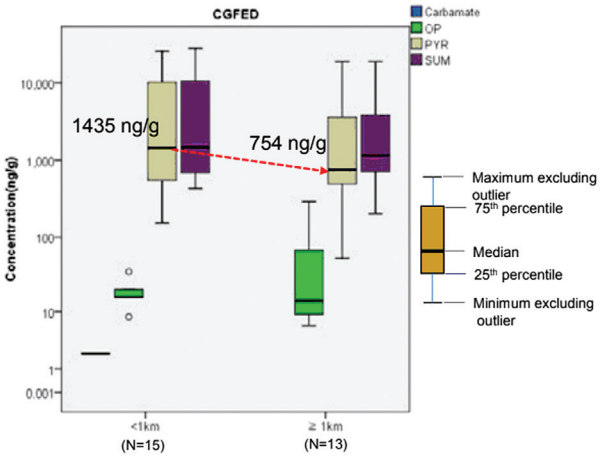
135. General Department of Environment - UNDP and Gef. 2015. Current status of environmental pollution caused by pesticide residual belonging to the group of persistent organic substances in Vietnam. Hanoi.
136. Braun G, Sebesvari Z, Braun M, Kruse J, Amelung W, An NT, Renaud FG. 2018. Does sea-dyke construction affect the spatial distribution of pesticides in agricultural soils? – A case study from the Red River Delta, Vietnam. *Environ Pollut* 243B:890-9.

Figure 6.1: 47 Pesticide Were Detected in Dust Collected from CGFED in Vietnam

(Unit: ng/g)

Insecticides	Hazard	Compounds	N	%	Median	GM	Min.	Max.
	HHP	Hexaconazole	29	96.7	19.4	17.7	4.6	59.0
PYRs	HHP	Permethrin	29	96.7	1054.4	1343.2	31.7	25086.0
	HHP, M(1B),R(1B)	Carbendazim	26	86.7	47.0	55.8	8.5	557.1
		2,6-Diisopropylnaphthalene	21	70.0	7.3	9.3	2.3	92.0
PYRs	HHP	Cypermethrin	21	70.0	189.5	230.9	17.3	2258.7
	HHP	Chlorfluazuron	18	60.0	16.2	16.9	9.0	48.3
		Cinmethylin	14	46.7	49.9	50.2	32.7	85.5
PYRs		Phenothrin-trans	14	46.7	47.8	55.6	14.3	423.2
		Acetamiprid	11	36.7	5.6	8.2	2.4	33.6
	HHP	Chlorantraniliprole	10	33.3	15.3	14.1	8.2	30.9
PYRs	HHP	Deltamethrin	8	26.7	150.4	236.0	45.6	5176.8
OPs	HHP, Banned	Chlorpyrifos	7	23.3	13.1	11.5	6.3	19.7
PYRs	HHP	Cyhalothrin	4	13.3	36.2	26.8	9.6	88.7
OCs	HHP, Banned	DDT	1	3.3	179.9	179.9	179.9	179.9
Carbamate	HHP, Banned	Carbofuran	1	3.3	2.2	2.2	2.2	2.2

HHP: Pesticide Action Network(PAN) International List of Highly Hazardous Pesticides(March 2021));
Banned: PAN International consolidated list of banned pesticides(2022)
M(1B): Mutagenicity, Group 1B; R(1B): Reproductive toxicity, Group1B
PYRs: Pyrethroid insecticide; OPs: Organophosphate insecticides
Pesticides in red are banned in Vietnam.



Source: Research results of "Impact of pesticides on the environment, farmers and their families" in Hai Cuong commune, Hai Hau district, Nam Dinh province, CGFED & Wonjin Institute, 2022.

Impact on Biota

A study conducted by Ha Danh Duc and colleagues (2017) at Dong Thap University evaluated the effects of three herbicides, Mizin 80WP (atrazine), Dosate 480SC (glyphosate), and Nimaxon 20SL (paraquat), on soil bacteria, demonstrating that these herbicides reduced the bacterial population in the soil, particularly at concentrations of 1.5X and above, where a significant reduction was observed.[137]

6.2 Water

Bangladesh

The above-mentioned systematic review of the environmental impacts of pesticides in Bangladesh by Ruba et al. (2023),[138] found significant contamination of waterways and impacts on aquatic species:

Contamination

- Chlorpyrifos and carbofuran were found in water from a paddy field and a lake in Rangpur, indicating contaminated water sources with high environmental risk.
- The concentrations of malathion in the Rangpur district ranged from 2 ppm to 221 ppm, above the pesticide contamination limit.
- Diazinon, carbaryl, and chlorpyrifos were detected in pond water of coastal regions; even though they were below WHO acceptable limits these residues are concerning.
- In Savar and Dhamrai, water bodies were extremely contaminated with carbaryl residues, as well as with major residues of malathion, diazinon, and carbofuran, with gross residues crossing the EEC's allowable limit.

137. Ha Danh Duc, Nguyen Thi Kim Khanh, Bui Minh Triet. 2017. Effects of herbicides on the number of bacteria and chemical composition of soil. *J Sci Technol* 9(118):89-93.
138. Ruba UB, Chakma K, Ali MP, Khan AU, Talucder MS. 2023. Environmental pollution from injudicious application of pesticides: Bangladesh context. *J Agroforestry Environ* 16(1):40-9.

- Dhamrai upazila's water source was found to be polluted with malathion and diazinon levels that surpassed the recommended level, posing a risk to health.
- High levels of malathion, carbofuran, and cypermethrin were found in pond water in the Brahmanbaria district.
- Concentrations of malathion, chlorpyrifos, and diazinon were identified in paddy field water and tube well water above the acceptable limits.
- Diazinon, chlorpyriphos, and carbofuran were found in pond water in the Meherpur district, and although residual levels were found to be within reasonable limits in certain situations, water contamination posed a serious threat to the ecosystem.
- Organophosphate and organochlorine insecticides were found in high concentrations in lake water near Dhaka.
- Despite being banned, HCB, DDT, and other POPs were found in water sources in the Narayanganj and Dhaka districts, and the elevated levels of concentration posed a major threat of ground and surface water contamination.
- Heptachlor and DDT concentrations in irrigated field water were above the WHO allowable level in Nator, Bandarban, Sunamganj, Madaripur, and Feni, Nawabganj, Kumilla, Sunamganj.

Impacts on aquatic species

- In North-west Bangladesh researchers measured chronic respiratory quotients for chlorpyrifos, malathion, diazinon, fenitrothion, and quinalphos in water, confirming threats for aquatic insects, macro- and micro- crustaceans, as well as indirect effects on macrophytes and algae, macro-invertebrates and rotifers.
- A study conducted in Mymensingh found that Sumathion (fenitrothion) harmed benthic invertebrates and aquaculture ponds.
- Farmers of Khulna and Bagerhat districts were found to use organophosphate, and carbamate insecticides widely, including carbofuran, malathion, diazinon, carbosulfan, chlorpyriphos, cyhalothrin, and cypermethrin; and accumulation of excessive pesticides was regarded as responsible for fish mortality along with disruption of physiology and behaviour.

A review of residues in Bangladesh by Barmon et al. (2021)[139] noted that "pesticides wash down to nearby canals, tributaries, rivers and eventually find their way into the coastal area" and that "25% of pesticides used in Bangladesh might pollute the sea". Marine sediments of the Chittagong coast had been found slightly contaminated with organochlorines. They reported, in addition to the above:

- 48% of water samples collected from Sonagazi Upazila contained organophosphates and carbamates with high concentrations of diazinon and chlorpyrifos
- Chlorpyriphos, diazinon and cypermethrin in water samples of Ghior upazila.
- 95% of paddy field water of Manikganj sadar upazila was contaminated with cypermethrin, and cypermethrin in the water samples from an agriculture field ranged from 54.36–80.5 µg/L in Savar upazila.
- 19.6 µg/L of DDT in the surface water sample collected from Begumganj; and organochlorines were detected in the range of 0.20 to 6.95 µg/L in Meghna-Dhangoda irrigation canal water.
- However, most drinking water supplies in Bangladesh did not contain detectable residues of organochlorine pesticides.

In addition to the above, Shammi et al. (2017) reported fenitrothion in surface water sampled from a paddy field in Gazipur and lake water samples in Savar Upazila, and parathion in the lake water from Savar Upazila.

Animal Poisoning Incidents in Bangladesh

In 2023, 65 ducks of native species died after eating 'pesticides' sprayed on crop land at Saidpur in Nilphamari District. This incident took place in Khalisha Dhulia Paikarpara area of Khatamdhupur Union of Upazila.[140]

In 2022, 171 Khaki Campbell ducks died after consuming granular poison in Boro paddy field at Dhamirhat in Naogaon District. Farmer Abdul Aziz lost about 40,000 Bangladeshi taka (equal to about USD 333).[141]

139. Barmon SC, Chaki BM, Wu Y. 2021. Pesticide use in Bangladesh: a review on potential Impacts. *Asian J Environ Ecol* 16(4):224-41.
140. 65 ducks died after eating 'pesticides' sprinkled on the ground. Daily Ajker Patrika, Dhaka, Bangladesh, 28/8/2023.
141. Pesticides kill chickens, anger neighbors. 8/12/2022.

India

A 2023 review of pesticides in India found that DDT, HCH, and endosulfan were the most commonly and dominantly detected pesticides in India's groundwater, even after a decade's ban. In West Bengal, 39 pesticides and some of their derivatives were detected in groundwater; 32% of samples contained two or more pesticides. Malathion, atrazine, diazinon, methyl parathion, and lindane were found in more than 75% of samples, chlorpyrifos in more than 60% of samples, and butachlor and alachlor in 50% of samples. Malathion and atrazine were detected predominantly with concentrations exceeding 46 times their permissible limits. In surface waters, metabolites or isomers of HCH, DDT, and endosulfan were the most abundantly traced pesticide in almost all locations. Malaoxon, an oxidative derivative of malathion, atrazine, and butachlor, were measured in more than 90% of river water samples, while malathion, lindane, and methyl parathion were detected in around 50% of samples. Chlorpyrifos and diazinon were also detected in surface waters.[142]

Laos

Pesticides used in commercial banana farming in northern Laos have led to contamination of soil and water resources. This contamination can have detrimental impacts on human health and the environment, with potentially harmful residues from currently used pesticides detected in surface water, groundwater, soil, and sediment sample.[143]

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142. Rajan S, Parween M, Raju NJ. 2023. Pesticides in the hydrogeo-environment: a review of contaminant prevalence, source and mobilisation in India. *Environ Geochem Health* 45:5481-5513.
143. Wentworth A, Pavelic P, Kongmany S, Sotoukee T, Sengphaxaiyalath K, Phomkeona K, Deevanhxay P, Chounlamany V, Manivong V. 2021. *Environmental risks from pesticide use: the case of commercial banana farming in northern Lao PDR.* International Water Management Institute Research Report 177. https://www.iwmi.cgiar.org/publications/iwmi-research-reports/iwmi-research-report-177/

Rassapong et al. (2018)[144] reported that paraquat (67%), cypermethrin (44%), chlorpyrifos (22%) and atrazine (11%) had all been found in sediment samples, and atrazine in 40% of water samples in Laos. Notably, atrazine contamination was found in a water supply source of the village.

Wentworth et al. (2021)[145] reported the detection of chlorpyrifos, imidacloprid and paraquat residues in surface water, as well as DDT, dieldrin, heptachlor and lindane break-down products. In groundwater, 14 OC compounds (including DDT) were detected and chlorpyrifos.

Vietnam

The overuse of pesticides has led to severe pollution of water resources and the environment in Vietnam. A study conducted by the World Bank (2017)[146] revealed that the amount of active ingredients used in rice fields by farmers in the Mekong Delta, Vietnam, has been increasing over the last few decades:

- 1981–1986: 0.30 kg/ha/yr active ingredient
- 1986–1990: 0.40–0.50 kg/ha/yr active ingredient
- 1991–2000: 0.67–1.00 kg/ha/yr active ingredient
- 2001–2010: 2.54 kg/ha/yr active ingredient

As reported by the Ministry of Natural Resources and Environment (2018),[147] agricultural wastewater pollution is a significant concern due to its high content of residual chemical fertilisers and diluted pesticides. With nearly two million

144 Rassapong S, Syfongxay C, Phanthanivong I, Syhalal B, Phimmahthut S, Manyvong T, Keothingkham B, Hongsibsong S, Shattuck A, Bartlett A. 2018. *Pesticide Use in Lao PDR: Health and Environmental Impacts*. Lao Upland Rural Advisory Service (LURAS). http://www.laofab.org

145. Wentworth A, Pavelic P, Kongmany S, Sotoukee T, Sengphaxaiyalath K, Phomkeona K, Deevanhxay P, Chounlamany V, Manivong V. 2021. *Environmental risks from pesticide use: the case of commercial banana farming in northern Lao PDR.* International Water Management Institute Research Report 177. https://www.iwmi.cgiar.org/publications/iwmi-research-reports/iwmi-research-report-177/

146. Tin Hong Nguyen. 2017. Overview of Agricultural Pollution in Vietnam: The Crop Sector. Report to the World Banks' Environment and Agriculture Department. https://documents1.worldbank.org/curated/en/681201516788003445/pdf/122934-WP-PUBLIC-Vietnam-crops-VNM.pdf

147. Ministry of Natural Resources and Environment. 2021. National Environmental Status Report for the period 2016-2020. Dan Tri Publishing House, Hanoi.

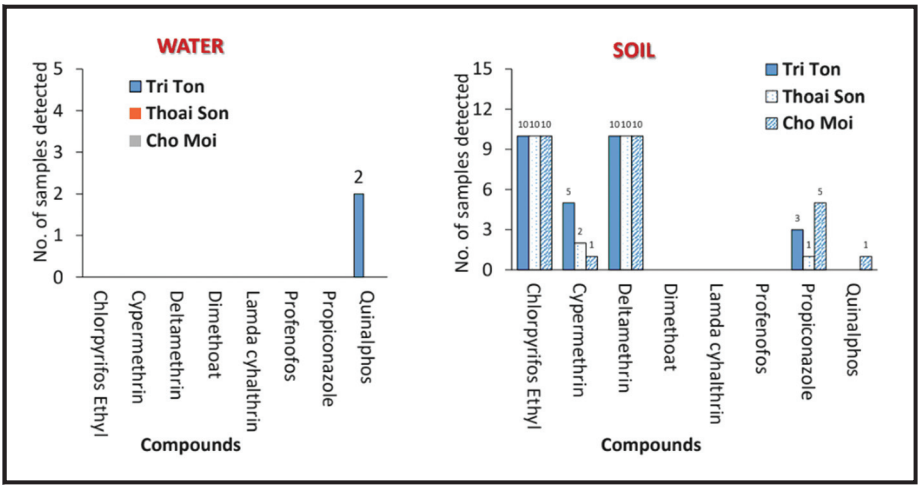
hectares of rice cultivation, and over 50% of that area dedicated to three-crop rice production, the Mekong Delta faces a water pollution problem arising from excessive agricultural wastewater. A study conducted by Nguyen Quoc Thinh and colleagues (2019)[148] on rice-fish fields revealed that three out of 10 water samples were contaminated with pesticide residues (accounting for 30%). The primary contaminant was identified as quinalphos, an organophosphate insecticide. Additionally, Professor Harr Futselaar, an international water treatment expert at Saxion University of Applied Sciences in the Netherlands, has highlighted the increasing contamination of groundwater in Vietnam, especially that over 60% of groundwater is contaminated with chemicals from agricultural practices, including pesticide spraying.[149]

The World Bank reported findings of isoprothiolane, diazinon, fenitrothion, and endosulfan in surface waters; buprofezin in sediment; and imidacloprid, fenitrothion, fenobucarb, trichlorfon and dichlorvos in groundwater extracted from wells[150].

The study by CCI and Wonjin Institute in 2022 on 30 soil samples and 30 water samples provided the results in the table below, showing elevated levels of quinalphos in water, and chlorpyrifos, cypermethrin, deltamethrin, propiconazole and quinalphos in soil (see Figure 6.2).

148. Nguyen Quoc Thinh and associates. 2019. Use of Pesticides in Fresh Water Aquaculture in the Mekong Delta, Vietnam, and Impacts on Environment and Food Safety. Doctoral Thesis, Université de Liège, Belgium. https://hdl.handle.net/2268/229948
149. Tran Huynh. 2019. Groundwater in Vietnam is increasingly polluted. https://tuoitre.vn/nguon-nuoc-ngam-viet-nam-ngay-cang-o-nhiem-nang-20191105084604618.htm
150. Nguyen TH. 2017. *An Overview of Agricultural Pollution in Vietnam: The Crops Sector*. Prepared for the World Bank, Washington, DC.

Figure 6.2: Pesticide Compounds Detected on Rice Samples



Source: CCI and Wonjin, 2022[151]

Crop Damage in Bangladesh

In 2020, the online news portal Silkcity News contained an article `Potato farmers lost their production for Entracol [sic] poisoning' on 21 December 2020. In the news they used a side-by-side photograph of a potato field with and without the fungicide Antracol, which contains propineb. The picture clearly shows that one land is scorched and discoloured, while the other is fresh. Antracol is widely used as a fungicide in tomato, potato and grape crops; it has a negative effect on insectivorous birds and bees.[152]

151. Wonjin, CCI. 2022: Environmental impacts of pesticides on farmers and their families (A study from Cho Moi, Tri Ton and Thoai Son district, An Giang province). https://drive.google.com/file/d/15sHFTm-KGFpH7VoJWBX54NbziL87NYW9/view?usp=drivesdk
152. Partha P, 2020. Who will provide security for potato fields? Daily Samakal, 25 December.

7.
CLIMATE CHANGE

Agricultural production is one of the main sectors of the economy contributing to greenhouse gas production in the four countries, but there are few studies calculating greenhouse gas emissions from fertilisers and pesticides.

In the literature on climate change and agriculture the use of pesticides receives scant regard. The World Bank's 28 page document on Climate-Smart Agriculture in Bangladesh,[153] refers to pesticides only once, and that is to support the use of disease-resistant varieties of wheat: "Reduces GHG emissions by reducing the use of synthetic pesticides (fungicides) therefore the carbon footprint reduction per unit of food produced." However, that can be taken as a fulsome admission that synthetic pesticides are contributing to climate change, and it is advisable to reduce their use.

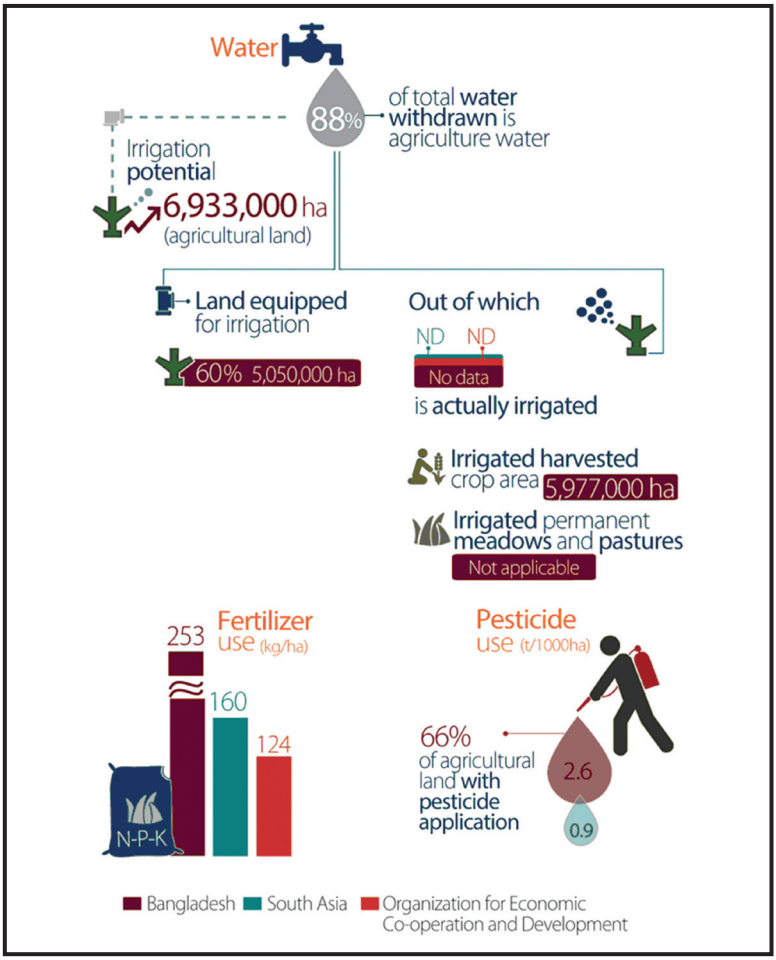
Bangladesh

Pesticides are fundamental to supporting the intensive agriculture that threatens the climate in many ways so are, at the least, indirectly linked to those impacts. Where intensive synthetic fertilisers are used, and particularly nitrogen-based ones, pesticides are commonly used to deal with the resulting increase in pests and disease. The extensive use of chemical fertilisers in Bangladesh, which saw a significant increase from 0.36 kg/ha in 1995 to over 298 kg/ha by 2007, leads to elevated emissions of nitrous oxide. This gas is released when fertilisers are applied to the soil and is a major contributor to global warming. Similarly, the use of pesticides, particularly herbicides like glyphosate, not only contributes to greenhouse gas emissions during production but also affects soil health, leading to reduced carbon sequestration. According to the World Bank,

153. World Bank. Undated. Climate-Smart Agriculture in Bangladesh. https://climateknowledgeportal.worldbank.org/sites/default/files/2019-06/CSA-in-Bangladesh.pdf

pesticides are applied to 66% of agricultural land in Bangladesh. Conversely, that means that weeds, pests and diseases are managed on 34% of agricultural and in Bangladesh *without use* of synthetic pesticides.[154]

Figure 7.1: Agriculture Input Use in Bangladesh



Source: World Bank[155]

154. World Bank. Undated. Climate-Smart Agriculture in Bangladesh. https://climateknowledgeportal.worldbank.org/sites/default/files/2019-06/CSA-in-Bangladesh.pdf
155. World Bank. Undated. Climate-Smart Agriculture in Bangladesh. https://climateknowledgeportal.worldbank.org/sites/default/files/2019-06/CSA-in-Bangladesh.pdf

Vietnam

A survey of the current status of pesticide use on citrus trees in Bac Tan Uyen district, Binh Duong province was conducted under the 2018 Scientific Research Project in Binh Duong and chaired by Nguyen Van Phuoc. The active ingredients commonly used on citrus trees were studied, including: abamectin/emamectin benzoate, cypermethrin, alpha-cypermethrin, chlorpyrifos, profenofos, petroleum oil, propargite, pyridaben, metalaxyl, carbendazim + hexaconazole, copper oxychloride, copper hydroxide, paraquat, glyphosate. According to the calculations, the total energy required to produce pesticides used on citrus trees in Bac Tan Uyen is 46,942,966 MJ/year, corresponding to an average greenhouse gas emission of 3,239 tons of CO_2e/year (Nguyen Van Phuoc, Nguyen Thi Thu Hien, 2021).[156]

Rice production is a major contributor to anthropogenic methane emissions worldwide. In Vietnam, according to the Third National Report sent to the United Nations Framework Convention on Climate Change, greenhouse gas emissions from rice are steadily increasing in Vietnam. FAO estimates that carbon emissions from rice have risen to over 35 million tonnes since 2000. From 2008 to 2017, emissions increased to nearly 40 million tonnes of CO_2. The estimated 44 million tonnes of CO_2 in 2020 shows that this trend is continuing to increase. Rice also accounts for about 75% of Vietnam's agricultural methane emissions. Rice is grown in flooded conditions, so the water prevents oxygen from entering the soil, creating ideal conditions for bacteria to thrive in decomposing organic matter, mainly rice straw residue, and releasing methane.[157]

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156. Nguyen Van Phuoc, Nguyen Thi Thu Hien. 2021. Emission estimates and proposals for greenhouse gas reduction due to pesticide use in citrus growing areas of Binh Duong province. https://tapchimoitruong.vn/gi/nghien-cuu-23/uoc-tinh-phat-thai-va-de-xuat-giam-thieu-khi-nha-kinh-do-su-dung-thuoc-bao-ve-thuc-vat-tai-vung-trong-cay-co-mui-tinh-binh-duong-25887
157. World Bank. 2022. Towards a green agricultural transition in Vietnam – Moving to a low carbon rice model. Report No: AUS0002201. https://documents1.worldbank.org/curated/en/099735009222218115/pdf/P1744820915fc203f0910008de36865074b.pdf

Statistics from survey results of Sustainable Development Goals indicator 2.4.1. in Vietnam showed that 16.28% of agricultural land area belongs to the group of households with land degradation rate of 50% or more. The Central Highlands has the highest land degradation rate in the country, meaning that the soil health of the region has the lowest sustainability, specifically: 52.52% of the agricultural land area of the region belongs to the group of households with land degradation area of less than 10%, and 22.57% of the agricultural land area of the region belongs to the group of households with land degradation area of 50% or more (p. 42). The national rate of achieved efficiency and sustainability of agricultural land of the component indicator "Use of pesticide products" is 39.03% (total green and yellow levels) and Unsustainability: 60.97% (GSO 2021).[158]

Hanoi has the world's leading fine dust pollution. The concentration of PM2.5 fine dust in Hanoi regularly exceeds the safety threshold recommended by the World Health Organization (WHO). Measurement data shows the average PM2.5 concentration in 2023 in Hanoi is 40–50 µg/m^3, which is 4–5 times higher than WHO standard of 10 µg/m^3, etc. The agricultural sector contributes to fine dust pollution in Hanoi through farming activities and the use of herbicides through the removal of soil cover. Fine dust can be released into the air through ploughing, harvesting, and transporting agricultural products. In particular, when the soil is dry and the wind is strong, dust from the fields can be swept up and spread in the air; pesticides used in agriculture can contaminate the fine dust into the air.[159]

According to statistics from the Department of Crop Production and Plant Protection of Quang Ninh province, about 70,000 tons of chemical fertiliser

158. General Statistics Office. 2021. Survey results of SDG indicator 2.4.1 in Vietnam - Proportion of agricultural land that is effective and sustainable; Statistical Publishing House, Hanoi.
159. Fine dust pollution in Hanoi: Current situation, causes and solutions. 2024. https://www.mayvesinhcongnghiep.com.vn/goc-chuyen-gia/kien-thuc-chuyen-nganh/o-nhiem-bui-min-o-ha-noi

and about 80-100 tons of chemical pesticides are used. The amount of fertiliser lost due to not being taken up by the plants (7,000-10,000 tons) and the amount of pesticide still adhering to the packaging after use (up to 2.15 tons of pesticide) along with nearly 10 tons of pesticide packaging will be released into the environment. This is a source of waste with a high risk of affecting the environment, increasing GHG emissions, the risk of water pollution (groundwater and surface water), and soil pollution.[160]

160. Institute of Strategy and Policy on Natural Resources and Environment. Government of Vietnam. https://isponre.gov.vn/vi/news/doi-thoai/danh-gia-muc-do-phat-thai-khi-nha-kinh-va-de-xuat-giai-phap-giam-thieu-tu-hoat-dong-canh-tac-lua-va-chan-nuoi-tai-tinh-quang-ninh-2531.html

8.
GOVERNMENT ACTIONS ON PESTICIDES

Bangladesh

Numerous authors[161] [162] [163] [164] of reviews and papers on pesticide residues in Bangladesh have noted that the country has a large population to support on limited growing areas and as a result has come to be heavily reliant on the use of quite toxic pesticides, often by ill-educated and illiterate farmers and workers who do not/cannot follow correct procedures regarding dosage rate, number of applications, use of PPE, storage of unused pesticides, washing and reuse of containers and disposal of excess spray. As a result, farmers and workers suffer from acute pesticide poisoning and from a number of chronic health conditions which may or may not be contributed to by pesticide exposure, and residues abound in food products and the environment, with a largely unknown impact on human health and other biota. Some of the residues are of pesticides not registered in Bangladesh, according to Shammi et al. (2017)[165] who blamed this on "the weakness in the existing legal regime of the pesticide governance in Bangladesh" which

161. Shammi M, Hasan N, Rahman MM, Begum K, Sikder MT, Bhuiyan MH, Khabir Uddin MK. 2017. Sustainable pesticide governance in Bangladesh: socio-economic and legal status interlinking environment, occupational health and food safety. *Environ Syst Decis* 37:243-60.
162. Ruba UB, Chakma K, Ali MP, Khan AU, Talucder MS. 2023. Environmental pollution from injudicious application of pesticides: Bangladesh context. *J Agroforestry Environ* 16(1):40-9.
163. Shahidullah AK, Islam A, Rahman M. 2023. Knowledge, attitude, and practice of pesticide use by vegetable growers in Bangladesh: a health literacy perspective in relation to non-communicable diseases. *Front Sustain Food Sys* 7:1199871.
164. Uddin MA, Chowdhury N, Rahman MA, Rashid MH, Chowdhury MA, Fardous Z. 2020. Identification and quantification of soil pesticides in coastal Lakshmipur District of Bangladesh. *J Asiat Soc Bangladesh* 46(2):191-200.
165. Shammi M, Hasan N, Rahman MM, Begum K, Sikder MT, Bhuiyan MH, Khabir Uddin MK. 2017. Sustainable pesticide governance in Bangladesh: socio-economic and legal status interlinking environment, occupational health and food safety. *Environ Syst Decis* 37:243-60.

was "threatening the livelihood and health of the farmers, food safety and consumer health". They concluded that "a consolidated uniform system" for pesticide management is lacking; and they proposed a pesticide governance system with "a stronger pesticide surveillance programme and coordination of ministries interlinking environmental, occupational health and food safety." They also stated that the proliferation of microfinance agencies giving microcredit for the purchase of pesticides and other agricultural inputs has serious ramifications for occupational safety and environmental contamination. Green microfinance to promote IPM, organics, bio-pesticides and agroecology could accelerate social development that is "people-centred, fosters human health, promotes social justice, generates income, addresses the issue of poverty and reduces environmental waste".

Shammi et al. (2017) could find no report on the management of expired pesticides by the companies that have taken them back from suppliers. Other problems with governance that they cite are lack of testing facilities at ports to ensure imported pesticides are registered and of appropriate quality, difficulty in identifying the person responsible for a registered pesticide, and smuggling from neighbouring countries. The lack of training in effective and low-risk methods of pest and disease control is a problem. There is a need for regulations "to inform growers, farmers, sprayers and garden owners and workers to protect children who live near orchards and crop fields from unintentional pesticide poisonings". Introduction of a single pesticide-related chronic/acute poisoning surveillance program could investigate cases of exposure circumstances. They also championed the introduction of a pesticide information database to draw together information on poisonings, environmental and food residues, etc.

On the positive side, most organochlorines were banned in the 1970s and 1980s, and on 2 December 2022, the last shipment of obsolete DDT left Chittagong Port. And on 18 January 2023, Bangladesh became the 88th county to ban carbofuran, a highly toxic carbamate insecticide frequently found as residues in food, soil and water in Bangladesh.[166]

166. Partha P. 2023. DDT gone, but Carbofuran will go? Daily Samakal, 6 November.

Laos

The Lao government has implemented regulations to control and limit the use of pesticides in agriculture. The Regulation on the Control of Pesticides in Lao PDR outlines the principles, rules, and measures for controlling activities that involve pesticides in the country.[167] This regulation aims to protect human, animal and plant health, as well as the environment, by ensuring the safety of people, animals, plants and the environment. It applies to all stakeholders involved in the use and management of pesticides. The regulation covers various aspects of pesticide control, including production, processing, import-export, distribution, transportation, storage, use and proper disposal of pesticides. It also defines the term "pesticide" and includes substances intended for use as a plant growth regulator, defoliant, desiccant, or agent for thinning fruit or preventing the premature fall of fruit. The regulation requires that pesticide products packed properly and prohibits the transportation of pesticides together with living organisms and other goods. The drivers of vehicles carrying pesticides must be selected properly, reliable and competent. These measures aim to prevent accidents and ensure the safe handling and transport of pesticides.[168]

While there are regulations in place to control and limit the use of pesticides in Laos, there are still reports of high levels of pesticide residues in food, particularly in the northern provinces, and there are reports of illegal and banned pesticides being used in agriculture. Continued monitoring and testing of pesticide levels in food are necessary to ensure the safety of the food supply and protect the health of the population.

In Laos, government and policymakers have taken significant actions regarding pesticides and agroecology to promote sustainable agriculture and environmental protection. The government has recognised the importance of Integrated Pest Management (IPM) for rural development and poverty

167. Regulation on the Control of Pesticides in Lao PDR. Ministry of Agriculture and Fisheries. No. 2860/MAF. Jun 11, 2010. Regulation_on_the_Control_of_Pesticides_in_Lao_PDR.pdf (ajcsd.org)
168. Regulation on the Control of Pesticides in Lao PDR. Ministry of Agriculture and Fisheries. No. 2860/MAF. Jun 11, 2010. Regulation_on_the_Control_of_Pesticides_in_Lao_PDR.pdf (ajcsd.org)

reduction, emphasising sustainable intensification of crop production.[169] The Ministry of Agriculture and Forestry (MAF) has acknowledged the necessity of sound pesticides legislation and reduced pesticide use for clean agricultural production, aligning with the Agriculture Development Strategy to 2025 and Vision to 2030. Moreover, the government has endorsed the Strategic Plan for National Organic Agriculture Development, setting priorities for promoting organic agriculture and agroecology practices. The GSAF encompasses various concepts like fair trade, organic agriculture, clean agriculture, agroforestry, and agroecology practices. To support the transition towards agroecology, the government has developed a narrative promoting green and sustainable agriculture (GSA) as the main policy orientation, incorporating various approaches within the field of agroecology.[170]

The government's actions include issuing guidelines on Good Agriculture Practices (GAP) to guide farmers and agribusiness, promoting phytosanitary certification and emphasising the importance of sustainable agricultural products for economic growth, poverty reduction and food security.[171]

Vietnam

Policy implementation on reducing/stopping use of certain pesticides

The registration and use of pesticides in Vietnam are regulated by various laws, including the Law on Plant Protection and Quarantine (Decision No. 41/2013/QH13), the Law on Chemicals (Decision No. 06/2007/QH12), the Law on Product and Goods Quality (Decision No. 06/2007/QH12), and the Law on Technical Standards and Regulations (Decision No. 68/2006/QH11). The specific management of pesticides is outlined in Circular No. 21/2015/

169. World Bank. Undated. Managing Pesticides for Greener Growth in Lao PDR. Policy Note. https://documents1.worldbank.org/curated/en/773471616735393941/pdf/Green-Growth-Advisory-Program-for-Lao-PDR-Managing-Pesticides-for-Greener-Growth-in-Lao-PDR-Policy-Note.pdf
170. Guéneau S. 2022. The Institutionalisation of Agroecology in Lao PDR. Policy Brief. TAFS, CIRAD, Malica. https://agritrop.cirad.fr/603611/1/Policy%20brief%20agroecology%20inst%20Lao%20PDR-16-12-2022.pdf
171. FAO. 2021. National Agricultural Innovation System Assessment in Lao PDR. Consolidated Report. Food and Agriculture Organization of the United Nations, Rome. https://openknowledge.fao.org/server/api/core/bitstreams/1dae23b6-a713-4b04-a749-b96ef8c0bd1f/content

TTBNNPTNT dated 8 June 2015, on management of pesticides (general principles on registration of pesticides; types of pesticides not allowed to be registered in Vietnam; pesticides removed from the List; the issuance of licenses for testing pesticides, etc.).

Reducing the use of pesticides in Vietnam is a challenging endeavour, as the practice of pesticide use has become deeply ingrained among the majority of farmers. The Vietnamese Government is currently working towards the gradual removal of toxic plant protection chemicals from the permitted list. According to an announcement by the Ministry of Agriculture and Rural Development in 2019, the list of permitted plant protection chemicals in Vietnam comprises a total of 503 active ingredients, categorized into three major groups: insecticides (133 active ingredients), fungicides (157 active ingredients) and herbicides (85 active ingredients).

Implementation of bans on pesticides

Vietnam has banned numerous POP and highly hazardous pesticides (HHPs). These active ingredients were prohibited during an extended period from 2000–2017. During this period, several new active ingredients were added to the list of permitted pesticides. However, there have been positive developments since 2017. The Ministry of Agriculture and Rural Development has issued decisions to restrict or remove active ingredients belonging to the HHPs group from the list of pesticides allowed in Vietnam. Specifically, from 2017 to 2019, five decisions were implemented, leading to the removal of 10 active ingredients and 740 corresponding commercial products from circulation within the country (see Table on page 73). This represents a significant step towards the complete elimination of these active ingredients in Vietnam soon.

List of HHPs banned in Vietnam from 2017–2019

No.	Active Ingredients	Pesticides	Products	Date of Issue	Date of Ban	Government's Decisions
1.	Carbendazim	Fungicide	71	03/01/2017	03/01/2019	No.03/QD-BNNBVTV
2.	Benomyl	Fungicide	15	03/01/2017	03/01/2019	No.03/QD-BNNBVTV
3.	Thiophanate Methyl	Fungicide	48	03/01/2017	03/01/2019	No.03/Qd-BNNBVTV
4.	2.4 D	Herbicide	36	08/02/2017	08/02/2019	No.278/QD-BNNBVTV
5.	Paraquat	Herbicide	82	08/02/2017	08/02/2019	No.278/QD-BNNBVTV
6.	Trichlorfon	Insecticide	11	16/10/2017	16/10/2017	No.4154/QD-BNNBVTV
7.	Carbofuran	Insecticide	4	16/10/2017	16/10/2017	No.4154/QD-BNNBVTV
8.	Glyphosate	Herbicide	104	10/04/2019	10/04/2020	No.1186/QD-BNNBVTV
9	Chlorpyrifos ethyl	Insecticide	228	12/02/2019	12/02/2021	No.501/QD-BNNBVTV
10	Fipronil	Insecticide	141	12/02/2019	12/02/2021	No.501/QĐ-BNNBVTV
Total	**10**		**740**			

The Minister of Agriculture and Rural Development issued Circular No. 09/2023/TT-BNNPTNT on 24 October 2023, outlining the list of plant protection drugs permitted and prohibited for use in Vietnam. Circular No. 09/2023/TT-BNNPTNT specifies 31 prohibited active ingredients, including 23 pesticides and forest product preservatives, six fungicides, one rat poison, and one herbicide.[172]

172. Circular No. 09/2023/TT-BNNPTNT dated October 24th, 2023, of the Minister of Agriculture and Rural Development, Government of Vietnam.

The Government has also established penalties for the sale of prohibited plant protection 'drugs'. Accordingly, the Regulation on penalties for violations in the trading of plant protection drugs is stipulated in Article 26 of Decree 31/2016/ND-CP (amended by Clause 5, Article 1 of Decree 04/2020/ND-CP); Point a, Clause 1 of this Article is abolished by Point b, Clause 3, Article 2 of Decree 07/2022/ND-CP). A person who trades in prohibited pesticides will be fined from 3,000,000 to 50,000,000 VND, subject to additional penalties and responsible for taking remedial measures. For organizations, the above fine will be doubled. Therefore, the maximum fine for organisations can be up to 100,000,000 VND.

Other relevant actions

Vietnam officially ratified the Rotterdam Convention on 7 May 2007, aiming to promote cooperation and shared responsibility among parties for certain harmful industrial chemicals and pesticides in international trade through information exchange on their properties. To fulfil its obligations under the Rotterdam Convention, Vietnam has internalised its commitments by developing and implementing a comprehensive system of relevant policies and laws. Specifically, these include the Law on Chemicals dated 21 November 2007, Circular No. 32/2017/TT-BCT detailing and guiding the implementation of certain articles of the Law on Chemicals, and Decree No. 113/2017/ND-CP dated 9 October 2017, detailing and guiding the implementation of other articles of the Law on Chemicals.

To date, Vietnam has developed, promulgated, and implemented several regulations establishing maximum residue limits (MRLs) for pesticides in food. These regulations include the Food Safety Law 55/2010/QH12, Decree 15/2018/ND-CP, and Circular No. 50/2016/TT-BYT. The MRL values specified in Circular No. 50 of the Ministry of Health are based on the CODEX and ASEAN MRLs as of 2016 and are applied in the management of domestic food safety, as well as import and export activities.

On 17 November 2017, the Vietnamese Government issued Resolution No. 120/NQ-CP on the sustainable development of the Mekong Delta in response to climate change. This resolution aligns agricultural production with quality standards and environmental values in the context of climate

change. Subsequently, on 29 August 2018, the Government issued Decree No. 109/2018/ND-CP on organic agriculture, paving the way for its development in Vietnam. Furthermore, the Vietnamese Ministry of Science and Technology has issued two decisions: No. 3965/QD-BKHCN dated 26 December 2018, and No. 3883/QD-BKHCN dated 29 December 2017, promulgating standards for organic agricultural production.

In 2019, the Plant Protection Department (Ministry of Agriculture and Rural Development) and the Sustainable Trade Initiative IDH jointly organized a ceremony to launch a mobile pesticide lookup software. Farmers scan the QR Code to download the mobile-app. In addition, farmers can also find instructions on how to use pesticides correctly for crops such as coffee, tea, and pepper. Since May 2019, the software and database have been officially managed and regularly updated by the Plant Protection Department and will be continuously upgraded based on farmers' feedback.[173]

The Minister of Agriculture and Rural Development (MARD) has recently signed and issued Decision No. 5415/QD-BNN-BVTV dated 18 December 2023, approving the Project on development of production and use of biological pesticides (BVTV) until 2030, with a vision to 2050.

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173. Đỗ Hýõng. 2019. Announcing national pesticide lookup software. May 17. https://baochinhphu.vn/print/cong-bo-phan-mem-tra-cuu-thuoc-bao-ve-thuc-vat-quoc-gia-102256099.htm

9.
CSO ACTIONS ON PESTICIDES

Vietnam

Campaigns to eliminate/ban pesticides

To date, the Center for Gender, Family, and Environment in Development (CGFED) and the Center for Sustainable Rural Development (SRD) are the only CSOs in Vietnam actively engaged in awareness-raising and educational activities aimed at eliminating or banning pesticides. These efforts are often conducted within the framework of cooperative projects with PANAP. Examples include activities commemorating World Environment Day (5 June), the Protect Our Children from Toxic Pesticides (POC) Campaign (20 November), the 16-Day Action Campaign for Rural Women and Ecological Agriculture (1–16 October), and the No Pesticide Use Week (NPUW) Campaign (3–10 December).

Reports created by the CSOs

CGFED has been consistently conducting research and writing reports on the impact of pesticides over the past ten years, with the support of PANAP. Additionally, our review of CSO websites revealed that CISDOMA[174] has conducted research on "Managing the risks of chemical use affecting surface water in Vietnam" (2018–2019) and "Minimizing the harmful effects of pesticides and herbicides on the health of farmers and consumers.[175] These studies aimed to understand farmers' awareness of the dangers of pesticides to the environment and the health of agricultural chemical users. However, we have not been able to access or find a published version of these reports.

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174. Consultative Institute for Socio-Economic Development of Rural and Mountainous Areas. Agroecology Learning Alliance of South East Asia. https://ali-sea.org/alisea-member/consultative-institute-for-socio-economic-development-of-rural-and-mountainous-areas-cisdoma/
175. Minimizing the harmful effects of pesticides and herbicides on the health of farmers and consumers. https://cisdoma.org.vn/giam-thieu-tac-hai-cua-thuoc-bvtv-thuoc-tru-co-den-suc-khoe-nong-dan-va-nguoi-tieu-dung/

10.
SUMMARY OF INFORMATION AND CONCLUSIONS

Acute Occupational Pesticide Poisoning

Occupational pesticide poisoning continues to be a major problem in all four countries. Yet the number of studies and the information available on OAPP is still very inadequate. Even so, for the large part the available information shows that the incidence of OAPP is actually increasing rather than decreasing as should be expected. Perhaps this is because the power of the pesticide industry, as demonstrated by their ability to get the only recent global estimate of occupational poisoning (Boedeker et al. 2020) retracted, keeps the problem pesticides on the market. This power no doubt influences governments and hampers their ability to improve conditions for their farmers should they wish to.

Laos, in particular, suffers from a shortage of studies on acute poisoning, and the only available studies have the incidence increasing from 39% in Boedker et al. (2020) to over 90% in both of the two studies since that publication.

Most information is available for India, and here the incidence has increased from the 62% reported by Boedeker et al. (2020) to 73.63% when studies since then are incorporated into the figure.

In Bangladesh, there may be a decrease in OAPP – or not – with the incidence reported by Boedeker et al. (2020) of 55.64% reducing to 21.21% in one subsequent study but rising to 60% in another. Additionally, local media have reported a number of deaths of farmers who collapsed in their fields whilst spraying; there is no record of the number of farmers who fell ill whilst spraying but did not die.

In Vietnam, again recent data is not showing any significant decrease in acute pesticide poisoning since the publication of the 57.35% incidence by Boedeker et al. (2020) with two subsequent surveys arriving at 26.92% and 78% incidence.

Occupational poisoning appears to be worse for some crops than for others: in India it is cardamon with a 100% incidence in some studies in Kerala; in Laos it is maize with a 92% incidence; in Bangladesh it is summer vegetables with an incidence of 60%. In Vietnam no one crop stands out.

Child poisoning is a particularly serious problem in the floriculture industry in Tamil Nadu, with the only available study reporting a 87.5% incidence.

Recommendations on OAPP

- Significantly increase the number of well-designed surveys of occupational poisoning across a number of different crops, especially in Laos, Bangladesh and Vietnam, but also in India, and all other countries in South and South East Asia.
- Drastically reduce access to pesticides that are causing this poisoning:
  - organophosphate: chlorpyrifos, malathion, diazinon, quinalphos, dimethoate, monocrotophos.
  - carbamate: carbofuran, carbosulfan, carbaryl.
  - pyrethroid: cypermethrin, lambda-cyhalothrin.
  - others include imidacloprid, fipronil, thiamethoxam, profenofos, phorate, permethrin, and herbicides such as 2,4-D, paraquat, glyphosate, atrazine.
- Stop children working in fields in which pesticides have been applied.

Chronic Health Effects

There is a significant body of highly reputable work showing the chronic health effects that can result from exposure to pesticides. This exposure usually takes the form of ongoing exposure to low levels of pesticides and the high incidence of OAPP are testament to that exposure. These effects include numerous cancers (breast, prostate, bladder, colon, lung and pancreatic cancers, and leukaemia and non-Hodgkin's lymphoma), reduced nervous system functioning, disturbed neurodevelopment of children, diabetes, asthma, decreased male and female

fertility, spontaneous abortion, birth defects and Parkinson's disease, among others. One recent study in the US[176] put pesticides on a par with cigarette smoking for some types of cancer causation.

However, whilst it is known that pesticides can cause a wide range of chronic health effects, it is exceptionally difficult to link particular pesticides with chronic health conditions in the field, because of the often long latency period between exposure and manifestation of the disease, and the myriad genetic, environmental and other aspects that can contribute to chronic conditions – not least the wide range of pesticides a person might have been exposed to during the latency period. Some studies of acute poisoning also note the existence of chronic conditions amongst exposed farmers; although this is useful, it falls short of proof of casual link. And is often used to exclude farmers from studies of acute effects, even though acute exposure may have caused those chronic effects in the first place.

In Bangladesh, surveys for acute poisoning also noted diabetes, hypertension, asthma and other respiratory problems, tuberculosis, poor vision, urine control problems, reduction of sexual urge, and physical weakness. In India, breast cancer in younger women is linked to pesticide exposure, whilst a survey on OAPP also found asthma, hypertension, diabetes, cancer, immune suppression, hormone disruption, and reproductive abnormalities. In Vietnam, reduced sperm count and motility and abnormal sperm shape were recorded amongst farmers with OAPP.

Recommendations on chronic health effects

- Much greater effort needed to identify chronic health conditions being experienced by farmers and their communities as a result of exposure to pesticides.
- Surveys on acute pesticide poisoning should not discard participants with chronic conditions: rather those conditions should be recorded in both those exposed to pesticides and in control subjects not exposed to pesticides.

176. Gerken J, Vincent GT, Zapata D, Barron IG, Zapata I. 2024. Comprehensive assessment of pesticide use patterns and increased cancer risk. *Front Cancer Control Soc* 2:1368086.

Gender

Very little information is available on the impact of pesticides on women as the vast majority of surveys do not differentiate between men and women, or intentionally select only male farmers. Apart from one survey of cardamom pickers in Kerala, only the field surveys carried out by PAN Asia Pacific and its partner CSOs adequately sample for women. Shammi et al. (2017)[177] noted the "largely non-existence" of reviews of occupational health and safety of women and children handling pesticides in Bangladesh. This is perhaps based on the view that only males are farmers, only males spray and so only males are exposed. This is, of course far from the truth. In the indigenous tribal areas of Bangladesh there are more farms maintained by women, and two studies by PANAP in Bangladesh included women.[178] In India, cultural operations like weeding are largely carried out by women, especially in paddy fields where large quantities of systemic pesticides have been used, as is the picking of sprayed cardamom pods. In West Bengal, where there is heavy pesticide usage in the tea plantations, women carrying babies on their backs, and with small children alongside, pick recently sprayed foliage. In Vietnam, with men migrating in search of work, there is a 'feminisation' of the rural workforce and women now constitute the majority of the agricultural workforce, including using pesticides.

Disaggregation of data reveals that male and female workers are not always equally affected by pesticides. In Kerala, women cardamom pickers were found to have a higher proportion of moderate poisoning than were the male pickers (this may possibly be because women have thinner skin on their hands allowing for greater dermal absorption of pesticides lingering on the trees). However, in Vietnam men were found to be experiencing higher incidence of a number of symptoms (headache, excessive sweating, dizziness and vomiting), whilst women experienced a higher incidence of hand tremors and blurred vision.

177. Shammi M, Sultana A, Hasan N, Rahman MM, Islam MS, Bodrud-Coza M, Uddin MK. 2020. Pesticide exposures towards health and environmental hazard in Bangladesh: A case study on farmers' perception. *J Saudi Soc Agric Sci* 19:161-173.
178. Watts MA. 2023. Acute Pesticide Poisoning in Asia: a Four Country review. PAN Asia Pacific, Penang.

Recommendation

- All field surveys should include both male and female farmers and workers and should disaggregate the date, even down to particular symptoms as in the survey in Vietnam carried out by CGFED.

Pesticides Implicated

Where a number of different pesticides are being used, it is very difficult to identify the exact one/s causing the poisoning. Unfortunately, the Bangladesh media reports of farmers who died whilst they are spraying, or shortly afterwards, did not identify the pesticides they were using. In India, two workers died whilst spraying a mixture of quinalphos and cypermethrin.

Overwhelmingly the pesticides most implicated in adverse health effects in the four countries are organophosphate, carbamate and pyrethroid insecticides. In Laos, finger-prick tests for acetylcholinesterase revealed that 76.9% of those sampled are at significant risk from exposure to organophosphate and carbamate insecticides.[179]

The currently used pesticides in these classes, of most concern are:

- organophosphate: chlorpyrifos, malathion, diazinon, quinalphos, monocrotophos, dimethoate
- carbamate: carbofuran, carbosulfan, carbaryl
- pyrethroid: cypermethrin, lambda-cyhalothrin

But there are others too: imidacloprid, thiamethoxam, profenofos, phorate, fipronil, permethrin, and herbicides such as 2,4-D, paraquat, glyphosate, atrazine. And many more are identified as posing a risk in in these countries in the 2023 Four-Country Review of pesticide poisoning in Asia.[180]

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179. Hughes D, Vo TV, Turnbull N, Sycareun V, Jordan S. 2022. Study in Press. Data taken from presentation. Pesticide uses and health impacts on farmers in Thailand, Vietnam, and Lao DPR. Ancient Capital Conference on Science and technology, Hue University, August 2022.
180. Watts MA. 2023. *Acute Pesticide Poisoning in Asia: A Four-Country Review.* PAN Asia Pacific, Penang.

Lambda-cyhalothrin is of particular concern: in 2017 lambda-cyhalothrin (LYCH) was notified to the Chemical Review Committee of the Rotterdam Convention by Georgia because of a number of poisoning cases in that country. The shocking response from the person representing both Syngenta and CropLife, which was echoed by the representative of the Government of India was that, actually, they expected more poisonings than that. The words of Syngenta representative Dr Roland Diertele were: "the number of LCYH-related incidents would be broadly in line with or lower than would be expected based on the frequency of use."[181] These words written in a letter from Syngenta were then repeated verbally at the meeting and echoed by the member of the Committee from India.[182] This makes plain that Syngenta knows lambda-cyhalothrin causes poisoning, as does the Indian Government. It makes plain also their appalling attitude towards pesticide poisoning and the cavalier disregard of the lives of farmers and workers. PAN International provided a submission describing hundreds of acute poisoning incidents caused by lambda-cyhalothrin in Tanzania, USA, Canada, Germany, Turkey, China, Chile and a number of other incidents in which the country was not specified. There were 403 OAPP incidents in USA alone from 2002–2010, with many more since. There were also many poisonings of domestic pets and bees, as well as fish and aquatic invertebrate kills.[183]

As reported in Watts (2023)[184] cypermethrin is also a particular problem, especially if it is used in combination with chlorpyrifos. It has been reported to have caused poisonings in Bangladesh and Tanzania.

Recommendations

- Immediate ban of all organophosphates. These highly toxic insecticides cannot be used safely under the conditions of use common in South and South East Asian countries.

181. Dieterle R. 2017. CRC-13: Syngenta comments on the draft task group reports on the proposals from Georgia to include lambda-cyhalothrin containing formulations of type EC & CS at 50 g/L in Annex III. Letter to the Secretariat to the Rotterdam Convention. 10 October. CRC.13-REL-SUBM-CropLife-lcyhalothrin.
182. This was witnessed by the author.
183. Watts M. 2017. SHPF Lambda-cyhalothrin emulsifiable concentrate 50 g/L: Comments by PAN International on the CRC Task Group Report October 2017.
184. Watts MA. 2023. *Acute pesticide Poisoning in Asia: a Four-Country Review*. PAN Asia Pacific, Penang.

- Immediate ban of lambda-cyhalothrin and cypermethrin – these insecticides also cannot be used safely.
- Immediate ban of the carbamates carbofuran and carbosulfan, both recommended by the Rotterdam CRC for listing under the Convention. Carbofuran has been listed, but the listing of carbosulfan is still being prevented by a small handful of countries even though they agree it meets the requirements of the Convention. They refusal to allow the listing doesn't in any way make the pesticide safer!
- Phase out the other pesticides implicated in poisonings, here and in Watts (2023).
- Dramatically ramp up efforts nationally and internationally to help farmers implement agroecological alternatives: there is no point replacing these pesticides with others that will also cause poisonings.

Residues in Food

High levels of residues in food result from farmers using more than the recommended amount (up to 5–6 times, in Bangladesh), using adulterated formulas and/or not adhering to the required withholding period between last application and harvest. In Laos, a survey found that 59% of vegetable farmers in Xieng Khouang province overuse pesticides leading to high levels of residues. In Bangladesh, 93.3% of summer vegetable growers did not even consider a withholding period; perhaps because most (60%) were unaware of health risks from eating pesticide-contaminated vegetables.

The high level of residues in food in India are demonstrated by the rejection of exports by Saudia Arabia and the European Union, at least, for the presence of unacceptable residues, particularly in cardamom and basmati rice (35% loss of basmati trade with EU). Cardamom from the Idduki district in Kerala were found to contain residues of 15 different pesticides, mostly organophosphate or pyrethroid, and mostly banned in many countries. One study found quinalphos in cardamom at 25 times the MRL.[185] Chlorpyrifos was found in a sample of turmeric from India, tested in Germany in 2023. Chlorpyrifos, malathion, profenofos and triazophos were found in wheat, gram and mustard in Rajasthan. And lindane,

185. Misra SS. 2011. Misra SS. 2011. Kerala gets cautious. DownToEarth. https://www.downtoearth.org.in/environment/kerala-gets-cautious-33029

DDT, endosulfan, cypermethrin, cyhalothrin, permethrin, chlorpyrifos, ethion, profenophos and fipronil were found in cow milk, with levels of fipronil, lindane, DDT and ethion posing risks for children.

And it is not only farmers and workers that are being poisoned: in Laos 42% of people consuming vegetables from the market had unacceptable levels of cholinesterase inhibition (caused by organophosphate and carbamate insecticides) – more than did farmers (37%). Of the 422 schoolchildren tested for organophosphates and carbamates, 33% had unacceptable levels of residues, higher than farmers and other consumers. A consistent finding in these surveys is that higher-income groups – i.e., those with access to food markets – had higher levels of residues. Other residues found in surveys included glyphosate and pyrethroids. Taken together this is powerful evidence that residues in food are a serious health problem across the country.

So concerned were the authorities in Bangladesh about residues of toxic pesticides in mangoes that in 2019 the police were deployed, by a High Court order, to prevent the overuse of pesticides. The same newspaper article reporting on this also reported that organic growers are bagging their fruit and using pheromone sprays to reduce insect attack, and have significantly reduced the amount of spraying. Numerous surveys in Bangladesh have found residues to be widespread, including at levels above the allowable MRLs and particularly in vegetables. Organophosphate residues (chlorpyrifos, malathion, diazinon, dimethoate, malathion, quinalphos, fenitrothion) were especially common as were cypermethrin and lambda-cyhalothrin. Earlier studies reported organochlorines like DDT and endosulfan, but they are no longer common since their banning. Other residues found include ethion, acephate, mancozeb, imidacloprid, fenvalerate, propiconazole.

In Vietnam, nearly 50% of 570 fresh food samples were found to contain pesticide residues, with 3.5% above MRLS and 10.2% not permitted for that use. Some contained seven different pesticides. Other surveys found residues in a variety of vegetables and in rice. Again, the most common residues were organophosphates, carbamates, pyrethroids (cypermethrin, permethrin), carbendazim, imidacloprid, difenoconazole and acetamiprid, and a number of fungicides.

As with acute poisoning, in terms of residues, the main culprits appear to be organophosphate, carbamate and pyrethroid insecticides. This no doubt reflects their high usage.

Recommendations

- Banning the pesticides that are causing poisoning will dramatically reduce the levels of those residues in food.
- Because simply replacing these pesticides with others will only result in different residues in food, it is imperative that there is national and international action to assist farmers to replace their pesticide use with agroecological approaches to growing – such as those demonstrated by the organic mango growers in Bangladesh.
- Governments should increase their residues testing in the four countries, work with farmers whose produce has high residues to reduce the residues, remove produce with residues above MRLs from the market and report their findings to the public.

Residues in the Environment

When such overuse of pesticides occurs as to result in acute and chronic health effects and significant residues in food, not surprisingly it also results in residues in the environment that can affect all organisms from human, to wildlife, to livestock, to companion animals, to beneficial insects that are vital for pollination and managing pests, to the very tiny microorganisms that keep the soil healthy and on which plants depend for the uptake of nutrients through their roots. A survey of farmers in Bangladesh found that more than half of them knew that excessive use of pesticides was polluting surface waters and destroying beneficial insects. And research in Vietnam demonstrated that the herbicides atrazine, glyphosate and paraquat reduce the population of bacteria in the soil. In Bangladesh researchers found that the accumulation of commonly used pesticides was responsible for disruption of fish physiology and behaviour, as well as causing fish mortality.

Soil

Analysis of soil samples in Bangladesh found diazinon, carbofuran and carbaryl in vegetable and paddy fields sometimes exceeding the EEC allowable level.

Because most organochlorines were banned in Bangladesh there was little evidence of them in recent sampling. In India, in 2014, soils in the cardamom plantations of the Idduki area were contaminated with endosulfan, DDT, chlorpyrifos, quinalphos, and ethion; earlier in 2011–2012 they also contained profenophos, lambda-cyhalothrin, bifenthrin, cypermethrin, imidacloprid and indoxacarb. More recently, soils in apple and mango orchards in Himachal Pradesh contain residues of DDT, HCH, endosulfan, chlorpyrifos, cypermethrin, cyfluthrin, dicofol and chlorothalonil. Sampling in Bihar in vegetable growing areas found chlorpyrifos, cypermethrin, quinalphos, dimethoate, deltamethrin and fenvalerate, as well as DDT and endosulfan.

There is little information available on soil contamination in Laos, but soils have been found to contain carbendazim, glyphosate, paraquat, dicofol, and cypermethrin. And in Vietnam, in 2018, isoprothiolane, chlorpyrifos and propiconazole were found in paddy rice field soil and irrigation ditch sediments in the Red River delta. Azoxystrobin was also found in the sediment. Analysis of dust samples in houses in Vietnam found 47 different pesticides, including carbendazim, carbofuran, chlorfluazuron, chlorpyrifos, cyhalothrin, cypermethrin, hexaconazole, permethrin and DDT.

Water

In Bangladesh, numerous pesticides have been found in waterways, pond water, water from paddy fields, lakes, rivers. These were, commonly, carbaryl, chlorpyrifos, carbofuran, cypermethrin, diazinon, and malathion. Fenitrothion, quinalphos, and parathion were also found in water bodies. One review noted that 25% of pesticides being used might pollute the sea. In India, pesticides found in groundwater include DDT and HCH, even after a decade's ban, and endosulfan and lindane. Current use pesticides found in groundwater included malathion, atrazine, diazinon, methyl parathion, chlorpyrifos, butachlor and alachlor. In surface waters, metabolites or isomers of HCH, DDT, endosulfan, malathion, as well as atrazine, and butachlor, were found in more than 90% of river water samples, while malathion, lindane, and methyl parathion were detected in around 50% of samples. Chlorpyrifos and diazinon were also detected in surface waters. In Laos, paraquat, cypermethrin, chlorpyrifos, imidacloprid, atrazine and the breakdown products of DDT, dieldrin, heptachlor and lindane have all been found in sediment samples, and atrazine contamination in a village

water supply. In Vietnam, the primary contaminants of water are chlorpyrifos, quinalphos, isoprothiolane, diazinon, fenitrothion, imidacloprid, endosulfan, fenobucarb, trichlorfon and dichlorvos.

Recommendations

- Increased monitoring for pesticides in the environment.
- Work with farmers to reduce the excessive use of pesticides that result in environmental contamination.
- Banning pesticides implicated in OAPP and food residues will reduce contamination by current use pesticides, but they must be replaced with agroecological practices to prevent contamination by different pesticides.

Climate Change

There is very little information available on pesticides and climate change, anywhere, let alone in the four countries. Even though it is known that the manufacture of one kilogram of synthetic pesticide requires about 10 times more energy than one kilogram of nitrogen fertilizer, the World Bank's report on Climate Smart agriculture talks extensively about fertilisers but says only this about pesticides: disease-resistant varieties reduce greenhouse gas emissions by reducing the use of synthetic pesticides (fungicides). That is an admission that synthetic pesticides contribute to climate change.

Pesticides are fundamental to supporting the intensive agriculture propped up by synthetic fertilisers and especially nitrogen-based ones that create weak, pest and disease-prone plants. The widespread use of herbicides reduces carbon sequestration in soils. The World Bank's report on Climate-Smart agriculture states that pesticides are applied to 66% of agricultural land in Bangladesh and therefore, conversely, 34% is managed without them. In Vietnam, the use of pesticides on citrus trees in Bac Tan Uyen results in greenhouse gas emissions of 3,239 tons of CO_2e/year.

Recommendations

- Governments must recognise the role of pesticides in climate change and assist farmers to implement agroecological farming which not only reduces climate change emissions but also increases carbon sequestration in soils

and assists farmers to develop better climate resilience in their cropping systems.

Government Actions on Pesticides

The governments of all four countries have taken some actions to manage pesticides – primarily enacting laws and regulations to manage them and banning some of the worst pesticides.

However, the high level of acute pesticide poisoning, together with the significant occurrence of residues in food and the environment indicates that there is a huge amount more that is needed to be done.

In Bangladesh, Laos and Vietnam pesticides that are not registered in the county have been found in use or as residues in food or the environment, indicating inadequate regulatory, surveillance and compliance regimes. In India, pesticides are commonly used for uses for which they are not approved. Bangladesh also has a problem with microfinance agencies giving micro credit for the purchase of pesticides rather than 'green' alternatives. In all four countries there is a lack of training for farmers in effective low-risk methods of pest management. Bangladesh was proactive in banning most organochlorine insecticides in the 1970s and 1980s but failure to follow this up with training in IPM or agroecology has left farmers relying on the highly toxic organophosphate insecticides with the resultant poisoning problems.

Laos, although it has taken some good actions to promote sustainable agriculture and has endorsed a Strategic Plan for National Organic Agriculture Development is rather hamstrung by having a mountainous country with massive land borders across which illegal pesticides are regularly smuggled. Laos has banned at least 39 current use pesticides. It would be greatly assisted by regional bans on pesticides to prevent this problem. In the absence of such, greater international and national effort to reduce the desire for such pesticides by training farmers in cost-effective agroecological approaches is essential.

Vietnam has banned at least 44 current use pesticides, and is working towards the gradual removal of toxic pesticides. The level of OAPP in the country suggests that the process needs to be speeded up. Vietnam has also issued a decree on organic agriculture and promulgated standards, paving the way for its development.

Recommendations

- Speed up the removal of the pesticides causing acute poisoning and toxic residues in food and the environment.
- Work to establish regional regulation of pesticides to prevent the cross boundary smuggling of illegal pesticides.
- Greatly increase the training of farmers in agroecological and organic methods of pest, weed and disease management to remove their perceived need for toxic chemicals.

CSOs

CSOs in all four countries have been very active undertaking community monitoring of pesticide use practices and acute poisoning, producing reports, raising awareness about the dangers of pesticides and the advantages of agroecological alternatives, campaigning to ban pesticides. Their work is often conducted within a framework of cooperative projects with PANAP, including through commemorating World Environment Day, the Protect Our Children Campaign, the 16-Day Action Campaign for Rural Women and Ecological Agriculture, and the Pesticide-Free Week Campaign.

Recommendations

- Increase resources for CSOs to continue their work to reduce the damage caused by toxic pesticides and in implementing agroecological alternatives.
- Greater recognition by governments of the positive role CSOs are playing in assisting farmers to farm better and more productively.
- Greater responsiveness and collaboration of governments with CSOS to speed up the phase out of toxic pesticides and their replacement with agroecological approaches to farming.

Footnotes

1. RCRD, CGFED, SRD, PANAP. 2015. *Knowledge, Attitude and Practice (KAP) Towards the Use of Chlorpyrifos and Paraquat and their Impact on Human Health and the Environment*. PAN Asia Pacific, Penang.

2. Rengam S, Serrana MS, Quijano I. 2018. *Of Rights and Poisons: Accountability of the Agrochemical Industry*. PAN Asia Pacific, Penang.

3. CGFED, SRD, PANAP. 2020. *School Children's Exposure to Pesticides in Vietnam: A Study in Three Districts*. PAN Asia Pacific, Penang.

4. CGFED, PANAP. 2020b. *A Community-based Pesticide Action Monitoring (CPAM) in Hai Hau and Nghia Hung District, Nam Dinh Province*. Research Centre for Gender, Family and Environment in Development, PAN Asia Pacific, Penang.

5. Diyana A, Rajendran D, Watts M, Rengam S, Alviar E. 2022. *Field Survey: Use and Impacts of Pesticides in Four Countries in Asia*. PAN Asia Pacific, Penang.

6. PAN International List of Highly Hazardous Pesticides, 2024

7. PAN International Consolidated List of Banned Pesticides, 2024

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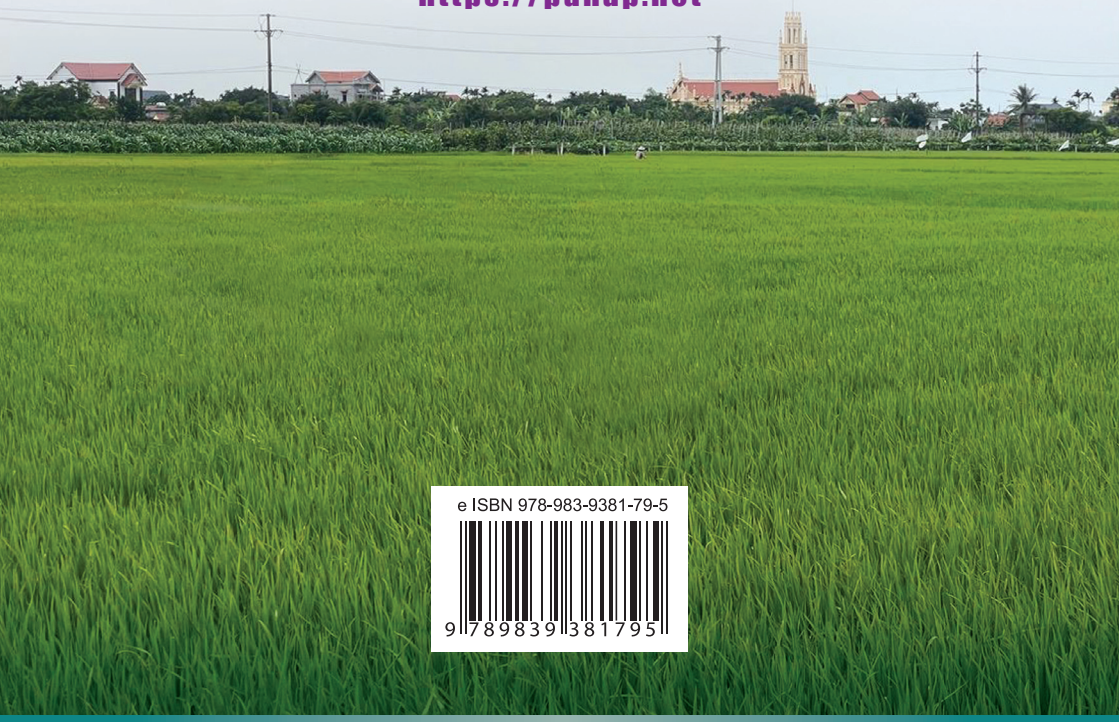

e ISBN 978-983-9381-79-5
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