



Toxic Inequities: The Global Health Burden of Pesticide Exports to Low- and Middle-Income Countries

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ABSTRACT

Background: The continued export of banned pesticides from high-income countries (HICs) to low- and middle-income countries (LMICs) remains a critical yet under-addressed global health issue. These hazardous chemicals are legally shipped to nations with weaker regulatory frameworks. As a result, workers and communities in LMICs face disproportionate exposure to toxic substances that contribute to acute poisoning, developmental disorders, and chronic disease.

Aims: This paper examines the international trade of banned pesticides through view of global health equity and frames these practices as a form of structural violence that endangers LMIC populations and violates the right to health.

Methods: This qualitative study uses document and policy analysis of international trade records, legal frameworks, and public health literature. It outlines the legal mechanisms and policy gaps, such as the weaknesses of the Rotterdam Convention and the permissiveness of export laws in the EU, U.S., and Switzerland that enable the ongoing flow of hazardous substances.

Results: Pulling on case studies, epidemiological evidence, and international human rights frameworks, the paper investigates the health impacts of pesticide exposure and highlights the ethical failures related to current trade practices.

Conclusion: Our synthesis foregrounds the research gap and advances a rights-based, structural-violence framing that clarifies the policy mandate. We suggest aligning export bans with domestic prohibitions, strengthening Rotterdam prior-informed-consent and enforcement, and financing transitions to IPM, biopesticides, and agroecology in LMIC supply chains.

Keywords: Banned pesticides; Export regulation; LMICs; Structural violence; Rotterdam Convention.

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1. Introduction

Many pesticides that cause cancer, poisoning, nerve damage, and birth defects are banned in high-income countries. But companies in these countries still send them to low- and middle-income countries. The World Bank says about 30% of farm workers in these areas are poisoned by pesticides each year. This leads to around 200,000 deaths annually (World Bank Group, 2018). This problem is worse because of unfair trade rules. Countries like the U.S., Switzerland, and those in the EU ban these pesticides at home but still let companies export them abroad. From 2015 to 2019, more than 81% of pesticides banned in the U.S. were shipped to lower-income countries (Donley, 2024).

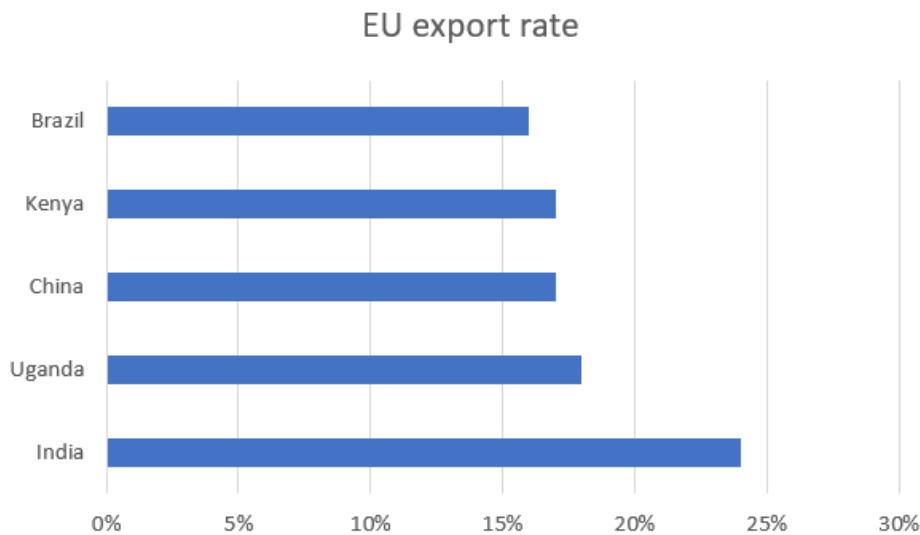


Figure 1. Exports of banned EU pesticides (2022): Top recipient countries by volume
Made by author using PAN Europe, 2024.

The European Union reflects this same pattern. A 2024 investigation by PAN Europe found that EU-banned pesticides were shipped to over 80 countries, with the top five importers being LMICs (PAN Europe, 2024). These exports are maintained by loopholes in international trade law and weak enforcement of global agreements. This includes the Rotterdam Convention and asymmetric power relations that favor exporting nations. As a result, the global pesticide economy functions as a one-way flow of risk. Chemicals considered too dangerous for use in HICs are sent to LMICs and threaten public health and the environment.

This study aims to examine how current legal frameworks, trade policies, and governance gaps enable the export of banned pesticides from HICs to LMICs, and to analyze their health and ethical implications through the lens of global health equity. While prior reports and advocacy documents have described pesticide-related harms in LMICs, few academic studies have explicitly linked these outcomes to the structural features of global trade and legal regimes, particularly using a human rights and structural violence framework.

This study addresses that gap. The paper focuses on pesticide-related health outcomes, international trade practices, and ethical frameworks, structured into sections that present the methods, results, discussion, and proposed solutions.

This paper argues that the export of banned pesticides constitutes structural violence. By analyzing this issue through the view of global health equity, the paper examines pesticide-related health outcomes in LMICs. This criticizes the legal systems that enable this imbalance and discusses alternative models that could mitigate harm. Through this analysis, the study contributes to ethical reform in international agricultural practices.

The risk is especially high in low- and middle-income countries. Health systems in these areas are underfunded, and worker protections are weak. Farmers and other laborers often use toxic pesticides without safety gear or training. This puts them in constant danger. Studies from West Africa and South Asia show that many farm workers suffer from skin rashes, breathing problems, nerve damage, and liver disease (Handford et al., 2015).

The harm doesn't stop with the workers. Pesticides often end up in water sources used for drinking and cooking. Over time, these chemicals build up in people's bodies. This leads to more cancer, hormone problems, and birth issues. These chemicals stay in the soil and water for years and cause long-term damage, especially in areas already struggling with poor health care. Few syntheses connect HIC export of domestically banned active ingredients to structural violence and states' human-rights obligations in LMICs. This paper bridges the gap by mapping export pathways, regulatory asymmetries, and health outcomes across jurisdictions.

2. Methods

Study design and data sources

This study uses a qualitative approach to explore how pesticide exports from high-income countries (HICs) affect health in low- and middle-income countries (LMICs). Especially, it uses document and policy analysis of international trade records, legal frameworks, and public health literature. The study focuses on published research, trade records, laws, and global agreements to look at health risks, legal gaps, and ethical concerns.

Operational definitions

"Banned pesticide" means an active ingredient prohibited for domestic use by a national authority, regardless of export permissions. "LMICs" follow the World Bank's current classification for the study period.

Search strategy

Search strategy included journal articles from PubMed and Scopus and reports from the World Health Organization (WHO), the Food and Agriculture Organization (FAO), and the World Bank. Search terms were "banned pesticide exports," "pesticide trade LMIC," "structural violence pesticides," and "pesticide health impacts" publications from 2000 to 2024.

Eligibility criteria

Inclusion criteria were studies or reports addressing pesticide exports from HICs to LMICs, sources containing information on health outcomes, legal frameworks, or policy analysis, English-language publications, and publicly available documents. Exclusion criteria included studies without clear relevance to pesticide exports, laboratory-based toxicology studies without trade or policy context, and duplicate records.

Thematic content analysis

Sources were analyzed using thematic content analysis. Contents were from global health equity, environmental justice, and structural violence. This process involved coding material for recurring themes related to trade mechanisms, health impacts, and ethical implications.

Rationale for qualitative/document-based approach

A qualitative and document-based method was chosen because it allows investigation of both legal and health dimensions across multiple contexts without the resource and ethical constraints.

Limitations

Limitations are reliance on secondary/public sources, which may omit underreported pesticide-related harms in LMICs. The absence of fieldwork interviews also means the analysis depends on the accuracy and completeness of existing records. Findings may reflect publication bias toward better-documented events and English-language sources, which can underrepresent some regions.

Ethical considerations

This study analyzed publicly available sources only. No human or animal participants were involved, and formal ethics approval was not required. Because the research only uses public sources and does not involve people or animals, no ethics approval was needed.

3. Results

From 2000 to 2024, exports of domestically banned active ingredients from HICs to LMICs persist. Paraquat, chlorpyrifos, and atrazine are the most frequently observed in trade flows linked to acute poisoning clusters and chronic exposure risks. In 2024 alone, U.S. pesticide exports totaled \$4.83 billion, with most value shipped to LMICs.

Medical Consequences of Pesticide Exposure in LMICs

In many low- and middle-income countries, pesticide exposure causes more than just short-term poisoning. The chemicals used are often highly toxic and tied to serious health problems. These include problems with fertility, brain development, chronic illness, and early death. The danger grows when workers don't have proper gear, medical systems are weak, and doctors aren't trained to spot pesticide-related illness.

Chlorpyrifos is still exported to LMICs, even though it's banned in many places. It's known to harm children's brain development. Studies show that babies exposed before birth can have lower IQ, memory problems, and more behavior issues (Rauh et al., 2006).

Paraquat is also widely sold. It's deadly if swallowed or breathed in. It can scar the lungs, shut down the kidneys, and there's no treatment. Over time, it's been linked to higher rates of Parkinson's disease, especially in male farm workers (Tanner et al., 2011).

Other chemicals, like atrazine and DDT, affect hormones. Atrazine has been tied to delayed puberty, lower sperm count, and birth defects (Hayes et al., 2010). DDT is banned in most rich countries but still used in some places to control mosquitoes. It has been linked to higher breast cancer risk in women (Cohn et al., 2007).

Ongoing exposure to pesticides is also linked to cancer, liver problems, and autoimmune disease. In many LMICs, doctors may miss the link because records are poor and testing is too expensive. Many health workers are not trained to recognize pesticide-related illnesses (London et al., 2012).

Women and children face more risk than others. In farming communities, women often handle treated crops without protective gear or training (Jaga & Dharmani, 2003). Children are at even greater risk because of their size and developing bodies. A study in rural Brazil found more cases of developmental delays in children living near pesticide-treated fields (Panis et al., 2022).

Health Outcome	Organochlorines	Organophosphates	Carbamates	Multiple/Unclassified
Acute poisoning				
Reproductive harm				
Neurological symptoms				
Birth defects				
Cancer				
Respiratory issues				
Suicide/self-harm				

Figure 2. Health Effects Reported by Pesticide Class in Brazilian Epidemiological Studies.

Made by author using Data source: Panis et al., 2022.

The health impacts of pesticide exposure vary depending on chemical class. Organochlorines, although widely banned, persist in the environment and are strongly associated with cancer and birth defects. Carbamates are also responsible for serious acute and chronic health effects in agricultural settings. The Brazilian systematic review illustrates how multiple classes of pesticides contribute to overlapping, serious health outcomes in LMIC populations (Panis et al., 2022).

These findings show observable health effects across multiple regions and pesticide classes. They are drawn directly from documented studies and reports and interpreted as evidence of systemic policy failure and global inequity. In short, the medical harms of pesticide exposure in LMICs are systemic outcomes of policy failures and global indifference. These effects are not unfortunate side effects of agricultural development. They are foreseeable consequences of unequal global governance. Any evaluation of pesticide trade must centre lived realities of those facing direct, often unrecognized, harm.

Beyond Brazil and West Africa/South Asia, additional documented cases reveal similar patterns of harm. In Sri Lanka, pesticide self-poisoning remains a leading cause of acute poisoning in rural areas, with incidence rates reaching 447 cases per 100,000 people annually. In Ghana, surveillance of food markets found that 26.5% of vegetables exceeded European Union maximum residue limits for pesticides (Bempah et al., 2012). These findings highlight that the health risks associated with banned pesticide exports are widespread and an ongoing threat to public health in multiple LMIC contexts.

Evidence of Double Standards in Trade

Although HICs have enforced strict bans on many hazardous pesticides for domestic use, the same chemicals are exported to LMICs. For example, the EU reduced pesticide risks through the 'Farm to Fork' strategy. This aims to cut pesticide use by 50 percent and increase organic farming to 25 percent of total agricultural land by 2030 (European Commission, 2020). However, this progressive plan is sabotaged by an export policy that permits the international trade of prohibited pesticides. A 2020 investigation by Greenpeace revealed that in just one year, EU countries exported over 81,000 metric tons of chemicals banned for domestic use due to their severe toxicity (Dowler, 2020). This includes paraquat, atrazine, and chlorpyrifos.

These exported pesticides often end up in LMICs, where agricultural labor has less oversight. For instance, in Brazil, more than a dozen pesticide formulations containing banned substances in the EU were imported and used between 2019 and 2020. These included Bayer's propineb, associated with reproductive harm, and Ascenza Agro's chlorpyrifos, associated with neurodevelopmental disorders in children (PAN Europe, 2024). Current regulations require prior informed consent from importing countries, but they still allow the export of substances banned domestically so long as procedural requirements are met (European Parliament, 2012).

The United States exhibits a similar regulatory contradiction. Under the Federal Insecticide, Fungicide, and Rodenticide Act, pesticide companies are allowed to manufacture and export products that are not approved in the U.S. (U.S. Environmental Protection Agency EPA, 2024). This means that U.S. manufacturers can legally ship neurotoxicants like 1, 3-dichloropropene to Latin American countries. These chemicals are frequently used in banana, tobacco, and soybean plantations, where laborers work with limited protective equipment and minimal access to healthcare (Donley, 2024).

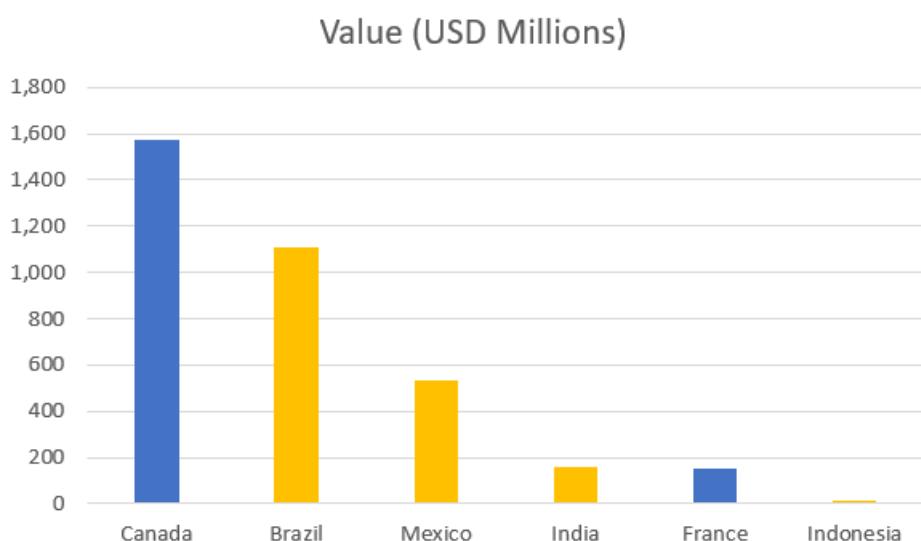


Figure 3. Top U.S. pesticide export destinations (2024); LMICs highlighted.
Made by author using Observatory of Economic Complexity, 2025.

In 2024, U.S. pesticide exports totaled \$4.83 billion, with more than 50 percent destined for LMICs. These included Brazil (\$1.11B), Mexico (\$532M), and India (\$158M). Even countries with less environmental oversight received substantial volumes. Canada (\$1.57B) was the only high-income country with a larger import volume than low-income countries. This underscores an imbalance. While the U.S. preserves domestic pesticide safety, it contributes to the international circulation of harmful chemicals in vulnerable settings (OEC, 2025).

The data above are primarily qualitative and descriptive. However, integrating quantitative indicators could further illustrate the persistence and scale of these double standards.

4. Discussion

Policy Gaps and Failures

Toxic pesticides are known to cause serious harm. Still, current laws do not protect the people most exposed. Many rules are shaped by politics, not health. Even when laws exist, they are often not enforced. The Rotterdam Convention is one of the main global rules on pesticide trade. It says that exporters must get permission before sending certain dangerous chemicals to another country. This sounds protective in theory. But the treaty only lists a few chemicals. Countries that make and sell pesticides often block efforts to expand the list. Even when a chemical is on the list, it can still be sold. The treaty does not ban trade. It only asks for paperwork and approval from the importing country. This creates a gap. Companies can keep selling banned pesticides with little oversight. Many low- and middle-income countries do not have enough staff, money, or training to review the risks or block the imports (Handford et al., 2015).

These problems show up in national laws too. In the European Union, certain pesticides are banned for local use. But companies can still export those same pesticides to other countries with weaker rules (European Parliament, 2012). Switzerland does something similar. Switzerland restricts several toxic pesticides inside the country. Still, firms like Syngenta export harmful ones, including atrazine and paraquat, to other nations. In 2020, the government blocked the export of five such chemicals, but many others were not included (Public Eye, 2020). These laws focus more on permission than on safety. They hide the deeper problems with how pesticide trade is managed. Without stronger global rules and real enforcement, these exports will keep putting people at risk.

A brief comparative analysis shows that the EU, U.S., and Switzerland all maintain domestic bans on specific hazardous pesticides, but their export regulations differ in scope. The EU allows export under prior informed consent procedures, the U.S. permits export of unregistered pesticides with minimal restrictions, and Switzerland applies partial bans covering only select chemicals. These differences create uneven global governance and opportunities for regulatory evasion.

Global Health Inequity Framing

The export of hazardous pesticides from HICs to LMICs is not just a matter of policy inconsistency. It represents a global health injustice embedded in power imbalances. The exposure has the greatest impact on low-income and politically marginalized communities. These countries often lack the tools, environmental safeguards, or adequate healthcare.

One useful concept related to this injustice is structural violence. Structural violence means the systematic ways in which social, economic, and political arrangements harm communities by limiting access to resources or protections essential for health and survival (Farmer, 2004). In the context of pesticide exports, structural violence shows when laborers in LMICs are exposed to chemicals considered too dangerous for domestic use in HICs. They lack protective gear and regulatory safeguards.

The right to health further emphasizes the inequity embedded in these trade practices. Article 12 of the International Covenant on Economic, Social, and Cultural Rights declares that every person is allowed to 'the highest attainable standard of physical and mental health' (United Nations General Assembly, 1966). This foundational right is disregarded when toxic substances are exported to nations without safe handling. The persistent disconnect between legal rights and life conditions illustrate a deeper failure in global health governance.

Structural violence extends this framing to trade agreements. It operates through national export policies and multilateral systems that limit a country's ability to restrict imports for health reasons. Industry owners argue that pesticide exports support agricultural productivity and economic development. However, these justifications overlook the disproportionate health burdens and long-term environmental damage. These counterarguments directly strengthen the ethical case for reform.

Moral and political responsibility of pesticides challenges policymakers, corporations, and multilateral institutions to consider what is legally permitted and ethically defensible. This framing echoes broader decolonial critiques in global health and calls for the dismantling of exploitative systems.

Proposed Solutions and Alternatives

Fixing the global pesticide problem takes more than small technical changes. We need to consider how policies treat health, fairness, and the environment. Turning to agroecology is one way to cut back on toxic pesticide use. Policy change can also close legal gaps that let these exports continue. One of the most direct steps is to ban the export of banned pesticides. In 2020, France passed a law to stop this kind of export. The decision came after strong public pressure and concern about double standards (PAN Europe, 2024). Switzerland followed with a smaller ban on five of the most toxic chemicals. These cases show that change is possible when there is political will. But most exporters still allow sales of pesticides they will not use themselves. Making France's rule a global standard would help bring fairness and accountability.

Policy reform is not enough. We must also change how food is grown. One option is Integrated Pest Management (IPM). This mixes natural and mechanical ways to manage pests and uses pesticides only when needed. It includes crop rotation, pest tracking, and insects that eat harmful bugs. Research shows IPM can cut pesticide use by up to 90% without lowering crop yields. In some cases, yields even improve (Pretty & Bharucha, 2015).

Biopesticides are another safer option. They come from nature—bacteria, minerals, or plant oils. Examples include *Bacillus thuringiensis*, neem oil, and pyrethrin. These break down fast and are less harmful to people and nature (PAN Europe, 2024). Still, use remains low. Many areas lack money, public support, and local production. More funding and local factories are needed to make biopesticides easier to access.

Agroecology offers a full-system shift. It uses compost, mixed planting, and better soil care to manage pests and grow strong crops. Examples from Cuba, Senegal, and Sikkim show that this kind of farming can succeed when backed by policy, training, and market access (Copping & Menn, 2000).

To sum up, ending banned pesticide exports is important, but not enough. A real solution also needs better global laws, safer pest control, and strong support for farmers. We can break the cycle of toxic farming and health inequality only by acting on all of these aspects.

5. Conclusion

Banned-pesticide exports from HICs to LMICs perpetuate preventable, inequitable harm. Trade, regulatory, and health evidence show how current practices conflict with states' duties to protect health.

This study found that these exports are enabled by legal loopholes in international agreements, permissive export policies in the EU, U.S., and Switzerland, and insufficient enforcement capacity in importing countries. Case studies from Brazil, Sri Lanka, Ghana, West Africa, and South Asia demonstrate consistent patterns of disproportionate health burdens and environmental contamination. This is not just about a few legal gaps. It is part of how global pesticide trade works. Weak rules, like the Rotterdam Convention, and loose national laws allow this trade to go on. Market pressure also plays a big role. Health and ethics are often ignored. The result is the same: poisonings, chronic disease, and a growing divide in global health. These outcomes are not accidents. They are the result of policies that put profit first.

This paper has offered real ways to fix the problem. Examples of policy recommendations are adopting national bans on the export of prohibited pesticides, expanding global enforcement mechanisms under multilateral agreements, and strengthening monitoring systems to track and penalize violations. International agencies such as the WHO and FAO should play a central role in coordinating these efforts and supporting LMIC governments.

National bans like the one in France, stronger global enforcement, and better accountability are all possible. We also already have working solutions in farming. IPM, biopesticides, and agroecology can reduce toxic use without lowering crop yield. Some even raise it. But these options are not supported enough. The problem is not technology; it is lack of political will and industry pushback.

As Rachel Carson warned decades ago, it is not right to see the harm and do nothing. Urgent and coordinated reform can solve double standards in pesticide trade and protect both public health and the environment. Silence in the face of related illness and death must end. We need fair policies, funding for safe alternatives, and a strong global push for justice. To fix the toxic imbalance in farming, we must face the ethics of trade, the failure of law, and the unequal burden of risk. Real global health must deal with all of this.

Conflict of Interest

The author declares no competing interests.

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