THE POISONED PLANET:

THE HARMS OF AGROCHEMICAL DEPENDANCE AND A CASE FOR PESTICIDE REFORM

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I. Introduction

In the face of accelerating climate change, biodiversity collapse, and growing concerns about global food security, the sustainability of current agricultural practices has come under increasing scrutiny. At the center of this debate lies a class of agrochemicals that has come to define industrial agriculture: synthetic pesticides. Initially used to combat pests and enhance crop yields, pesticides have become ubiquitous in global farming systems, perceived as indispensable tools for ensuring economic stability and agricultural productivity. However, the growing body of scientific evidence reveals that this chemical dependence carries profound and often irreversible ecological, health, and climatic consequences.

The urgency of rethinking pesticide use is not new. In Silent Spring, Rachel Carson warned, as early as 1962, of a future defined by ecological imbalance and human suffering, emphasizing that, "the central problem of our age has become the contamination of man's total environment."[1] Her prophetic account of pesticide-driven environmental harm was not merely a critique of chemicals, but a call to reconsider humanity's relationship with nature.[2] Carson's insights remain painfully relevant today, as the very issues she raised—biodiversity collapse, bioaccumulation, and regulatory complacency—have intensified in scale and complexity.

Pesticide use is now recognized as a leading driver of biodiversity loss, a significant source of environmental pollution, and a contributor to climate vulnerability. These impacts are not confined to isolated applications or rural areas, but extend across ecosystems and affect human communities, often disproportionately burdening low-income populations and farmworkers who

[1] Rachel Carson, *Silent Spring,* HOUGHTON MIFFLIN HARCOURT (1962).
[2] *Id.*

face heightened exposure risks. Pesticides contaminate soil, leach into groundwater, disrupt aquatic ecosystems, and decimate insect populations, including pollinators critical to both wild and cultivated plant reproduction. Their persistence in the environment and ability to bioaccumulate in animal and human tissues further amplifies their harmful effects, undermining ecosystem services essential for long-term agricultural resilience.

Moreover, the relationship between pesticides and climate change is multifaceted and underappreciated. The production, distribution, and application of synthetic pesticides are energy-intensive processes that contribute to greenhouse gas emissions. At the same time, pesticide-driven monocultures and soil degradation reduce the land's natural capacity to sequester carbon, weakening one of agriculture's key defenses against climate change. As climate instability intensifies pest pressures, pesticide use is likely to increase, creating a feedback loop of chemical dependency and ecological stress. Yet, despite these clear linkages, pesticide governance remains largely siloed from climate policy, both in the United States and internationally.

This paper seeks to address the gap between pesticide regulation and the harmful effects of pesticides by examining pesticide use through the lens of climate change law and environmental justice. Addressing the gap begins by analyzing the scientific consensus on the environmental harms associated with pesticides, focusing on biodiversity decline, soil degradation, and disruption of natural ecological processes. This paper then explores the human health risks posed by chronic and acute pesticide exposure, emphasizing the unequal distribution of these risks across racial, economic, and occupational lines. The regulatory landscape is then examined in depth, with particular attention to the failures of U.S. pesticide law under the

Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), and how that framework compares to more precautionary regimes abroad.

The paper also includes a case study on the banana industry in Latin America, using the documentary *Banana Land: Blood, Bullets & Poison* to illustrate the real-world implications of weak pesticide oversight, including developmental disorders and community displacement. The analysis concludes by presenting a set of proposed reforms aimed at building a more sustainable, equitable, and climate-resilient approach to pest management. These include strengthening federal regulation, supporting Integrated Pest Management (IPM), implementing risk-based taxation, leveraging technology, promoting agroecology and regenerative farming, and fostering international cooperation to phase out hazardous agrochemicals.

Ultimately, the assertion of this analysis is that any serious strategy to combat climate change and protect public health must confront the environmental and social costs of pesticide dependency. Reforming pesticide governance is not merely a matter of agricultural policy—it is a vital step toward securing a livable planet and a just future for generations to come.

II. Pesticides and Environmental Harm

The use of synthetic pesticides has become a widespread and near-universal agricultural practice aimed at controlling pests, diseases, and weeds to ensure high crop yields and economic stability. While their contribution to food production cannot be denied, mounting evidence reveals that their ecological and climatic impacts are profound and increasingly unsustainable. Pesticides are not only a primary driver of biodiversity loss, but they also contribute to environmental pollution, ecosystem degradation, and greenhouse gas emissions.

A. Pesticides and Biodiversity Decline

One of the most direct and well-documented effects of pesticide use is the widespread decline in biodiversity across various ecosystems. Pesticides often fail to discriminate between target pests and beneficial or non-target organisms.[3] This indiscriminate action has severe consequences for birds, mammals, aquatic organisms, soil fauna, and especially insects, many of which play vital ecological roles.[4]

Aquatic ecosystems are among the most affected. Pesticides enter water bodies through drift, leaching, and runoff. Even low concentrations of pesticides can alter species composition, reduce fish and amphibian populations, and lower oxygen levels in aquatic habitats.[5] Herbicides, like atrazine, impair immune systems in amphibians, making them more vulnerable to parasitic infections, while insecticides, such as chlorpyrifos, have lethal and sublethal effects on aquatic invertebrates, contributing to a decline in regional taxa richness of up to 42%.[6]

Soil biodiversity also suffers greatly from pesticide exposure. The chemicals degrade the quality of soil by harming nitrogen-fixing bacteria and mycorrhizal fungi, which are essential for plant health, nutrient cycling, and the overall productivity of agroecosystems.[7] Earthworms, vital for aerating soil and enhancing organic matter breakdown, have been found to contain pesticide residues, providing direct evidence of soil contamination and long-term ecological damage.[8]

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[3] K. Chandrakumara, *et al.*, *Impact of Pesticide Usage on Biodiversity*, ANNALS OF MULTIDISCIPLINARY RESEARCH, INNOVATION AND TECHNOLOGY (Dec. 29, 2023), https://www.researchgate.net/profile/Mukesh-Dhillon/publication/377441039_SPECIAL_REVIEW_ARTICLE_Impact_of_Pesticide_Usage_on_Biodiversity/links/65a74dbfcc780a4b19bf4dd5/SPECIAL-REVIEW-ARTICLE-Impact-of-Pesticide-Usage-on-Biodiversity.pdf.
[4] *Id.*
[5] *Id.*
[6] *Id.*
[7] *Id.*
[8] *Id.*

Pesticides are also commonly found in groundwater, with at least 143 different pesticide compounds and 21 transformation products detected in aquifers in studies conducted by the United States Geological Survey.[9] These residues not only compromise water quality but also pose risks to the flora and fauna dependent on these water sources.

The effects on pollinators and other beneficial insects have gained considerable attention in recent years. Systemic insecticides such as neonicotinoids persist in the soil and are absorbed by plants, eventually ending up in pollen and nectar.[10] Bees and other pollinators exposed to these chemicals exhibit reduced reproduction, behavioral abnormalities, and increased mortality.[11] This does not just affect the insects themselves, but undermines pollination services vital for the reproduction of both crops and wild plant species, thereby affecting entire ecosystems.[12]

B. Health and Ecosystem Risks Amplified by Pesticide Persistence

The persistence of many pesticide compounds in the environment results in long-term and far-reaching ecological consequences. Pesticides do not remain confined to application zones. Instead, their physical and chemical properties facilitate movement across ecosystems. Fat-soluble pesticides, for example, accumulate in animal tissues and magnify through food chains, leading to biomagnification, placing top predators at heightened risk of toxic exposure.[13]

Many bird species have experienced population declines linked directly to pesticide use. In the United States, one in three bird species is now endangered, threatened, or of conservation concern due to the cumulative effects of habitat destruction, food chain disruption, and chemical

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[9] *Id.*
[10] *Id.*
[11] *Id.*
[12] *Id.*
[13] *Id.*

pollution.[14] In Europe, farmland birds, like the corn bunting and yellowhammer, have shown reduced breeding success linked to pesticide-induced declines in the insect prey available during the nesting season.[15]

Rodenticides have caused secondary poisoning in mammals such as foxes, stoats, and weasels. Studies in the United Kingdom revealed residues of anticoagulant rodenticides in 33% of tawny owl livers collected from deceased individuals, suggesting widespread contamination in mammalian and avian predators.[16]

The negative impact of pesticides on plants is also considerable. Herbicide use reduces weed diversity, which in turn affects insect and bird populations reliant on these plants for food and habitat.[17] Certain herbicides, such as tribenuron-methyl, have been shown to harm algae and aquatic micro-organisms even at very low concentrations, contributing to declines in water quality and aquatic biodiversity.[18]

The destruction of weed populations also leads to the loss of key habitats for many species of farmland birds and insects. For instance, grey partridge populations have declined due to herbicides removing the weeds that serve as insect hosts and seed food.[19] Such losses reduce the structural complexity and resilience of ecosystems, leading to further biodiversity erosion.

C. Case Study: Banana Land

The documentary, *Banana Land: Blood, Bullets & Poison*, offers a chilling glimpse into the intersection of agricultural capitalism, environmental degradation, and human health.[20] Focusing

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[14] *Id.*
[15] *Id.*
[16] *Id.*
[17] *Id.*
[18] *Id.*
[19] *Id.*
[20] BANANA LAND: BLOOD, BULLETS & POISON (Sherbet 2014), https://www.youtube.com/watch?v=MoRmtQht8-E.

on the banana industry in Latin America, particularly in countries like Ecuador and Nicaragua, the film highlights the indiscriminate use of pesticides—including aerial application—and its profound impact on rural communities.[21] Among the most disturbing implications raised, is the potential link between pesticide exposure and developmental disorders, including autism spectrum disorder (ASD).[22]

In the film, several families recount tragic stories of children born with physical and neurological impairments.[23] While the documentary does not explicitly diagnose these children with ASD, the symptoms described—delays in speech, difficulty with social interaction, and repetitive behaviors—are consistent with diagnostic criteria for autism.[24] These anecdotal accounts align with a growing body of scientific literature suggesting a potential association between prenatal and early childhood pesticide exposure and increased risk of ASD.[25]

The use of organophosphate pesticides in banana cultivation is especially alarming. These chemicals are known neurotoxins, originally developed as nerve agents during warfare.[26] When sprayed from planes over large plantations, pesticides do not remain confined to the target area; instead, they drift into nearby homes, schools, and water supplies, increasing the risk of human exposure, particularly for pregnant women and young children.[27] A study published in the *BMJ* found that prenatal exposure to several classes of pesticides, including organophosphates, within

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[21] *Id.*
[22] *Id.*
[23] *Id.*
[24] *Autism diagnostic criteria: DSM-5,* AUTISM SPEAKS, https://www.autismspeaks.org/autism-diagnostic-criteria-dsm-5 (last visited May 1, 2025).
[25] Ondine S von Ehrenstein, *et al., Prenatal and infant exposure to ambient pesticides and autism spectrum disorder in children: population based case-control study,* BRITISH MEDICAL JOURNAL (Mar. 20, 2019), https://pmc.ncbi.nlm.nih.gov/articles/PMC6425996/.
[26] BANANA LAND, *supra* note 17.
[27] *Id.*

2,000 meters of maternal residence was associated with a 10%–30% increased risk of ASD diagnosis in children.[28]

Further, the ecological and social context depicted in *Banana Land* compounds the risk. In many rural communities, poverty and inadequate infrastructure limit access to protective equipment, clean water, and healthcare.[29] These conditions exacerbate the health impacts of pesticide exposure and hinder early diagnosis or intervention for developmental disorders.[30] Research in South America has demonstrated that regions with heavy pesticide use also exhibit higher rates of congenital malformations and cognitive delays in children.[31] While causation cannot be definitively proven from existing epidemiological data, the correlation is striking and warrants urgent further investigation.

It is also important to note that the affected populations often lack political power or legal recourse. *Banana Land* recounts instances in which workers were dismissed or silenced after speaking out about health concerns.[32] This structural vulnerability limits the ability of exposed individuals to seek compensation or advocate for stricter pesticide regulations, perpetuating cycles of environmental injustice.

Ultimately, while *Banana Land* does not serve as a scientific study, its human-centered narrative amplifies the lived realities that epidemiological statistics may only suggest. When viewed alongside peer-reviewed research linking pesticide exposure and neurodevelopmental disorders, the documentary becomes a powerful case study of environmental health risks in

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[28] Ehrenstein, *supra* note 21.
[29] *Id.*
[30] *Id.*
[31] Liliana A. Zúñiga-Venegas, *et al., Health Effects of Pesticide Exposure in Latin American and the Caribbean Populations: A Scoping Review,* ENVIRONMENTAL HEALTH PERSPECTIVES (Sept. 29, 2022), https://ehp.niehs.nih.gov/doi/full/10.1289/EHP9934.
[32] BANANA LAND, *supra* note 17.

industrial agriculture. It underscores the need for multidisciplinary approaches that blend scientific inquiry with ethical scrutiny and social advocacy.

D. Environmental Pollution and Ecosystem Imbalance

Beyond biodiversity loss, pesticide use contributes to broader forms of environmental degradation. Excessive application of chemical pesticides results in soil, water, and air pollution, all of which contribute to the deterioration of ecosystem services.[33] Persistent pesticide residues contaminate agricultural lands and adjacent natural habitats through wind dispersal and water transport, increasing the spatial footprint of their environmental impact.[34]

Pesticide pollution affects not just the organisms directly exposed, but entire ecological processes. The loss of soil microbial communities, for example, diminishes natural pest control mechanisms and nutrient cycling, which are essential for healthy soil function and long-term agricultural sustainability.[35] This disruption fosters increased dependence on synthetic inputs, creating a cycle of ecological degradation and chemical dependency.[36]

In addition, pesticides used improperly or excessively can lead to pest resistance. Over time, many pest species evolve resistance to commonly used pesticides, forcing farmers to use higher doses or shift to more toxic alternatives, thereby exacerbating the ecological damage.[37] This resistance also undermines food security by making pest outbreaks harder to control and reducing overall agricultural resilience.

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[33] Mhaveer Singh, *Pesticide Predicament: Exploring Environmental and Health Impacts, and Possible Eco-Friendly Solution*, INTERNATIONAL JOURNAL OF ENVIRONMENTAL HEALTH AND SCIENCES (Mar. 29, 2024), https://www.stenvironment.org/images/artical/Paper5_IJEHS_Vol6_Issue1_2024.pdf.
[34] *Id.*
[35] *Id.*
[36] *Id.*
[37] *Id.*

Even the storage, transportation, and disposal of pesticides contribute to environmental pollution. Improper disposal can lead to the leaching of these chemicals into the soil and groundwater, while storage mishandling increases the risk of accidental contamination and spills.[38] Farmers who lack training or access to proper infrastructure for pesticide handling face heightened risks of environmental pollution and health hazards.[39]

E. Pesticides and Climate Change Linkages

The relationship between pesticide use and climate change is complex and multifaceted. One direct link is through the production and distribution of synthetic agrochemicals, which are energy-intensive and contribute significantly to greenhouse gas (GHG) emissions.[40] The manufacture of pesticides relies heavily on fossil fuels, emitting large quantities of carbon dioxide and other GHGs, which exacerbate global warming.[41]

Moreover, pesticide-driven agricultural intensification supports monoculture systems that degrade soil health and reduce the land's carbon sequestration potential.[42] Healthy, biodiverse soils act as vital carbon sinks, and their degradation releases stored carbon into the atmosphere, intensifying the effects of climate change.[43]

The environmental degradation induced by pesticide use also reduces the capacity of ecosystems to buffer climatic extremes such as droughts, floods, and heatwaves. Ecosystems

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[38] Maura Calliera, *et al., Integrating Environmental and Social Dimensions with Science-Based Knowledge for a Sustainable Pesticides Management,* MULTIDISCIPLINARY DIGITAL PUBLISHING INSTITUTE (May 10, 2023), https://doi.org/10.3390/su15107843.
[39] *Id.*
[40] Guillaume Gruere, *et al.*, *Pursuing Higher Environmental Goals for Agriculture in an Interconnected World: Climate Change and Pesticides*, THE ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT (April 2023), https://www.oecd.org/content/dam/oecd/en/publications/reports/2023/04/pursuing-higher-environmental-goals-for-agriculture-in-an-interconnected-world_6c014142/99d917ab-en.pdf.
[41] *Id.*
[42] *Id.*
[43] *Id.*

disturbed by chemical inputs lose resilience and the ability to recover from environmental shocks, thereby increasing their vulnerability to climate-induced disturbances.[44] Climate change itself may compound the problem by altering pest dynamics and increasing the frequency and severity of pest outbreaks, leading to increased pesticide use and a feedback loop of escalating environmental damage.[45]

F. Conclusion

The scientific consensus across diverse studies is clear: pesticides are causing widespread harm to biodiversity, degrading ecosystems, and contributing to climate change. Their pervasive use across agricultural landscapes results in persistent contamination, health hazards, and ecological imbalance. The systemic nature of the harm underscores the need for a radical shift in how pest management is approached globally. Continued reliance on synthetic pesticides is incompatible with the goals of sustainable development and climate resilience.

While the need for crop protection remains, it is imperative to prioritize regulatory reform, farmer education, and international policy alignment. Only through coordinated global efforts can the agricultural sector transition to a more sustainable and environmentally responsible model. This transition must be grounded in environmental ethics, informed by science, and supported by robust institutions and public awareness campaigns. Agriculture must evolve to serve not only human needs but also the long-term health of the planet.

III. Federal Pesticide Regulation in Crisis

[44] Singh, *supra* note 16.
[45] Gruere, *supra* note 23.

At the core of pesticide regulation in the United States lies a troubling paradox: although federal agencies such as the Environmental Protection Agency (EPA) are tasked with protecting public health and the environment, they continue to allow widespread and repeated exposure to hazardous pesticides.[46] Even with existing frameworks like the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) and the Toxic Substances Control Act (TSCA), U.S. policies permit the use of numerous chemicals that carry well-documented risks to human and environmental health.[47]

A. Historical and Legal Foundations of Regulatory Failure

From a historical standpoint, the roots of today's regulatory failures are deep and longstanding. The 1972 amendments to FIFRA were intended to improve pesticide oversight, yet decades later, critical gaps remain.[48] Government audits and investigations, such as those conducted by the Government Accountability Office (GAO), found that many widely used pesticides had not been tested for serious health effects including cancer, reproductive toxicity, and genetic damage.[49] Perhaps even more alarming, were cases of outright fraud—such as the Industrial Bio-Test Laboratories scandal, which revealed that the EPA had approved hundreds of pesticide registrations based on falsified safety data.[50]

B. The Problem of Cumulative Risk

These regulatory shortcomings have continued, especially through the failure to address cumulative chemical risk. Rather than considering the effects of multiple, simultaneous

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[46] Bryan C. Williamson, *Rethinking Chemical and Pesticide Regulation*, THE REGULATORY REVIEW (Jul. 6, 2017), https://www.theregreview.org/2017/07/06/williamson-rethinking-chemical-pesticide-regulation/.
[47] Jay Feldman, *The U.S. Federal Pesticide Law: Why it is Not Protecting Users and the Public, and the Need for Legislative Action,* INTERNATIONAL SOCIETY OF ARBORICULTURE (March 1985), https://auf.isa-arbor.com/content/11/3/76.
[48] *Id.*
[49] *Id.*
[50] *Id.*

exposures, current pesticide law evaluates chemicals in isolation.[51] This fragmented approach disregards real-world exposure patterns, where individuals and the environment regularly encounter mixtures of toxins across food, air, and water.[52] Worse still, disclosure-based strategies assume consumers can manage these risks on their own, despite lacking the expertise or data to understand the full extent of chemical interactions.[53]

C. International Comparisons and U.S. Lag

The regulatory lag in the U.S. becomes particularly clear in international context. Compared to the European Union, Brazil, and China, the United States continues to approve and apply pesticides that have been banned elsewhere for health and environmental reasons.[54] Paraquat, for example—a herbicide linked to acute poisonings and fatalities—is banned in 32 countries, but remains widely used in the U.S., where its use has even increased in recent years.[55] Similarly, chlorpyrifos remained on the U.S. market for over a decade after the EU had banned it due to developmental toxicity concerns affecting children.[56]

D. Regulatory Capture and Institutional Bias

This divergence in policy is not a product of scientific disagreement, but of regulatory capture. The EPA relies primarily on voluntary industry cancellations of pesticide registrations, with the agency initiating only a handful of bans between 2000 and 2018.[57] This reliance signals an agency reluctant to challenge powerful chemical manufacturers. The problem is exacerbated

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[51] Williamson, *supra* note 42.
[52] *Id.*
[53] *Id.*
[54] Nathan Donley, *The USA lags behind other agricultural nations in banning harmful pesticides*, ENVIRONMENTAL HEALTH (2019), https://doi.org/10.1186/s12940-019-0488-0.
[55] *Id.*
[56] *Id.*
[57] Nathan Donley, *How the EPA's lax regulation of dangerous pesticides is hurting public health and the US economy*, BROOKINS (Sept. 29, 2022), https://www.brookings.edu/articles/how-the-epas-lax-regulation-of-dangerous-pesticides-is-hurting-public-health-and-the-us-economy/.

by a revolving door between regulators and industry; every head of the EPA's pesticide office who has stayed in the field post-tenure has moved into positions with companies they once oversaw.[58]

E. Environmental Justice and Public Health Disparities

The health burdens imposed by weak regulation do not fall evenly across the population. Low-income communities and farmworkers bear the brunt of exposure risks.[59] Studies show that Mexican-American individuals have higher pesticide levels in their blood and urine compared to white individuals, even when income levels are controlled.[60] These disparities are rooted in systemic inequities, including discriminatory housing policies and environmental zoning, that have historically situated marginalized communities closer to areas of pesticide application or production.[61]

Nowhere are these inequities more visible than in the lives of agricultural workers. The vast majority of U.S. farmworkers are Hispanic, and many are immigrants who work long hours near fields recently sprayed with pesticides. These workers can have exposure levels up to 400 times the national average.[62] Official EPA figures estimate 13,000 to 15,000 annual pesticide-related illnesses among farmworkers, though some studies suggest the true number could be as high as 300,000 due to underreporting.[63] Enforcement of worker protection rules remains minimal, with

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[58] Nathan Donley & Robert Bullard, *US pesticide regulation is failing the hardest-hit communities. It's time to fix it.,* BROOKINGS (Jan. 18, 2024), https://www.brookings.edu/articles/us-pesticide-regulation-is-failing-the-hardest-hit-communities-its-time-to-fix-it/.
[59] *Id.*
[60] *Id.*
[61] *Id.*
[62] *Id.*
[63] *Id.*

only 1% of agricultural operations inspected each year and few violations resulting in meaningful penalties.[64]

F. Economic Consequences of Regulatory Weakness

Ironically, the economic rationale used to justify lax pesticide regulation is increasingly untenable. Instead of boosting competitiveness, outdated pesticide practices are now harming U.S. agriculture in international markets. Thailand's decision to ban imports of crops treated with paraquat and chlorpyrifos has cost the U.S. an estimated $1 billion in annual soybean and wheat exports.[65] Likewise, France's ban on dimethoate led to $5 million in lost cherry exports over a four-year period.[66] As global standards shift toward more precautionary approaches, the United States risks becoming a chemical outlier whose products are no longer accepted by its trading partners.

G. Global Gaps in Pesticide Governance

While the United States lags in its pesticide regulation, international regimes are not immune to similar criticisms. Despite early praise for initiatives like the European Union's Green Deal and its Farm to Fork Strategy—aimed at reducing pesticide use by 50% by 2030—these efforts have faced significant political pushback.[67] Following protests by European farmers, EU Commission President Ursula von der Leyen withdrew the proposal, labeling it a "symbol of polarization."[68] This reversal demonstrates how even well-intentioned reforms are vulnerable to agricultural lobbying and political compromise.

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[64] *Id.*
[65] Donley, *supra* note 53.
[66] *Id.*
[67] Daphne Ewing-Chow, *'Irresponsible' Global Pesticide Regulations Spark Mass Outrage,* FORBES (Feb. 29, 2024), https://www.forbes.com/sites/daphneewingchow/2024/02/29/irresponsible-global-pesticide-regulations-spark-mass-outrage/.
[68] *Id.*

Transatlantic tensions have exposed a disconnect between environmental ambition and trade policy. U.S. industry representatives criticized the EU's pesticide standards as protectionist, arguing they undermine international cooperation and limit market access.[69] Meanwhile, regulatory inconsistency across regions enables the continued export of dangerous chemicals. In 2018, over 81,000 tons of pesticides containing banned substances were exported from the EU to countries with weaker regulations, primarily in the Global South.[70]

These discrepancies create a dual standard that disproportionately harms lower-income nations. More than 80% of neurotoxic pesticides banned in the U.S. are exported to countries with limited regulatory capacity.[71] In Nigeria, over half of the approved pesticides include substances banned in the EU, leading to tragic consequences—including an incident in 2020 when drinking contaminated water resulted in the deaths of 270 people.[72]

The situation is similarly dire in South Africa, where farmworkers protested Bayer's continued sale of banned agrochemicals.[73] In Colombia, laboratory tests confirmed the presence of fipronil—a banned pesticide—in thousands of dead bees, contributing to ecological decline.[74] Brazil, the world's largest pesticide consumer, registers thousands of agrochemicals, nearly half of which are highly hazardous. Glyphosate residue levels in Brazilian drinking water were found to be 5,000 times higher than EU limits.[75]

These examples underscore a dangerous global trend: pesticide governance remains fragmented, heavily influenced by industry, and ethically questionable. Minister Saboto Caesar

[69] *Id.*
[70] *Id.*
[71] *Id.*
[72] *Id.*
[73] *Id.*
[74] *Id.*
[75] *Id.*

of St. Vincent and the Grenadines calls for an international standard that prioritizes food safety, bans known toxicants, and implements rigorous residue testing.[76] Until such unified and enforceable frameworks are adopted, the world will continue to suffer from a patchwork of inadequate protections that fail to shield communities and ecosystems from chemical harm.

H. Conclusion

This broader context of ecological degradation and climate vulnerability underscores the urgency of reforming U.S. pesticide regulation. Cumulative evidence from both environmental science and public health research illustrates a regulatory system that fails to prevent harm and actively perpetuates it by allowing widespread pesticide use to undermine ecological resilience, exacerbate social inequities, and contribute to global climate disruption. As we consider the path forward, it is essential to recognize that meaningful progress will require more than technical adjustments. The path forward will demand a fundamental realignment of regulatory priorities toward justice, sustainability, and the long-term health of both people and the planet.

IV. Proposed Solutions: Toward a More Sustainable and Just Agricultural Future

A. Participatory and Context-Specific Approaches

One promising model comes from the Lombardy Region in Italy, where the *TRAINAGRO* project implemented a context-specific and stakeholder-driven strategy for sustainable pesticide management.[77] This initiative engaged farmers, advisors, researchers, and public officials in developing accessible tools, such as pictographic guidelines, checklists, and a GIS-based risk assessment tool called MIMERA, which allowed farmers to visualize the environmental impact

[76] *Id.*
[77] Calliera, *supra* note 34.

of their pesticide practices and simulate alternatives.[78] By focusing on tailored, field-level engagement rather than top-down mandates, the project increased adoption of safer pesticide practices and demonstrated the importance of collaborative knowledge-sharing.

B. Integrated Pest Management and Risk-Based Taxation

Governments should prioritize participatory and educational strategies that enhance farmer capacity to implement Integrated Pest Management (IPM). IPM reduces reliance on chemical pesticides by combining biological control, habitat manipulation, and resistant crop varieties.[79] Although IPM has been promoted by the EPA for decades, adoption remains inconsistent due to gaps in training and support. Policy incentives—such as cost-sharing for non-chemical controls, technical assistance, and crop insurance linked to IPM practices—could accelerate its use at scale.[80]

In Denmark, risk-weighted pesticide taxes have successfully encouraged a shift toward less harmful chemicals without reducing agricultural output.[81] U.S. state-level programs could replicate this approach by levying tiered pesticide taxes and earmarking the revenue for farmer training, ecological research, and remediation of contaminated environments.

C. Strengthening U.S. Regulatory Frameworks

At the federal level, reforming the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) is essential. Current policy allows continued approval of pesticides banned in other countries and relies too heavily on voluntary industry withdrawals. Adopting a precautionary principle, like that used in the European Union, would shift the burden of proof to chemical

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[78] *Id.*
[79] Singh, *supra* note 16.
[80] *Id.*
[81] Gruere, *supra* note 23.

manufacturers and prevent the use of hazardous substances until they are proven safe to humans and the surrounding environment.[82]

Congress should also establish an independent scientific advisory board to review pesticide data and advise the EPA. This would help insulate regulatory decisions from corporate influence. In addition, toxicological data used in pesticide registration should be subjected to independent, peer-reviewed testing, not just industry submissions.

D. Advancing Environmental Justice and Farmworker Protections

Given the disproportionate impact of pesticide exposure on marginalized communities, environmental justice must be at the heart of pesticide reform. This includes enhanced enforcement of Worker Protection Standards, free multilingual safety training for farmworkers, and medical facilities equipped to recognize and treat pesticide-related illnesses.

Housing and zoning regulations should also be updated to prevent chemical drift into residential areas. Legal support for whistleblowers, stronger labor protections, and immigration safeguards would empower agricultural workers—many of whom are immigrants—to report unsafe conditions without fear of retaliation.

E. International Cooperation and Trade Reform

The global nature of pesticide production and trade demands international harmonization of pesticide regulations. Wealthy nations must stop exporting banned chemicals to countries with weaker enforcement. The Rotterdam Convention, which governs the trade of hazardous chemicals, should be strengthened to prohibit such exports altogether.[83] Furthermore, countries should adopt unified maximum residue limits (MRLs) to protect consumers and simplify

[82] Donley, *supra* note 50.
[83] Rotterdam Convention, *Overview*, https://www.pic.int/TheConvention/Overview (last accessed Apr. 6, 2025).

international trade. The Codex Alimentarius Commission, a joint body of the FAO and WHO, already issues MRLs, but these should be made binding and enforced via the World Trade Organization.[84]

F. Consumer-Driven Change and Public Procurement Standards

Governments and retailers can also play a role in shifting market demand toward low-pesticide or pesticide-free products. Eco-labeling programs—which certify products based on environmental criteria—enable consumers to make informed choices.[85] These labels can help reduce pesticide use by creating incentives for farmers to meet sustainability standards.[86] Public procurement programs can further support change by requiring organic or low-residue food in schools, hospitals, and other public institutions.[87] This would not only reduce exposure risks to some of the most vulnerable populations, but also expand market access for environmentally responsible producers.[88]

G. Technological Innovation and Agroecology

Precision agriculture technologies, such as drone-assisted spraying and AI-powered pest monitoring, can drastically reduce pesticide use.[89] These tools enable targeted application, minimizing off-site contamination and human exposure.[90] Public investment in these technologies, combined with cooperative purchasing programs, can make them accessible to smaller farms.

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[84] Codex Alimentarius, *About Codex Alimentarius*, https://www.fao.org/fao-who-codexalimentarius/about-codex/en/ (last accessed Apr. 6, 2025).
[85] Gruere, *supra* note 23.
[86] *Id.*
[87] *Id.*
[88] *Id.*
[89] Michael Abramov, *AI Drones in Agriculture: Transforming Crop Monitoring and Precision Farming*, KEYMAKR (Jan 12, 2025), https://keymakr.com/blog/ai-drones-in-agriculture-transforming-crop-monitoring-and-precision-farming.
[90] *Id.*

However, technology alone is not enough. A transition to agroecology and regenerative farming—characterized by crop rotation, polycultures, cover cropping, and soil health restoration—is vital for building long-term agricultural resilience.[91] These practices reduce the need for synthetic inputs while enhancing biodiversity and carbon sequestration.[92]

H. Reorienting Agricultural Subsidies and Policy Goals

To achieve systemic change, agricultural policy must move away from supporting high-input, chemically intensive models. Governments should redirect subsidies toward farmers who adopt biodiversity-friendly and climate-resilient practices. Instead of rewarding yield maximization, policies must incentivize ecosystem services such as pollination, water retention, and carbon storage. This reorientation would benefit the environment and simultaneously protect long-term food security by reducing dependency on vulnerable global supply chains and volatile input markets.

V. Conclusion

The challenges posed by pesticide dependence are multifaceted and deeply woven into some of the most pressing environmental, health, and social justice issues of our time. As this paper has shown, synthetic pesticides are not merely tools of agricultural productivity—they are also drivers of biodiversity collapse, ecosystem degradation, and climate vulnerability. Their effects ripple far beyond the fields where they are applied, contaminating water sources, impairing soil health, harming pollinators and non-target species, and placing disproportionate burdens on marginalized communities. These harms are not accidental, but systemic, and enabled by

[91] Chandrakumara, *supra* note 1.
[92] *Id.*

regulatory frameworks that prioritize economic convenience over ecological integrity and public welfare.

The U.S. regulatory regime illustrates how deeply entrenched industry influence has stymied meaningful reform. Through loopholes in FIFRA, reliance on industry-submitted data, and a fragmented approach to cumulative risk, the Environmental Protection Agency continues to permit the use of dangerous chemicals long banned in other jurisdictions. This regulatory inertia is not just a domestic failure; it also undermines international environmental goals and positions the U.S. as a laggard in the global movement toward sustainable agriculture. At the same time, the export of banned pesticides to countries with weaker regulatory capacity reflects an ethically indefensible double standard that perpetuates global environmental injustice.

The intersection of pesticide exposure and social inequality also demands urgent attention. Farmworkers and low-income communities disproportionately bear the toxic legacy of chemical agriculture. These groups are too often rendered invisible in policy discussions, despite facing heightened exposure risks and systemic barriers to justice. Protecting public health requires centering these communities in regulatory decision-making, not just allowing them to be collateral damage in the pursuit of agricultural efficiency.

Yet, despite these daunting realities, pathways for transformation exist. Participatory models like Italy's TRAINAGRO project, risk-weighted taxation in Denmark, and international efforts to harmonize pesticide standards show that alternative approaches are both, possible and effective. Integrated Pest Management, agroecological practices, and precision technologies offer scalable tools to reduce pesticide reliance while safeguarding yields and ecosystem services. Importantly, these solutions are not merely technical fixes, but reflect a deeper paradigm shift—

one that recognizes agriculture's role not only as an economic activity but as a stewardship of land, life, and climate.

More than sixty years ago, Rachel Carson closed Silent Spring by envisioning a choice between the "control of nature" and "the understanding of nature."[93] Today, that choice remains stark. Our continued reliance on toxic pesticides reflects not a failure of knowledge, but a failure of will. In honoring Carson's legacy, we must confront the systemic forces that prioritize short-term gain over long-term planetary stewardship. Reforming pesticide governance is not only a scientific or regulatory necessity—it is a moral imperative.

Reforming pesticide governance will require a reorientation of agricultural subsidies, stronger international treaties, and a regulatory apparatus insulated from industry capture. It will demand robust public engagement, consumer awareness, and institutional commitment to science-based policymaking and environmental ethics. The task ahead is as complex as it is critical—but the cost of inaction is higher. Climate-resilient, equitable, and biodiversity-supporting food systems cannot coexist with the current regime of widespread pesticide use. To protect both planetary health and human dignity, the transition away from chemical dependency must begin now, guided by precaution, justice, and the long-term sustainability of life on Earth.

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[93] Rachel Carson, *supra* note 1.