GREENHOUSE GAS FROM HOUSE FUMIGATION | JANUARY 11, 2022

Common Home Fumigation Pesticide Associated with Increased Greenhouse Gas Emissions

A study finds that the pesticide sulfuryl fluoride, used for insect (e.g., termites, bedbugs, cockroaches, etc.) fumigation treatments, increases greenhouse gas (GHG) emissions, according to the report, "Termite Fumigation in California Is Fueling the Rise of a Rare Greenhouse Gas." Not only do most sulfuryl fluoride emissions in the U.S. occur in California, but a majority of global emissions also occur in California. When the use of methyl bromide for agricultural and structural fumigation was phased-out under the Montreal Protocol, sulfuryl fluoride became a replacement for fumigation treatments. However, researchers have identified concentrations of sulfuryl fluoride in the atmosphere due to the chemical's long half-life and greenhouse warming potential (GWP). The *California Global Warming Solutions Act of 2006* does not list sulfuryl fluoride emissions as a GHG risk. Therefore, the researchers note, "This work emphasizes the importance of considering [sulfuryl fluoride] SO2F2 in state and national greenhouse gas inventories and emissions reduction strategies."

Researchers employ a geostatistical inverse model (GIM)—commonly used to estimate GHG fluxes—alongside atmospheric measurements of sulfuryl fluoride to estimate emissions throughout the United States. Using programmable flask packages (PFPs), researchers examine atmospheric observational data from towers, observatories, and aircraft, measuring concentrations of sulfuryl fluoride via gas chromatography-mass spectrometry. To compare surface and downwind emission, the researchers use the Lagrangian particle dispersion model (STILT) with multiple variables, including county-wide uses of sulfuryl fluoride and the U.S. Geographical Survey National Land Cover Database.

The GIM results demonstrate that most U.S. sulfuryl fluoride emissions derive from California, specifically the greater Los Angeles (LA) area (up to 400 parts per trillion between 2015 and 2017), followed by the Bay area. Moreover, all regions outside of California have negligible sulfuryl fluoride atmospheric concentrations, resulting in little to no emissions. Thus, the study implies California is the world's leading sulfuryl fluoride emitter. Lead author Dylan Gaeta, a PhD student at Johns Hopkins University, extrapolates, "We expected to see little splotches of emissions throughout at least some other parts of the country…The fact that we are seeing almost all of it from California? That was the shocking part."

Sulfuryl fluoride is a fluoride compound with various adverse health effects, including cancer, endocrine disruption, neurotoxicity (reduced IQ), and reproductive damage. The *Food Quality Protection Act* (FQPA) amendments to *Federal Food, Drug, and Cosmetic Act* (FFDCA) require that a pesticide registered for use by the

agency cannot exceed acceptable risk thresholds for both dietary and nondietary exposure. However, a U.S. Environmental Protection Agency's (EPA) risk assessment of fluoride exposure finds that exposure to fluoride from various sources (e.g., sulfuryl fluoride residues in food commodities, fluoride exposure in water and toothpaste) did not meet the safety standard under FFDCA. Moreover, sulfuryl fluoride rapidly metabolizes (breaks down) in the body into fluoride. Considering the compound has a long half-life in human bones (~20 years), advocates have in the past petitioned EPA should withdraw the allowed tolerances for food uses of sulfuryl fluoride.

Sulfuryl fluoride, registered for termite and other wood-boring pest extermination in 1959, gained additional attention as a potential alternative to methyl bromide, a broad-spectrum insect fumigant used in post-harvest storage and food processing facilities. Methyl bromide's designation as a greenhouse gas under the Montreal Protocol (2005) caused a gradual reduction in use. However, when no feasible methyl bromide alternatives are available, the "critical use exemption" (CUE) allows the use of this chemical. Furthermore, others (Natural Resources Defense Council) argue that the disallowance of any sulfuryl fluoride uses will lead to prolonged or increased methyl bromide use. However, Beyond Pesticides and others maintain that without the phaseout of sulfuryl fluoride, there will be no incentive for grain storage facilities to upgrade and adopt modern practices that forego hazardous chemical use.

Although EPA decided to phase out sulfuryl fluoride use on food commodities in 2011, Dow AgroScience (the manufacturer of sulfuryl fluoride under the trade names Vikane and ProFume), along with others lobbied against efforts to phase out use, in the lead up to Congressional action to overrule the science on adverse health effects.

The U.S. Congress, in the 2014 Farm Bill (*Agricultural Act of 2014*), included a provision that requires EPA to ignore the science and law that establishes the safety threshold for exposure to fluoride. (See When Politics Trumps Science and Health Suffers.) The use of the pesticide sulfuryl fluoride, allowed in food production since 2004, in combination with fluoride use in water fluoridation, creates unacceptable hazards under EPA and National Academy of Sciences (NAS) scientific determinations. However, in an intervention that simply defies the scientific literature and thresholds for safety, the bill language orders EPA not to follow the law and science. The regulatory agencies responsible for protecting public health have identified elevated risk of dental fluorosis (breaking down of teeth enamel) in young children, and skeletal fluorosis (joint pain and muscle impairment), while the scientific literature raises serious issues of neurological and brain effects from elevated levels of fluoride.

If pesticide use and manufacturing are amplifying the impacts of the climate crisis, advocates argue that pesticide policy and regulation must address and eliminate chemical use. There are many viable alternatives to sulfuryl fluoride and methyl bromide fumigation.

The sulfuryl fluoride/GHG study represents an all too familiar pattern of widespread chemical use without proper knowledge of health and environmental effects before implementation. According to the most recent data by the California Department of Pesticide Regulations, sulfuryl fluoride is the 12th most used pesticide applied to sites across California, with over 2.9 million pounds used in 2018 for structural and agricultural pest control. Although sulfuryl fluoride emissions mainly stem from the greater Los Angeles area, researchers suggest other states, like Florida, may also produce emissions that remain unaccounted for by current National Oceanic and Atmospheric Administration (NOAA) chemical tracking. The California Air Resources Board (CARB) added sulfuryl fluoride to its list of "short-lived climate pollutants," being the only state to do so since 1990. However, California does not include sulfuryl fluoride in the list of GHG emissions to reduce by 2020 as researchers were not aware the chemical was a GHG until 2008. A 2009 study finds the termite insecticide to be a more potent GHG than carbon dioxide by up to 4,000 times over 100 years. Since sulfuryl fluoride has high global warming potential, it can remain in the atmosphere for more than 36 years.

Ninety-nine percent of structural fumigation treatments use sulfuryl fluoride. Recent work at the Massachusetts Institute of Technology (MIT) demonstrates that North America was the leading global source of sulfuryl fluoride emissions in 2019. The risk of multiple chemical contaminants in the atmosphere increases as global warming progresses. Melting glaciers can release persistent organic pollutants into waterways. Recently, pesticides and fertilizers overtook the fossil fuel industry in environmental sulfur emissions. Thus, health and environmental concerns will increase significantly, especially for individuals and ecosystems more vulnerable to the toxic effects of chemical exposure.

If pesticide use and manufacturing are amplifying the impacts of the climate crisis, advocates argue that pesticide policy and regulation must address and eliminate chemical use. There are many viable alternatives to sulfuryl fluoride and methyl bromide fumigation. These alternatives include temperature manipulation, atmospheric controls, biological controls, and less toxic chemical controls (diatomaceous earth). Many existing commodity storage facilities are too old and outdated to prevent pest infestation. This ineffectiveness leads to a reliance on toxic fumigation. Thus, a clean, regularly-maintained storage or processing facility can easily keep facilities pest-free.

As the climate crisis continues, banned and current-use pesticides put human and animal health at risk upon release into the atmosphere and waterways. Lack of adequate pesticide regulations highlights the need for better policies surrounding use. The European Union already bans sulfuryl fluoride from any food contact.

What to do: A switch from chemical-intensive agriculture to regenerative organic agriculture can significantly reduce the threat of the climate crisis by eliminating toxic, petroleum-based pesticide use, building soil health, and sequestering carbon. Current organic food production and handling do not permit conventional pesticide use, including fumigants like sulfuryl fluoride. Therefore, organic production reduces greenhouse gas emissions from chemical use. Learn more about how switching to organic management practices can mitigate the climate crisis by reading *Regenerative Organic Agriculture and Climate Change: A Down-to-Earth Solution to Global Warming*. For more information about organic food production, visit Beyond Pesticides' *Keeping Organic Strong* webpage. Learn more about the adverse effects chemical-intensive farming poses for various crops and how eating organic produce reduces pesticide exposure and benefits the environment.

SOURCE: Gaeta, D., Muhle, J., Vimont, I., Zhang, M., McKain, K., Crotwell, M., Miller, B., Miller, S. Greater Los Angeles Area dominates U.S. emissions of sulfuryl fluoride, a potent greenhouse gas. American Geophysical Union Fall Meeting. 2021; EOS

CHEMICAL NO-TILL CONTRIBUTES TO CLIMATE CRISIS | MAY 10, 2022

Chemical No-Till Failure Due to Herbicide Resistance Increases Greenhouse Gas Emissions

Widespread weed resistance on chemical corn and soybean farms is leading farmers to till their fields more often, significantly increasing greenhouse gas (GHG) emissions. These findings were published late last month in the journal *Nature Food* by a team of Iowa State University researchers. With agricultural practices accounting for roughly 10% of U.S. GHG emissions, and 25% of worldwide releases, farming practices that preserve soil health and sequester GHGs are essential for the future of food production.

Tillage is a farming practice that can provide a range of benefits for crop production, but only under the right conditions. A range of tillage practices exist, ranging from yearly conventional tillage, where most crop residue is plowed into the soil, to conservation tillage where some residue remains, and no-till systems where the soil remains covered. Repeated tillage causes significant harm to soil structure and biology, and results in erosion and the release

of GHGs like carbon dioxide, methane, and nitrous oxide from soil into the atmosphere. The harms of tillage have led both chemical and organic farmers toward no-till or reduced tillage systems.

Organic no-till farming, as practiced by farming groups like the Rodale Institute, employs the use of cover crops that are grown over the fall and winter and then matted down over the top of the soil using a machine called a roller-crimper. This process suffocates weeds and creates a rich mulch that can often be directly planted in. Some smaller scale organic farmers may till a single time, lay down cardboard or other weed suppressants, and then establish compost mulch beds in which crops can be grown.

From 1998 to 2008, corn and soy acreage under chemical no-till increased by over a combined 10 million hectares, roughly the size of Kentucky. This is associated with a reduction in tillage intensity during that time, which also reduces the GHGs emitted by tillage.

Chemical no-till, on the other hand, generally includes the use of herbicides sprayed directly over the top of plants to manage weeds competing with crops. This practice is reliant on genetically engineering row crops (specifically corn or soy) to be tolerant of a particular herbicide, or herbicide-tolerant (HT). Glyphosate-tolerant 'Roundup Ready' cropping systems have been the been the most popular over the last 25 years, providing chemical farmers a simple method of crop production without soil tillage.

Whatever gains this system provides in reducing atmospheric GHGs by reduced tillage is, according to researchers, eliminated by increases in tillage that have occurred since 2008, when weed resistance to glyphosate became widespread. To make this determination, researchers create a land-ecosystem model, use mapping data on environmental changes, and long-term farmer surveys to determine how the chemical no-till model came into widespread adoption and subsequently broke down. Corn-soybean cropping systems from the mid-1990s until the mid- 2010s are analyzed, with 2008 marking a shift in trends.

From 1998 to 2008, corn and soy acreage under chemical no-till increased by over a combined 10 million hectares, roughly the size of Kentucky. This is associated with a reduction in tillage intensity during that time, which also reduces the GHGs emitted by tillage. However, from 2009 to 2016, as glyphosate resistance spread rapidly across multiple different weeds, researchers found increases in GHG emissions from chemical farmers returning to tillage. Particular areas around the country, like the western corn belt in the Dakotas and Minnesota, represent some of the highest GHG emissions from returning to these practices.

"Our work implies that the benefit of HT crop adoption in reducing tillage has reached its peak, while the emerging weed resistance is found to contribute to intensifying tillage practices," the study reads. "As weed resistance persists and grows, tillage intensity is anticipated to continue to rise, which would further increase GHG emissions and contribute to global warming."

The shift from reduced tillage to increased tillage is a product of a cropping system that was always intended to provide short-term profits, rather than promote environmental sustainability. The study authors emphasize that farmer choices in managing herbicide resistance are critical in addressing the issue. But many farmers under contract with large agrichemical companies have a difficult time implementing alternative practices outside of a chemical cropping system. The pesticide/agrichemical industry is generally promoting new, more toxic herbicide products utilizing chemicals like glufosinate, dicamba, and 2,4-D to supplement glyphosate's diminishing returns.

This approach keeps farmers on a treadmill, delaying what is clearly inevitable, while contaminating food, surrounding soil and farmland, water, and air. "Without an effective strategy to control weeds, tillage intensity could continue to grow in the future and could undermine greenhouse gas mitigation achievements from other agricultural activities," said study author Chaoqun Lu, PhD in an Iowa State press release.

No-till organic addresses the failures of chemical no-till and has the potential to sequester carbon by retaining soil organic matter. Organic farms in general contain 13% more total soil organic carbon than conventional farms, as well as a higher level of the stable soil compounds fluvic and humic acid, a 2017 study found. According to calculations from the Rodale Institute in 2014, soil sequestration has the potential to store the greenhouse gas emissions of up to 52 gigatons of CO_2.

While the agrichemical industry continues to make arguments for chemical farming based primarily on the need for higher yields, this short-term, myopic focus loses sight of health and a sustainable future that humanity must create to continue life on earth. Research on organic agriculture shows it can provide quadruple the performance, synergizing financial, human health, ecological, and socio-economic well-being.

What to do: See Beyond Pesticides webpage on Organic Agriculture for more information and support organic food production with purchasing practices.

SOURCE: Lu, C., Yu, Z., Hennessy, D.A. *et al.* Emerging weed resistance increases tillage intensity and greenhouse gas emissions in the US corn–soybean cropping system. *Nat Food* 3, 266–274 (2022). https://doi.org/10.1038/s43016-022-00488-w; Iowa State press release

SULFURYL FLUORIDE, GREENHOUSE GAS, PETITIONED | NOVEMBER 3, 2022

California Petition Seeks Removal of Hazardous Fumigant Linked to Climate Crisis

In a fight against global warming, environmental groups Center for Biological Diversity (CBD) and Californians for Pesticide Reform (CPR) filed a formal legal petition in October 2022 urging the California Air Resources Board (CARB) to phase out the use of sulfuryl fluoride insecticides. This is not the first time sulfuryl fluoride has been petitioned for removal from the market. In 2006, Fluoride Action Network, Beyond Pesticides, and Environmental Working Group successfully petitioned the U.S. Environmental Protection, only to have EPA's decision overturned by Congress in the 2014 Farm Bill.

Sulfuryl fluoride is a fluoride compound with various adverse health effects, including cancer, endocrine disruption, neurotoxicity (reduced IQ), and reproductive damage. CARB added sulfuryl fluoride to its list of "short-lived climate pollutants," being the only state to do so since 1990. However, California does not include sulfuryl fluoride in the list of GHG emissions to reduce by 2020, as researchers were unaware the chemical was a greenhouse gas (GHG) until 2008. These termite and food use insecticides are 4,800 times more potent GHG than carbon dioxide at trapping carbon in the atmosphere. Furthermore, sulfuryl fluoride has high global warming potential and can remain in the atmosphere for more than 36 years.

The case of sulfuryl fluoride presents an all too familiar pattern of widespread chemical use without proper knowledge of health and environmental effects before adoption and a failure to take regulatory action on known hazards after allowed in commerce. Therefore, CBD's environmental health legal director Johnathan Evans, senior attorney, states, "Phasing out sulfuryl fluoride would provide the same climate benefits as taking one million cars off our roads every year… California's air regulators have a legal and moral obligation to reduce greenhouse gases that are helping to drive catastrophic global warming."

Sulfuryl fluoride, registered for termite and other wood-boring pest extermination in 1959, gained additional attention as a potential alternative to methyl bromide, a broad-spectrum insect fumigant. Ninety-nine percent of structural fumigation treatments use sulfuryl fluoride. However, researchers have identified concentrations of sulfuryl fluoride in the atmosphere due to the chemical's long half-life and greenhouse warming potential (GWP). Recent work at the Massachusetts Institute of Technology (MIT) demonstrates North America was the leading global source of sulfuryl fluoride emissions in 2019. The risk of multiple chemical contaminants in the atmosphere increases as global warming progresses. Melting glaciers can release persistent organic pollutants into waterways. Recently, pesticides and fertilizers overtook the fossil fuel industry in environmental

sulfur emissions. Thus, health and environmental concerns will increase significantly, especially for individuals and ecosystems more vulnerable to the toxic effects of chemical exposure.

In the 2022 report, "Termite Fumigation in California Is Fueling the Rise of a Rare Greenhouse Gas," researchers demonstrate that sulfuryl fluoride increases greenhouse gas (GHG) emissions. Although most sulfuryl fluoride emissions in the U.S. occur in California, most global emissions also occur in California. According to the most recent data from the California Department of Pesticide Regulations, sulfuryl fluoride is the 12th most used pesticide applied to sites across California, with over 2.9 million pounds used in 2018 for structural and agricultural pest control and over three million pounds used statewide in 2021. Although 50 to 60 percent of sulfuryl fluoride emissions occur in California, researchers suggest that other states, like Florida, may also produce emissions that remain unaccounted for by current National Oceanic and Atmospheric Administration (NOAA) chemical tracking.

Similar to this petition, Beyond Pesticides, and others maintain that without the phaseout of sulfuryl fluoride, there will be no incentive for grain storage facilities to upgrade and adopt modern practices that forego hazardous chemical use. In addition to the phaseout of sulfuryl fluoride, the petition also seeks to add this fumigant to California's greenhouse gas emission inventory for better monitoring.

The history of sulfuryl fluoride has pitted one chemical use against another, instead of incentivizing movement away from chemical dependency to viable alternative and organic management practices. For example, in 2011, the Natural Resources Defense Council (NRDC) sent a letter to EPA stating its opposition to EPA's phaseout of the toxic fumigant pesticide, which is marketed as a substitute for the outdated, ozone-depleting methyl bromide. EPA's action was in response to a 2006 petition cited above. According to its letter, NRDC believes that the "proposed action will imperil EPA's ability to complete the long-overdue phaseout of methyl bromide, leading to prolonged and increased depletion of the ozone layer, higher levels of ultraviolet radiation, and higher risks of cancer, cataracts, and immunological disorders." NRDC was objecting to EPA's announcement to cancel all allowable pesticide residue levels (tolerances) for sulfuryl fluoride over three years, effectively banning its use in January 2014.

The agency found that when residues on food products are combined with fluoridated drinking water and toothpaste, aggregate exposure levels are too high. Beyond Pesticides has repeatedly pointed to nontoxic practices that have eliminated the need for either hazardous fumigant throughout the petition process. Despite this, in 2014, buried in the *Agriculture Act of 2014* (the "Farm Bill"), Congress adopted an amendment at the behest of those seeking to keep sulfuryl fluoride on the market that prohibited EPA from moving against the chemical. For a more in-depth history on this, see When Politics Trumps Science and Health Suffers.

The current petition concludes, "Now that it is known and well-supported by science that sulfuryl fluoride is a highly potent greenhouse gas that can remain in the atmosphere for 36 years, and there are viable alternatives to the fumigant, Petitioners request that CARB 1) initiate a rulemaking to include sulfuryl fluoride in California's annual statewide greenhouse gas inventory pursuant to AB 32 and 2) initiate a rulemaking to phase out the use of sulfuryl fluoride."

As the climate emergency continues, banned and current-use pesticides put human and animal health at risk upon their release into the atmosphere and waterways. If pesticide use and manufacturing amplify the impacts of the climate crisis, advocates argue that pesticide policy and regulation must address and eliminate chemical use. There are many viable alternatives to sulfuryl fluoride and methyl bromide fumigation. These alternatives include temperature manipulation, atmospheric controls, biological controls, and less toxic chemical controls (diatomaceous earth). Many existing commodity storage facilities are too old and outdated to prevent pest infestation. This ineffectiveness leads to a reliance on toxic fumigation. Thus, a clean, regularly-maintained storage facility can keep facilities pest-free.

The European Union already bans sulfuryl fluoride from any food contact. Thus, switching from chemical-intensive agriculture to regenerative organic agriculture can significantly reduce the threat of the climate crisis by eliminating toxic, petroleum-based pesticide use, building soil health, and sequestering carbon. Current organic food production and handling do not permit conventional pesticide use, including fumigants like sulfuryl fluoride. Therefore, organic production reduces greenhouse gas emissions from chemical use.

What to do: Learn more about how switching to organic management practices can mitigate the climate crisis by reading *Regenerative Organic Agriculture and Climate Change: A Down-to-Earth Solution to Global Warming*. For more information about organic food production, visit Beyond Pesticides' *Keeping Organic Strong* webpage.

For more discussion, background, and strategy on fighting the climate crisis through the elimination of petrochemical pesticides and fertilizers, view Health, Biodiversity, and Climate: A Path for a Livable Future, the 2022 National Forum Climate Session, which will feature two speakers: Rachel Bezner Kerr, PhD, noted professor in Global Development at Cornell University (and Coordinating Lead Author for the United Nations Intergovernmental Panel on Climate Change report *Climate Change 2022: Impacts, Adaptation, and Vulnerability*); and Andrew Smith, PhD, chief operating officer at the Rodale Institute and coauthor of the report *Regenerative Organic Agriculture and Climate Change*.

SOURCE: Center for Biological Diversity, Californians for Pesticide Reform. Petition to Regulate Sulfuryl Fluoride To Reduce the Use of the High Global Warming Potential Pesticide. 2022; CBD Report

SOIL MANAGEMENT, CARBON SEQUESTRATION, ORGANIC

Listening to the Science on the Climate Crisis at All Levels–Federal, State, and Local

The undeniably grave climate crisis is evident to all. Increasingly, but not as urgently as advocates are advising, scientific understanding of the grave health and environmental effects are being incorporated into the deliberations on all policy decisions regarding petrochemical pesticide registrations and synthetic fertilizer use in agriculture and nonagricultural land management. The science, in this context, focuses on soil health—in particular, soil organic carbon, which sequesters atmospheric carbon and reduces its damaging atmospheric effects.

Although the soil is commonly recognized as a sink for atmospheric carbon, there is a false narrative that says carbon can be sequestered in the soil through chemical-intensive no-till agriculture. According to André Leu, international director at Regeneration International, "The main reason for the loss of soil carbon in farming systems is not tillage; it is synthetic nitrogen fertilizers. Research shows that there is a direct link between the application of synthetic nitrogenous fertilizers and a decline in soil carbon." Those same nitrogenous fertilizers act as potent greenhouse gases when volatilized.

The Rodale Institute's 40-Year Report (see page 169) on its "Farming Systems Trial" should end the myth of the toxic, petrochemical-based, GMO-herbicide, no-till systems. Rodale's scientific trials clearly show that these degenerative no-till systems are inferior to regenerative organic agriculture on every key criterion. The highest yields of corn are in the tilled organic manure system, and organic corn yields have been 31 percent higher than conventional/industrial farming systems in drought years. The trials show that herbicide no-till systems do not produce higher levels of soil organic carbon (SOC) than tillage systems, as the scientific literature finds.

Thus, chemical-intensive agriculture and nonagricultural land management contribute to climate change in multiple ways. Serious attention to combating climate change and mitigating its impacts requires all governmental bodies, at all levels of government, to consider climate impacts when making decisions. This means that the U.S. Environmental Protection Agency (EPA) must not approve registrations of pesticides that harm the soil or facilitate agricultural practices that interfere with carbon sequestration. It means that the U.S. Department of Agriculture (USDA), in a much more aggressive way, must lead the transition to organic agriculture as a replacement for chemical-intensive practices, ceasing all support for chemical-intensive agriculture immediately. It means that the Department of Interior (DOI) must manage all public lands with organic practices that ensure soil health and all that means for a livable future. It means that all lands managed by state and local governments transition to organic management practices.