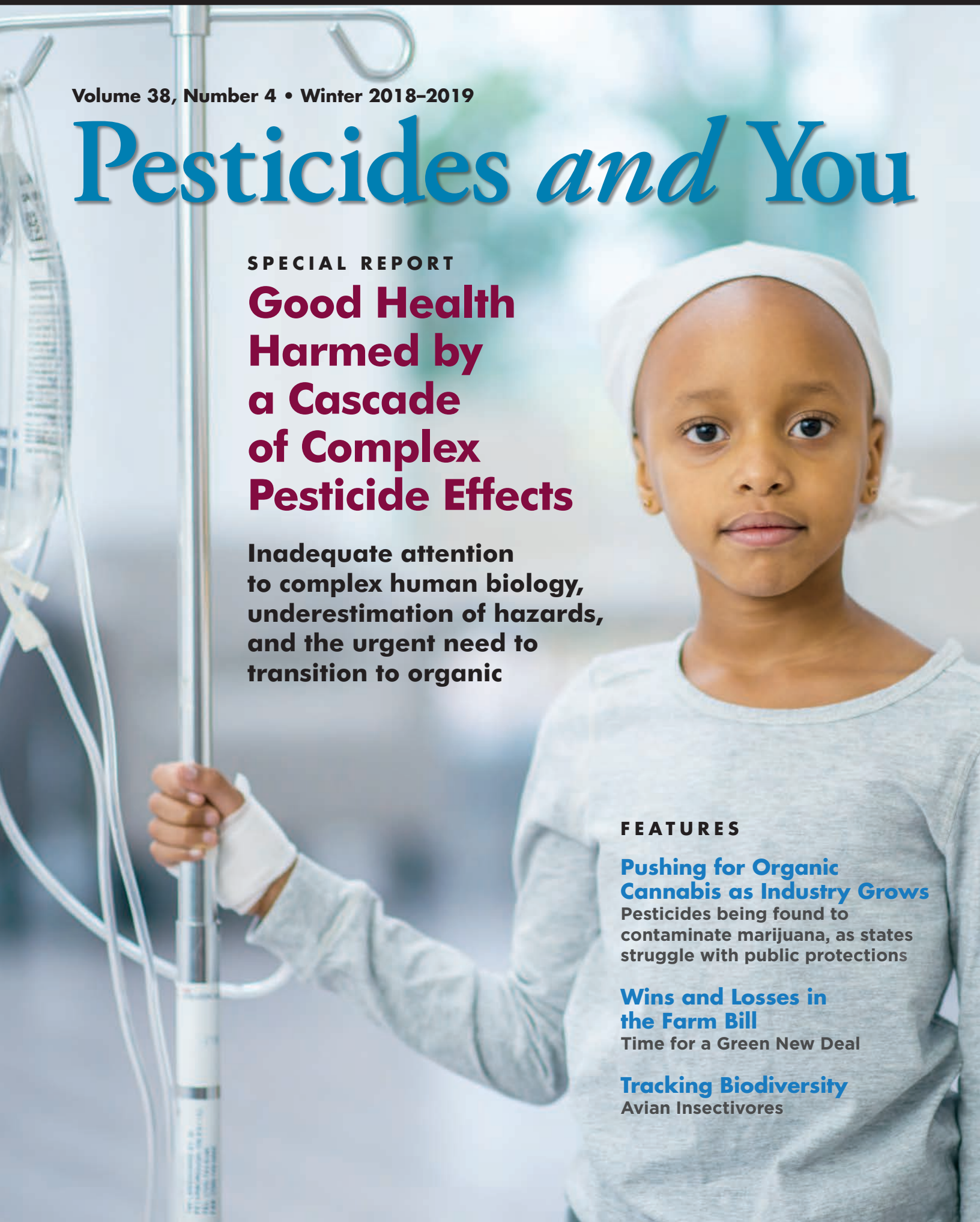
Beyond Pesticides: Protecting Health and the Environment with Science, Policy, and Action



Volume 38, Number 4 • Winter 2018–2019

Pesticides *and* You

SPECIAL REPORT

Good Health Harmed by a Cascade of Complex Pesticide Effects

Inadequate attention to complex human biology, underestimation of hazards, and the urgent need to transition to organic

FEATURES

Pushing for Organic Cannabis as Industry Grows
Pesticides being found to contaminate marijuana, as states struggle with public protections

Wins and Losses in the Farm Bill
Time for a Green New Deal

Tracking Biodiversity
Avian Insectivores

Advancing a Green New Deal

Why are we calling for urgent action to protect public health and the environment? Is a "green new deal" the vehicle we need to meet the urgent challenges in front of us, for young people and future generations? We face urgent health and environmental challenges and bold action is required. It is foundational that we as a society link the critical need to address environmental crises with programs that stimulate and support economic progress. We know that in the long-term we will only achieve economic security and sustainability with clear environmental standards. Green means protective of the environment, addressing issues critical to sustainability—clean air and water, managing carbon through regenerative soil management, and eliminating fossil fuel-dependent fertilizers and pesticides. It also means a healthy food supply that protects consumers and those who work on farms.

From an economic perspective, *U.S. Organic Hotspots and Their Benefit to Local Economies* (2016), by Penn State agricultural economist Edward Jaenicke, PhD, finds that organic hotspots—counties with high levels of organic agricultural activity whose neighboring counties also have high organic activity—boost median household incomes by an average of $2,000 and reduce poverty levels by an average of 1.3 percent. The research adds to scientific findings that organic can and must feed the nation and the world while dramatically reducing secondary health and environmental costs.

From an environmental perspective, our concerns related to chemical-intensive land and building management practices go to the production, use, and disposal of fossil-fuel based toxic pesticides and fertilizers, not simply the residues on finished food products. As a society, we must choose to support production practices that protect and enhance ecosystems essential to human survival—addressing biodiversity and global climate change.

Experience Demands Action

Over nearly four decades, Beyond Pesticides has been raising scientific concerns about the public health effects of pesticides and seeking to eliminate their use by shifting to organic, environmentally compatible practices. We have successfully worked to ban some of the most toxic pesticides: starting with remaining DDT uses, chlordane and other organochlorine pesticides in the DDT family, 2,4,5-T and phenoxy herbicides, chlorpyrifos (residential uses) and other organophosphates, and carbofuran and other carbamates. They have been replaced by ongoing dependency on other highly toxic pesticides: synthetic pyrethroids, glyphosate, and neonicotinoids, which we now seek to remove from the market. Because of this pattern, Beyond Pesticides' success in developing and advancing organic standards as a transformational shift to a paradigm that rejects toxic chemicals has taken on more and more urgency and must be central to a Green New Deal.

Documenting the Need for Transformation

Our comprehensive analysis, *Thinking Holistically When Making Land Management Decisions* (2018), documents the failure of the current laws and regulatory review to consider complex ecological impacts of pesticides. These effects are not captured in current ecological risk assessments, even though interactions among pesticides and their cumulative impacts are devastating to ecological balance and health. In this issue's special report, we document the irrefutable link of pesticide use to adverse effects that occur in ways not evaluated by regulators, such as the transgenerational effects that show adverse impacts over multiple generations. The report, *Good Health Harmed by a Cascade of Complex Pesticide Effects*, discusses elevated vulnerabilities to human diseases that are not evaluated under current regulatory reviews. Both these pieces serve as the underlying justification for embracing a Green New Deal that gives highest national priority to an integrated approach under the banner of a sustainable future.

Green as Intricately Linked to Organic

For the most part, consumer demand, organic farmers, and market forces have gotten the organic sector to where it is. While compliance with federal organic standards are only mandated for those who choose to certify their practices and label their food products as USDA Organic in commerce, the adverse impacts of chemical-intensive conventional agriculture and landscape management, along with all the serious deficiencies in the regulatory process, demand federal policy to effect an expedited transition away from toxic pesticide use. Slow chemical-by-chemical change must be replaced by a systems change that incorporates soil management and other cultural practices that support biological systems, natural cycling of nutrients, soil and aquatic food webs, and resiliency.

As we work out the details of the Green New Deal proposal, we will advance the idea that a green future must incorporate organic standards, principles, and values, if the law is to be successful in supporting life in all its complexities. Beyond Pesticides supports organic agriculture as effecting good land stewardship and working to strengthen organic farming systems with its nurturing of biodiversity and holistic, regenerative management practices.

Organic practices maintain and enhance ecological balance that makes chemical fertilizers and synthetic pesticides unnecessary. These practices are integral to a green future and a Green New Deal. We look forward to working with you and your elected members of Congress to make this a reality!

Jay Feldman, executive director of Beyond Pesticides

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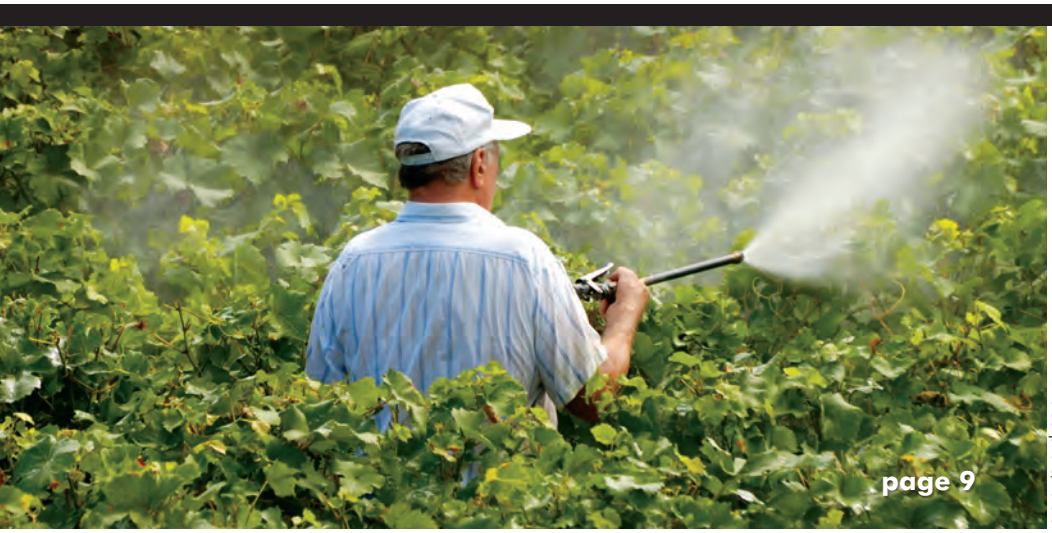
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NATIONAL HEADQUARTERS
701 E Street, SE Washington DC 20003
ph: 202-543-5450 fx: 202-543-4791
email: *info@beyondpesticides.org*
website: *www.beyondpesticides.org*

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Professional Assistance Required?

I'm having a pest problem in my home and am looking for a professional that can help me address the issue. We have a new baby and just bought the house, so we don't want any toxic pesticides to contaminate our living space. Any recommendations?

Cameron, Arizona

Hi Cameron,

We certainly understand your concerns. For common pest problems that are not an all-out infestation, we suggest you first check out Beyond Pesticides' ManageSafe webpage [*bp-dc.org/managesafe*], where you will find least-toxic management practices to address most household pests without the use of toxic pesticides. Not only can these guides be helpful for managing current pest problems, they provide help to establish pest prevention measures that eliminate the possibility you will need to call a pest management professional in the future.

If the pest problem does rise to the level of needing professional assistance, a good place to check first is our *Safety Source for Pest Management* [*bp-dc.org/safetysource*], which provides a resource of companies that have filled out our survey on pest management practices. Not all pest providers that have completed our survey utilize all organic management practices, so we encourage you to review the survey responses we post to our website—so you have a good understanding of a particular service provider.

If we do not have a listing in your state or near your residence, you may still be able to find companies that can provide least-toxic pest management services in your area. We urge you to do an internet search to find providers, and quiz them on their management practices with the questions that we ask in *Safety Source*. After you explain your issue, request the list of pesticide products they may use for your problem. You can consult Beyond Pesticides' Pesticide Gateway [*bp-dc.org/gateway*] or contact us if you need help understanding whether the active ingredient in a particular product is acceptable to use around you and your family.

Many chemical-focused companies will try to downplay the risks of any synthetic chemical or convince you they are safe; but, if that is how they are trying to get your business, we suggest that you try another provider. Be firm and persistent and we are confident you will find a service provider willing to meet your needs.

Golf Can Go Organic

I'm getting tired of the constant spraying going on in my community. We're surrounded by golf courses. I thought that would be great and convenient, but I didn't know they would be using so many chemicals. Are there organic golf courses out there that don't spray these toxic pesticides? I think I will need examples to take to them if I'll have any chance of changing their minds.

Linda, Minnesota

Hi Linda,

We are sorry to hear about the spraying occurring in your community. The development of housing associations around golf courses presents pesticide risks that many residents may not have expected when first deciding to move into an area.

Going organic on a golf course is a challenging undertaking, but it can be done, and there are several examples in different climates throughout the U.S. The Vineyard Golf Course in Martha's Vineyard, MA is a great example of this in action—particularly because the course has been successfully using organic methods for over a decade. And reports from superintendents indicate that increased cost is not a significant issue. In a 2008 *Golf Digest* report, it was reported that the "Vineyard budget is in the mid-range for New England private courses, spending a little more on labor costs."

There is also the Applewood Golf Couse in Golden, Colorado. The course, established by the Adolph Coors Brewery in 1961, transitioned to organic as far back as 1981 as part of efforts to ensure the water source for Coors beers was not contaminated.

Another example is the Big Trees Golf Course located outside Yosemite National Park. A nine hole course, it boasts

SHARE WITH US!

Beyond Pesticides welcomes your questions, comments, and concerns. Have something you'd like to share or ask us? We'd like to know! If we think something might be particularly useful for others, we will print your comments in this section. Mail will be edited for length and clarity, and we will not publish your contact information. There are many ways you can contact us: Send us an email at *info@beyondpesticides.org*, give us a call at 202-543-5450, or send questions and comments to: 701 E Street SE, Washington, DC 20003.

on its website, "The golf course is one of the few organic golf courses in the United States. No pesticides are applied to the course and only reclaimed gray water is used for watering the greens."

Providing these examples to your local golf course superintendent should help ease concerns over a potential transition. However, you will also need to garner support from members of the course and other residents in the surrounding community. Beyond Pesticides is always available to assist individuals with their efforts. Reach out to *info@beyondpesticides.org* or 202-543-5450.

Saving Water with Natural Land Care?

I've heard that natural land care saves water. As a California resident, I'd like to do that with my yard. Is there science that backs this up—what exactly do I need to do?

Diana, Sacramento, CA

Hi Diana,

Great to hear that you are working toward water savings in your backyard. Luckily, improving the water retention capacity of soils is not tough, and there is ample evidence that doing so will result in water savings that will translate to a lower water bill. All that is required is the consistent building of organic matter in your soil. Studies find that for every one percent of organic matter content added to soil, it can hold an additional 16,500 gallons of plant-available water per acre. At the landscape level, for every one percent of organic matter added, each cubic foot of soil will be able to hold an additional 1.5 quarts of water.

One great way to add organic matter to your yard's soil is through the use of compost topdressings, particularly on areas where you are growing turf. Adding roughly a quarter inch of compost in the fall will help ramp up organic matter in the landscape. It is also an important part of fostering an overall organic system. In addition to improving the soil's moisture retention, it also helps improve soil pore space and aggregation (arrangement of soil particles), making sure soil does not compact and water gets to plant roots. It also helps feed the microorganisms in your soil, which creates a positive feedback effect. More organic matter leads to higher rates of biological activity in the soil, as more and more microorganisms are able to find food, water, and shelter. These microorganisms then die and degrade back into the soil, further improving organic matter content.

To increase the sustainability profile of your home even more, source as much compost as you can create on site from kitchen scraps, yard waste, and other "brown" and "green" organic matter. See Beyond Pesticides' composting guide for assistance [*bp-dc.org/compost*]. Another great way to improve organic matter, and therefore water retention of soils is by adding green manures, which are plants that are cultivated to cover bare areas of the garden and deliver nutrients to the soil. Also called cover crops, these include plants such as clover, rye, and buckwheat. Let these grow for a couple months, and mow or lightly till them into the soil to add organic matter. That's a particularly helpful strategy for gardens and raised beds that may be fallow during certain times of the year. Around other areas, such as trees and shrubs, maintaining a thick layer of mulch will ensure you are adding organic matter and continuing to improve the soil's ability to hold water.

FROM THE WEB

Beyond Pesticides' Daily News Blog features a post each weekday on the health and environmental hazards of pesticides, pesticide regulation and policy, pesticide alternatives, and cutting-edge science, www.beyondpesticides.org/dailynewsblog. Want to get in on the conversation? "Like" us on Facebook, www.facebook.com/beyondpesticides, or send us a "tweet" on Twitter, @bpncamp!

Excerpt from Beyond Pesticides Daily News Blog article (12/7/2018): Release of GE Mosquitoes Canceled by Cayman Islands Officials. The British Cayman Islands will no longer fund the release of genetically engineered (GE) mosquitoes, as reports indicate that the program failed to achieve its intended goals.
John Norris, MD comments: Enjoyed the article. I would add physicians in the Florida Keys have petitioned for culturing of the to-be-released antibiotic dependent GE insects due to the concern that the tetracycline process could produce seriously antibiotic resistant bacteria and spread these bacteria to our patients' homes and businesses. This could be especially dangerous to our patients with weak immunity, such as diabetics, asthmatics, the very young, the very old, HIV patients, COPD patients, chemo patients, and so many more. The physicians want culturing of the insects to identify their microbiome and incorporation of the information into any release.

Excerpt from Beyond Pesticides Action of the Week (12/8/2018): Tell USDA All Ingredients Used in Organic Must Be Reviewed. The ingredients not listed on a pesticide product are not fully reviewed for their adverse effects and may be the most toxic chemicals in the formulation.
Sandra comments: Organic should mean organic. All ingredients need to be tested and monitored to assure compliance. Don't cut corners. This is America's food for our children.
Kathleen comments: Years ago, a family friend who was an agricultural researcher with the University of California Extension Service (called himself a "weed man") insisted to me that Roundup was perfectly safe. Now we know it is anything but safe. Other products the "experts" have told us are safe deserve the scrutiny that finally exposed the dangers of Roundup.

USDA GE Food Labeling Criticized as Confusing

In December, the U.S. Department of Agriculture (USDA) finalized its rule on genetically engineered (GE) food ingredient labeling. After years of local, state, and federal pressure to implement a clear, concise labeling requirement for GE foods, advocates say USDA's rule is a failure and a capitulation to agrichemical corporations that promote GE farming.U.S. Representative Chellie Pingree (D-ME) told the *Portland Press Herald* that the new rule is "an insult to consumers." She said, "These labels should give people the facts on whether ingredients in their food have been genetically altered, plain and simple." The standards are being adopted under the 2016 *National Bioengineered Food Disclosure Standard* (Public Law 114–216), a controversial law that was widely criticized as too weak, while preempting stronger state law. Products will display a label graphic of a sunny farmscape with the term "bioengineered" or "derived from bioengineering," language not widely understood by consumers.

USDA narrowly defines the ingredients subject to GE disclosure. When a food product has multiple ingredients, but the first listed is either meat, poultry, eggs, broth, stock, or water, any additional ingredients that may be GE are not subject to labeling. Consumers will have no way of knowing that they are buying food with GE ingredients. Further, "refined" GE ingredients (such as oil from GE soybeans, or candy bars with high fructose corn syrup from GE corn) will not be labeled as long as the refining process is "validated" by USDA. Advocates point to food certified and labeled organic as the solution, since GE is prohibited in organic production.

Senate Bill to Ban Chlorpyrifos Introduced

In the closing days of the 115th Congress, U.S. Senator Brian Schatz (D-Hawai'i) introduced a bill to ban the neurotoxic insecticide chlorpyrifos, shown to cause brain effects in children. The *Prohibit Chlorpyrifos Poisoning Students Act* (S.3764) would elevate Hawai'i's state ban to the national level, banning the use of the chemical near (300 foot buffer) schools in 2019 and banning its sale and distribution altogether the following year. The legislation follows a 2017 bill introduced by Senator Tom Udall (D-NM), *Protect Children, Farmers and Farmworkers from Nerve Agent Pesticides Act*, S. 1624, that deems any food with chlorpyrifos residues to be adulterated and therefore illegal. H.R. 3380, *Pesticide Protection Act*, introduced in 2017 and reintroduced in January by U.S. Representative Nydia Velasquez (D-NY), bans the registration and use of chlorpyrifos. EPA reversed a decision to ban the chemical's ongoing agricultural uses in 2017, after banning residential uses (except use on golf courses and for disease carrying mosquitoes) in 2000.

In June, 2018, Hawai'i became the first state to ban chlorpyrifos, effective 2022. Two months after the bill became law, the U.S. 9th Circuit Court of Appeals ordered the Environmental Protection Agency (EPA) to implement its previous proposed ban of the chemical in the U.S. EPA has appealed the ruling. A 2016 revised EPA human health risk assess-ment found that the agency's exposure threshold is exceeded for children, citing concerns about levels in the air at schools, homes, and communities in agricultural areas.

Rally in Hawai'i that pushed for the successful statewide ban on chlorpyrifos in 2018.

Multiple Pesticide Residues in Soil Raise Alarm

A study published in the November issue of *Science of the Total Environment* reveals numerous pesticide residues persisting in soil, harming the viability of agricultural lands, and increasing risk of off-site contamination. Funded by the Horizon 2020 programme of the European Commission, researchers from the European Diverfarming project at the University of Wageningen in the Netherlands suggest nations urgently reevaluate conventional land use and inputs, including water, energy, fertilizers, machinery, and pesticides.

The study objective: Determine which pesticides have the highest soil persistence and toxicity to nontarget species. Three hundred seventeen surface soil samples were analyzed from 11 European countries with the largest amounts of active agricultural land, including six distinct cropping systems, different soil properties, and crops with the highest pesticide use per hectare. Samples were then analyzed for 76 pesticides, which are most often applied on conventional crops. Eighty-three percent of samples contained varying degrees of pesticide residues, with 25% showing one pesticide residue, and 58% showing mixtures of two or more, and 17% with no detections.

Overall, 43 different residues were detected, with a total of 166 pesticide combinations. Glyphosate (the most widely detected), DDT (which was banned in 1972), and broad-spectrum fungicides, including boscalid, epoxiconazole, and tebuconazole, were the compounds detected most frequently and at the highest concentrations.

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Advocates say similar data revealing pesticide persistence demands improved short- and long-term environmental hazard analyses. Researchers indicate that risk assessments must be adapted to assess toxicity of mixtures of pesticide residues to a wide range of soil microorganisms, and for a range of environmental effects, from airborne pesticide residues and runoff into aquatic ecosystems.

Soil contamination alters microbial organism functions, soil biodiversity, and food safety. Meanwhile, organic agriculture specifically incorporates soil health management, cover crops, and crop rotations to enhance natural ecosystem processes.

EPA Continues to Defer to Chemical Industry

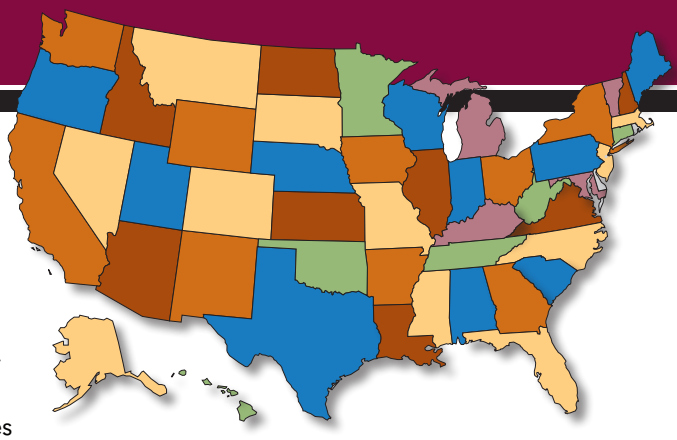
EPA ignored the input of an expert weed scientist on the controversial herbicide dicamba, bending to Bayer (Monsanto) and the pesticide industry, according to emails obtained by the *Arkansas Democrat and Chronicle* (ADC) through a Freedom of Information Act request. The scandal centers on the recent re-approval of the pesticide, a highly volatile, and drift-prone herbicide that has caused serious crop damage for many farmers. States, like Arkansas, are stepping in to restrict dicamba use in the absence of adequate federal action.

Emails that ADC received indicate that Jason Norsworthy, PhD, a weed scientist with the University of Arkansas, worked closely with Bayer (Monsanto) in conducting field trials and found high volatility and drift of the company's new dicamba-based herbicide, XtendiMax. The product was developed in the face of widespread resistance to glyphosate-based herbicides in genetically engineered (GE) farm fields.

Rather than respond to study results showing the need for a buffer of over 400 feet, and agreed upon by agency officials, Acting EPA Administrator Andrew Wheeler is ignoring adverse impacts to farmers and nontarget species, deferring to Bayer and setting the buffer at 57 feet. This decision raises questions of meddling with EPA's scientific process (similar to a 2017 decision to reverse its ban of the highly neurotoxic insecticide chlorpyrifos) and a litany of structural problems within the pesticide registration process: mixtures and synergy not tested, inert ingredients not disclosed, safety studies generated by industry, and conditionally registering pesticides, like XtendiMax, without required health and environmental safety information.

Petition Seeks to Prohibit Fracking Water in Organic

Following an outpouring of public comments to the National Organic Standards Board (NOSB) over several years, The Cornucopia Institute, in November, filed a petition seeking to prohibit the use of oil and gas wastewater in organic production. The petition calls for rulemaking to establish the wastewater as a prohibited substance. Organic consumers expect that the organic products they buy are grown without toxic chemical inputs. However, oil and gas wastewater (including fracking wastewater) can be used to irrigate crops. Chemicals present in the wastewater include heavy metals, antimicrobials, and other chemicals with carcinogenic, reproductive, developmental, endocrine disrupting, and a range of other toxic effects. When the *Organic Foods Production Act* (OFPA) was passed, there was no agricultural use of oil and gas wastewater, so the regulations did not address their hazards.



Blackberry Leaves Decompose to Thwart Mosquito Breeding

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A study at the University of Maine (UMaine) finds that adding blackberry leaf litter in stormwater catch basins creates an "ecological trap," enticing mosquito females to lay eggs in sites unsuitable for larvae survival. Stormwater catch basins regularly accumulate leaf litter, which serve as habitat for the mosquito species Culex pipiens (*Cx. Pipiens*). Previous UMaine research found that decomposing leaf litter from Amur honeysuckle (*Lonicera maackii*) and common blackberry (*Rubus allegheniensis*) produces chemical compounds that attract and stimulate *Cx. Pipiens* female to oviposit, or lay eggs. Results show that catch basins with blackberry leaves have consistently higher numbers of *Cx. pipiens* eggs, but very low larvae survival. Honeysuckle, however, shows high larvae survival and high adult emergence, but reduced larvae survival with a 50-50 mixture of honeysuckle and blackberry.

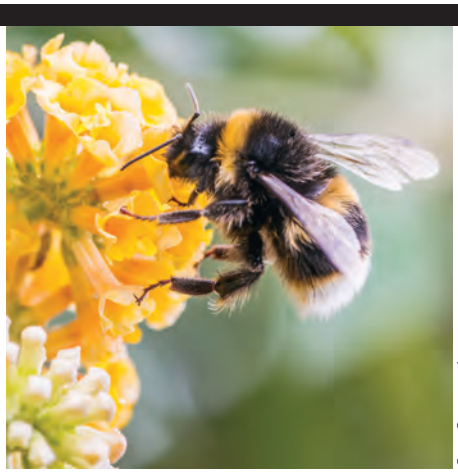
The study, *Discovery and exploitation of a natural ecological trap for a mosquito disease vector,* confirms that survival of mosquito larvae, being filter-feeding invertebrates, is dependent mainly on the aquatic habitat containing the appropriate bacterial community to suit the larvae's nutritional needs. *Cx. pipiens* females select oviposition sites based solely on the presence of decomposing leaf litter, regardless of whether the appropriate bacterial community may be lacking.

U.S. Asks World Trade Organization to Force Lower International Safety Standards

The U.S. is pushing back against international standards that restrict pesticides by asking the World Trade Organization (WTO) to intervene. At issue are new EU maximum residue levels (MRLs) on food for the following pesticides: buprofezin, diflubenzuron, ethoxysulfurom, ioxynil, molinate, picoxystrobin and tepraloxydim.

Advocates are concerned that a U.S. challenge to stronger EU standards, or special trade concerns (STC), could cause WTO to force a weakening of standards internationally. Most significantly, the EU proposed lowering its MRLs on imports. The EU said lower MRLs are needed to protect consumers. In response, the U.S. said new MRLs would cause barriers to trade and, therefore, must be rejected by WTO. Advocates point to the introduction of genetically modified organisms (GMOs) as an example of the U.S. attempting to use WTO to block standards that restrict potentially hazardous products. Recently, the U.S. has been involved in four of five new specific trade concerns raised before WTO. As part of reviewing the current agreement of the Committee on Sanitary and Phytosanitary Measures—which works to ensure protections for humans, animals, and plants, while avoiding barriers to trade—one STC the U.S. dislikes is the Vietnamese National Assembly's Livestock Production Law, which imposes an import ban on livestock products produced with the use of chemicals prohibited for domestic production in Vietnam.

The U.S. also expressed its dislike of an EU Court of Justice decision on "mutagenesis"—a process of inducing mutagenic changes—requiring that all organisms obtained through mutagenesis undergo the same risk assessment and review requirements, labeling, monitoring, and traceability laws as those imposed on GMOs. The EU has shown time and time again that it will enact stricter pesticide regulations than the U.S. In 2005, EU environment ministers agreed to uphold five national bans on GMOs. However, the U.S. once again claimed bans on GMO restrictions were barriers to trade and must not be honored. Advocates believe the latest move to block lower MRLs is an attempt by the U.S. to undermine other countries' decisions to protect their environment, human health, and social standards.



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Behavioral Effects in Bumblebees Linked to Neonicotinoid Insecticides

Harvard University researchers, publishing in the journal *Science,* have demonstrated the mechanisms by which neonicotinoid insecticides harm bumblebee populations. The study, *Neonicotinoid exposure disrupts bumblebee nest behavior, social networks, and thermoregulation,* finds that exposure to imidacloprid, a neonicotinoid—the most widely used category of insecticides worldwide—causes serious behavioral effects to the functioning and viability of bee colonies.

In the study, imidacloprid-exposed worker bees exhibit reduced general and nurturant activity, and a tendency to locate themselves at the periphery of the nest. The study notes decreased caretaking and nursing behaviors, which in turn harms productivity and thermal regulation in the colony. These tasks are important to colony development; impaired thermoregulation negatively affected the bees' typical construction of an insulating wax canopy for the nest, and poor caretaking can affect brood growth. Investigators note that, "These changes in behavior acted together to decrease colony viability, even when exposure was nonlethal." The authors also observed that many of these dysregulated behaviors are more pronounced at night than during sunlight hours, and are exhibited by queens, as well as workers. Prior to the subject study, neonicotinoids were

Endocrine Disrupting Herbicide, Atrazine, Exceeds Legal Drinking Water Limits in Midwest

Based on EPA reported data, "[N]early 30 million Americans in 28 states have some level of atrazine in their tap water," according to Environmental Working Group's updated Tap Water Database. EPA's annual drinking water quality reports reveal community drinking water systems in the Midwest that have seasonal exceedances of the allowable limit for the herbicide atrazine at three to seven times above the federal legal limit. Atrazine, linked to endocrine disruption, neuropathy, and cancer, is the second most widely used pesticide in corn growing areas, with over 73 million pounds applied to agricultural fields each year.

A 2009 study by Paul Winchester, MD, professor of clinical pediatrics at Indiana University School of Medicine and medical director of the Neonatal Intensive Care Unit at Franciscan Health in Indianapolis, linked birth defects to time of conception, with the greatest impact on children conceived when concentrations of atrazine and other pesticides are highest in the local drinking water. During peak use, atrazine levels in drinking water have been recorded at three to seven times above the legal limit. In addition to the well documented impact on the environment, recent studies have linked prolonged pesticide exposure to not only shortened gestation and preterm birth for women, but also neurodevelopment delays in children. Ultimately, these unreported seasonal peaks result in persistent adverse health impacts in affected communities.

Water utilities are familiar with persistent pollution from atrazine use. In 2012, water utilities settled a class action lawsuit against the manufacturer of atrazine, Syngenta, to clean up atrazine contamination of its treated water. Even at levels established as "safe" or acceptable by EPA drinking water standards, atrazine is linked to endocrine disrupting effects.

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understood to reduce growth in developing bee broods by impairing adults' foraging abilities—related to both spatial navigation and so-called "floral learning" (acquiring and remembering how best to secure nectar from a variety of flowers of varying structural complexity).

Neonicotinoids are used frequently as seed coatings, as well as on a great number of agricultural crops. They are systemic pesticides that are taken up by plants and transported to leaves, flowers, roots, and stems, as well as to pollen and nectar; pollinators are at great risk of exposure to these compounds through their foraging activities. These pesticides also contaminate waterways and are highly toxic to aquatic organisms.

DDT in Glacial Melt Puts Alaskan Communities at Risk

With climate change, meltwater and runoff from Alaskan glaciers are showing detectable levels of organochlorine pesticides that bioconcentrate in fish and put people at risk, according to researchers at the University of Maine (UMaine). DDT, lindane, and other organochlorines have been detected throughout the world, even in natural areas thought to be untouched and pristine. UMaine scientists, in *Organochlorine Pollutants within a Polythermal Glacier in the Interior Eastern Alaska Range* (published in the journal *Water*), show that the atmospheric transport and ubiquitous deposition of these pesticides continue to pose risks to U.S. residents long after regulations banned their use.

Although most of the highly toxic class of organochlorine pesticides, like DDT, were banned in the early 1970s, certain uses were retained. Lindane, for example, had its pest management uses phased out gradually until 2007, but is still allowed today as a scabies and lice shampoo. While use of these pesticides has declined in the U.S., much of the

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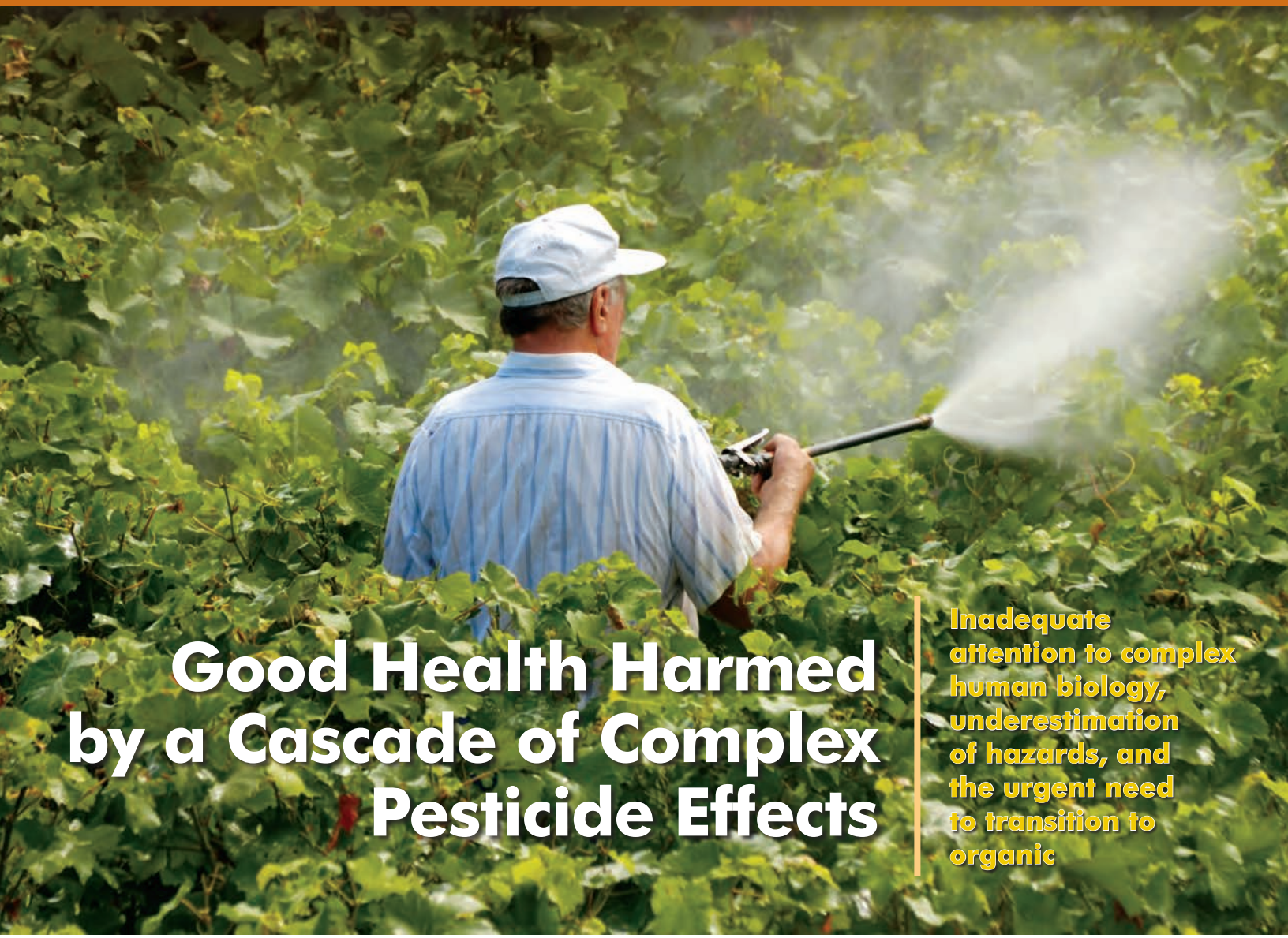
developing world, including many Asian countries, such as China, India, and North Korea, still report use. This results in atmospheric transport of the pesticides and, relevant to the UMaine research, increases the likelihood that the chemicals will eventually be deposited onto Alaskan glaciers through snow or rain. The UMaine research team investigated the amount of DDT and lindane historically and recently deposited into the Jarvis Glacier, located in Eastern Alaska, northwest of Juneau.

Researchers analyzed glacial meltwater and ice core samples down to the bedrock. Results found that ice core samples taken between 20 and 45 feet contain the highest concentrations of organochlorines, with concentrations decreasing closer to bedrock. Meltwater generally contains slightly higher levels of pesticides than any ice core samples taken. Although concentrations detected are low and none exceeded 1.12 ng/L (nanogram/liter), researchers indicate that the risk is not direct exposure, but the bioconcentration of these chemicals up the food chain.

Study coauthor Kimberly Miner, PhD, indicates that even with low levels of organochlorines, both adults and children who regularly consume fish from contaminated streams are at increased risk of cancer, as their consumption levels are likely to exceed EPA thresholds. She indicates that children are particularly vulnerable and, as climate change accelerates the rate of melting, these concerns are only likely to intensify. "This secondary impact of climate change will be felt most strongly by children, and needs to be addressed in a comprehensive way," Dr. Miner said. Organochlorine contamination not only puts individuals at health risk, it jeopardizes the traditions and subsistence way of life for many Alaskan native peoples, necessitating significant investment in culturally appropriate solutions.

California Criticized for Adopting Inadequate Measures to Restrict Chlorpyrifos

In mid-November, the state whose agricultural operations used more than 900,000 pounds of chlorpyrifos in 2016 (down from two million pounds in 2005) moved to establish some temporary restrictions on its use. Regulators at the California Department of Pesticide Regulation (CDPR) issued interim restrictions on the compound while the agency works on a formal regulatory process to list chlorpyrifos as a "toxic air contaminant" and develop permanent restrictions on its use. The interim measures in California include: banning aerial application of chlorpyrifos; ending its use on many crops—except for those determined to be "critical" by virtue of there being few, if any, alternatives (as determined by the University of California Cooperative Extension and listed on CDPR's website); establishing a quarter-mile buffer zone for 24 hours after any application of the pesticide; and requiring a 24/7/365, 150-foot application setback from houses, businesses, schools, and other sensitive sites. CDPR, it should be noted, is *recommending,* rather than *requiring,* implementation of the temporary restrictions beginning January 1, 2019. Groups seeking a ban of chlorpyrifos use have called the measures wholly inadequate, given the settled science on the pesticide's adverse effects on children's brains.



Good Health Harmed by a Cascade of Complex Pesticide Effects

Inadequate attention to complex human biology, underestimation of hazards, and the urgent need to transition to organic

EDITOR'S NOTE: This article sets forth an approach to evaluating the health impacts of pesticides within the human body's ecosystem, with all its compexities. Consideration must be given to a broad range of effects in a holistic assessment for maintaining and enhancing good health. The current regulatory review and underlying standards governing the U.S. Environmental Protection Agency's allowance, or registration, of pesticide products used in agriculture, communities, homes, and gardens adopts a narrow, and therefore unrealistic, approach to the determination of safety thresholds for exposure—putting the public at risk for widespread diseases, from cancer to respiratory illness, Parkinson's, diabetes, reproductive problems, and learning disabilities, including autism. The approach called for in this piece builds on an earlier article in *Pesticides and You, Thinking Holistically When Making Land Management Decisions: Regulatory analyses that support pesticide use ignore complex ecological impacts*, which focuses on ecological impacts of chemical-intensive practices. (See *PAY*, 38:1, 2018.) Both assessments, ecological and human health, evaluate the dominant chemical-intensive approach to land management in the context of commercially available organic and sustainable approaches that eliminate pesticide exposure. In considering this approach, the question is whether it is reasonable for regulations to allow toxic pesticide use when nontoxic alternatives are available and economically viable. The need for a more realistic assessment of pesticides' impact on human health is being advanced at time when the urgency for the transition away for toxic chemical use has never been greater to ensure long-term human survival.

TERRY SHISTAR, PHD

Human health depends on the proper functioning of interacting parts of the body. Weakening the body increases and/or changes the effect of toxic substance exposures. These impacts are not easily captured in current health risk assessments used by regulators because they may result from interactions among pesticides and cumulative impacts of single or multiple stressors. In order to assess the reasonableness of toxic chemical exposures associated with chemical-intensive agriculture and land management, it is necessary to evaluate the effects of that entire management system and compare its effects with those of organic management systems that eliminate toxic chemical exposures.

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PART ONE

Holistic Assessment of Health Effects

THE CONTEXT OF PESTICIDE USE

When determining the acceptability of pesticide use from a human health perspective, two issues emerge as particularly inadequate in the regulatory assessment: (i) the dramatic deficiency of evaluations that ignore the complex biological systems and exposure realities that must be considered to ensure good health, and (ii) the failure to consider the availability of less or nontoxic management systems for achieving pest management goals. The legal standard for registering a pesticide in the U.S. under the *Federal Insecticide, Fungicide and Rodenticide Act* (FIFRA) requires a determination of "no unreasonable adverse effects, taking into account the risks and benefits of pesticide use." However, the chemical-by-chemical approach used by the U.S. Environmental Protection Agency (EPA) to assess the acceptability of a pesticide's hazards and its assumed benefits to society or pesticide users belies the critical scientific need to assess pesticide use in a broader context of both exposure and pest management and prevention. Key to an adequate assessment is always the question of whether there is an alternative to using the chemical that does not involve merely substituting a different chemical into the same management system. To perform an accurate evaluation of the hazards of using a pesticide, it must be considered in the context of the chemical-intensive management system in which it is judged to be needed or essential—and the pesticide *in that system* must be compared to a system in which the pesticide is not used because it is unnecessary.

DETERMINING HUMAN HEALTH HAZARDS FROM PESTICIDES

Human health depends on many factors that may or may not be under the control of the individual. External threats to health go beyond toxicity to factors that affect the environment in which people live, the functioning of the body, and the importance of uncontaminated air, water, and food in supporting life. Thus, it is important to consider factors like human nutrition, gut microbiology, and the endocrine system, in addition to, and in conjunction with, the toxicity of pesticides.

IMPROVING THE STANDARD FOR MEASURING HEALTH EFFECTS OF PESTICIDES

Distinct from risk assessments undertaken by EPA, which measure risks of individual chemicals (see Box 1), a holistic health assessment approach is needed that evaluates individual chemical hazards in combination with the impacts of a chemical-intensive land management system, contrasted with a regenerative organic systems approach and an uncontaminated environment. With this method, regenerative organic agriculture and land management is understood to be a valid baseline because it is based on natural ecological systems and seeks to restore soil health, sequester carbon, improve animal welfare, and provide economic stability, fairness, and health protection for farmers, ranchers, and farmworkers.

A HOLISTIC LOOK AT HEALTH EFFECTS OF PESTICIDES

Health effects need to be evaluated in the context in which they occur—and the co-occurring threats presented by other aspects of chemical-intensive land management and pest management. The reasonableness of these impacts must be considered in the context of viable organic systems and least-toxic management systems. Compared to this approach, EPA's risk assessment is a one-dimensional view of a multi-dimensional system, in which the outcome is a single reference dose or cancer risk number.

Just as the needs of human biology are complex, so are the patterns of exposures to pesticides and other toxic chemicals. People are rarely exposed to just one chemical—they may be exposed to several chemicals at the same time, one or more chemicals sequentially, or inherit a transgenerational effect. In addition, timing of exposure can be very important, as well, as is the case with minute doses of endocrine disrupting pesticides.

EPA's risk assessment mostly ignores multiple chemical exposures. The exception is the cumulative assessment mandated by the *Food Quality Protection Act* (FQPA) (see Box 2) of chemicals with a "common mechanism of toxicity." However, to address more broadly the basic requirements for good health, a holistic evaluation looks at the many ways in which varied pesticide exposures interact and interfere with the normal and healthy functioning of the human body. To do this, the evaluation considers a range of exposures discussed below.

Clean Air. Key to the human need to breathe air is the oxygen that is required for cellular respiration—to break down food used for energy—and the exhaling of the waste

BOX 1

EPA's Health Risk Assessment

Toxicity tests required for EPA pesticide registration are performed on laboratory animals and assessed in relation to a number of standardized endpoints. These endpoints may or may not correspond directly to effects seen as a result of actual human exposure.

EFFECTS OF ACUTE EXPOSURE TO PESTICIDES

"Acute toxicity" refers to the effects of a single exposure to the chemical. EPA requires chemical manufacturers, or registrants, to submit results of tests of acute toxicity through oral, dermal, and inhalation routes of exposure; primary eye irritation; primary dermal irritation; and dermal sensitization. All of these tests must be performed, under the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA), using both the technical grade active ingredient and the end-use product that people buy and use (which includes "inert"—not disclosed to the public—ingredients). In addition, acute neurotoxicity and delayed neurotoxicity tests are required for the active (that part of the formulation that the manufacturer claims attacks the target pest) ingredient only.

EPA uses the acute toxicity tests to set an acute reference dose (aRfD), which is the highest dose at which no adverse effect is found in the animal testing (also known as the no-observed-adverse-effect-level or NOAEL) divided by safety factors that EPA deems appropriate. The aRfD is used in establishing requirements for personal protective equipment (PPE) for applicators, reentry periods for farmworkers (time before returning to treated fields), classification as general or restricted use, and application rates. The data is also used to set allowable residues in food (tolerances) under federal food law.

CHRONIC EFFECTS OF EXPOSURE TO PESTICIDES

Chronic effects may be persistent effects that linger after acute exposure to pesticides, or they may result from chronic, low-level exposure over time. Chronic, low-level exposures can result from food residues, environmental contaminants, repeated use of home and garden products, or a body burden of persistent chemicals. EPA chronic risk assessments measure the impacts of repeated doses of chemicals over the lifetime of an experimental animal.

EPA's cancer risk assessment contains four steps: hazard identification, dose-response estimation, exposure evaluation, and risk characterization. In hazard identification, human data, animal data, and supporting evidence are combined to characterize the weight-of-evidence regarding the agent's potential as a human carcinogen. The current guidelines, as finalized in 2005, assign categories separately for the oral and inhalation routes: Carcinogenic to Humans, Likely to be Carcinogenic to Humans, Suggestive Evidence of Carcinogenic Potential, Inadequate Information to Assess Carcinogenic Potential, and Not Likely to be Carcinogenic to Humans. Dose-response estimation uses data from animal studies to develop a mathematical relationship between the dose and the likelihood of developing cancer. Exposure assessment assumes the amount of chemical to which a person will be exposed—with a high degree of uncertainty and without any thought to pre-existing medical conditions, genetic predisposition, exposure history (including workplace exposure), community exposure from toxic waste sites, and unique diets. Risk characterization combines the results of the earlier steps into a statement of risk.

All experiments on chronic effects used in pesticide registration decisions are performed on the technical active ingredient, not the product, including so-called "inert" ingredients. EPA also requires some intermediate-length subchronic tests. Of those, only the dermal tests must be performed on the end-use product as well as the active ingredient.

product carbon dioxide created in cellular respiration. The unimpeded exchange of gases requires healthy lungs. Polluted air can carry fine particles deep into the lungs and prevent efficient breathing.

Chemical fertilizers are used in chemical-intensive land management and animal agriculture, resulting in fine particulate pollution (nitrate and ammonia) that is carried deep into the lungs. Fine particulates have been identified as the most dangerous particles because they penetrate most deeply, affecting gas exchange within the lungs.

Asthma. Asthma is a leading chronic childhood disease—a serious inflammatory disease characterized by recurrent breathlessness, coughing, chest tightness, shortness of breath, and wheezing. It is the third leading cause of hospitalization among children under the age of 15 years, leading to an annual cost of treatment of $27 billion—and the incidence continues to increase. Experts agree that causation involves the interplay of different factors. "[A]t the exposure to relatively low concentration levels of air pollution, synergism of the inhaled pollutants is one of the basic phenomena and absolutely cannot be ignored," according to researcher and author Jozef Pastuszka, PhD (2015).

The linkages between pesticide exposure and asthma have been investigated by mechanistic, toxicological, and epidemiological studies. Some pesticides appear to be allergic sensitizing agents. Others are associated with airway hyperreactivity, oxidative stress, and immunological sensitization. Some epidemiological studies have found an association between organophosphate pesticides and asthma. These studies have all, to the extent possible, addressed pesticide exposure in isolation from other possible causes. However, agricultural pesticide use occurs within a system in which other factors associated with asthma are also present.

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Health effects need to be evaluated in the context in which they occur—and the co-occurring threats presented by other aspects of chemical-intensive land management and pest management.

There is an established association between obesity and asthma. While obesity increases the incidence of asthma, the class of endocrine disruptors known as obesogens—chemicals that increase fat mass in a living animal—includes a number of pesticides.

Clean Water. Water is the most essential human nutrient. It is recommended that an adult male consumes at least 12 cups of non-alcoholic, non-caffeinated fluids per day (9 cups for a female) to maintain a healthy level of hydration. Although much of that liquid is consumed in forms other than pure water, consumption of water that is contaminated with toxic chemicals is counterproductive because water is the medium for the safe elimination of toxins and waste products.

Pesticides and fertilizers are detected in the nation's drinking water resources—both surface water and groundwater. The U.S. Geological Survey (USGS) found pesticides in 97% of streams in urban and agricultural areas. Pesticides are detected in 61% of groundwater samples from agricultural areas and 55% of samples from urban areas. Samples from areas of mixed land uses or undeveloped areas are contaminated less frequently, but the majority of surface water samples from every land use pattern are contaminated. A significant number of the streams in agricultural and urban areas (9.6% and 6.7%, respectively) contain pesticides above human health benchmarks.

Related drinking water resources are contaminated by fertilizers. USGS found, "Concentrations of all five nutrients—nitrate, ammonia, total nitrogen, orthophosphate, and total phosphorus—exceed background levels at more than 90 percent of 190 streams draining agricultural and urban watersheds. Nitrate concentrations exceeded background levels in 64 percent of 86 shallow aquifer studies sampled in agricultural and urban areas." USGS also found that the maximum contaminant level (MCL) is exceeded in nearly 30% of agricultural streams, 7% of urban streams, 7% of domestic wells, 3% of public water supply wells, and 57% of all major aquifers.

Whether or not an individual pesticide or fertilizer exceeds the health-based standard is not as important as it could be because the standard is not based on exposure to multiple

chemicals. USGS found that almost all urban and agricultural stream samples contain two or more pesticides—two or more pesticide compounds more than 90% of the time, and 10 or more compounds about 20% of the time. Similarly, the vast majority of wells in which pesticides are detected contain two or more pesticide chemicals. Fertilizer chemicals are also present in surface water and groundwater where pesticides are found.

A more recent USGS study of 100 Midwestern streams detected complex mixtures of pesticides and degradation products—a total of 94 pesticides and 89 degradation products, with a median of 25 chemicals per sample and 54 per site.

The toxicology community is taking note of the fact that mixtures of toxic chemicals often have serious effects at doses considered "safe" based on traditional toxicity testing. The new editor-in-chief of *Toxicology Reports,* for example, says he "has a special interest in low-dose, long-term effects from combined exposures." Of relevance to assessing the health impacts of pesticides are non-monotonic responses to low-dose mixtures of pesticides, pesticide products that exhibit different toxicological effects from their individual or combined active ingredients, synergistic effects of pesticides and heavy metals, synergistic and novel effects on the endocrine system, immunity, and behavior from multiple pesticide/fertilizer exposures at levels found in surface water and groundwater. Jaeger et al. (1999) point out six ways that testing of pesticides is deficient:

From: Rosi-Marshall EJ , et al. (2007). "Toxins in transgenic crop byproducts may affect headwater stream ecosystems." Proc Natl Acad Sci USA 104:16204–16208. © 2007 National Academy of Sciences, U.S.A.

1. Pulse doses (elevated levels during certain periods) at low concentrations are not considered;
2. Simultaneous exposure through multiple routes is not considered, and surfactants that increase entry through skin and other membranes are not included;
3. Immune, endocrine, nervous system, and developmental endpoints are not considered;
4. Contaminants, additives, and "inert" ingredients are excluded;
5. Commonly occurring mixtures are not tested; and
6. Naturally occurring stresses (such as nutrition, disease, and climate) are excluded.

BOX 2

Common Mechanism of Toxicity

The *Food Quality Protection Act* (FQPA) of 1996 requires that EPA base its assessment of the risk posed by a pesticide chemical on aggregate (i.e., total dietary, residential, and other non-occupational) exposure to the pesticide and available information concerning the cumulative effects to human health that may result from non-occupational exposure to other substances that have a "common mechanism of toxicity." EPA explains, "A person exposed to a pesticide at a level that is considered safe may in fact experience harm if that person is also exposed to other substances that cause a common toxic effect by a mechanism common with that of the subject pesticide, even if the individual exposure levels to the other substances are also considered safe."

EPA has applied the concept of "common mechanism of toxicity" very narrowly, to "two or more pesticide chemicals or other substances that cause a common toxic effect to human health by the same, or essentially the same, sequence of major biochemical events." It has identified five groups, or chemical families, that are assessed as having a common mechanism of toxicity: organophosphates, N-methyl carbamates, triazines, chloroacetanilides, and pyrethrins/pyrethroids.

The restriction of aggregate and cumulative assessments to those materials having a "common mechanism of toxicity" is another example of the one-dimensional view in EPA's risk assessment. From the perspective of the whole body, exposure to chemicals with varied mechanisms of toxicity may be much more hazardous. For example, an exposure to a substance that targets detoxification organs (e.g., liver) or the immune system sets the stage for much greater impacts from other toxic and pathogenic materials. In addition, synergistic effects (where the effect of two chemical exposures together is greater than each individual exposure alone) associated with chemical mixtures are not evaluated.

PART TWO

Organic Supports Healthy Management Systems

CLEAN DRINKING WATER

Organic practices reduce or eliminate pesticide runoff. Organic farming and land management reduce or eliminate water pollution and help conserve water and soil. According to the Food and Agriculture Organization (FAO), several countries in Europe compel or subsidize organic farmers to use organic techniques specifically to combat water pollution problems.

Organic production reduces nutrient runoff. Organic standards stipulate that soil fertility and crop nutrients can be managed through tillage and other cultivation practices, such as crop rotation, which preserve and maintain the fertility of the soil so that synthetic inputs become unnecessary. Organic therefore eliminates the need for and use of synthetic nitrogen/phosphorus-based fertilizers. Organic standards require that manure be managed in a way that avoids nutrient pollution of water. Thus, organic practices significantly reduce the threats that nitrogen and phosphorus runoff pose to aquatic ecosystems and drinking water sources.

Organic standards prohibit the use of sewage sludge/biosolids. Sewage sludge, which is often contaminated with a host of chemicals, including heavy metals, pharmaceuticals, and pesticides, is not allowed in organic production. These can all reenter the aquatic environment once the sludge is recycled on land.

Genetic engineering (GE) is prohibited. Genetic engineering that incorporates the popular herbicide-tolerant, Roundup Ready corn and soybeans, or insecticidal genes into plants, is prohibited in organic management. GE crops have led to a dramatic increase in herbicide use, as farmers are able to apply these chemicals without killing their crop. Weed and insect resistance develop in response to GE methods, ultimately leading to increased use of herbicides and insecticides.

FREEDOM FROM CANCER

Eliminating the use of cancer causing pesticides is important to fighting a disease that is debilitating to both patients and their families. Cancer, like other diseases caused by environmental contaminants, places a huge personal and financial strain on sufferers. The National Cancer Institute says, "In 2018, an estimated 1,735,350 new cases of cancer will be diagnosed in the United States and 609,640 people will die from the disease." The number of cancers continues to increase, especially among children.

The link between pesticides and cancer has long been a concern. In addition to agriculture-related cancers from pesticides, 19 of 30 commonly used lawn pesticides and 28 of 40 commonly used school pesticides are linked to cancer. Even with the growing body of evidence linking environmental exposures to cancer in recent years, a 2010 report by the President's Cancer Panel finds that the true burden of environmentally-induced cancer is greatly underestimated. The Panel's report, *Reducing Environmental Cancer Risk: What We Can Do Now,* concludes that while environmental exposure is not a new front on the war on cancer, the grievous harm from carcinogenic chemical use has not been addressed adequately by the nation's cancer program. As of this writing, the Beyond Pesticides Pesticide-Induced Diseases Database contains 430 epidemiological studies linking pesticides to 31 types of cancer. Many of these studies involve more than one pesticide,

emphasizing the message that the pesticide-dependent agricultural system must be considered as a whole.

The controversy over glyphosate makes another point. The World Health Organization's International Agency for Research on Cancer (IARC) finds sufficient evidence of carcinogenicity in experimental organisms to classify glyphosate as "probably carcinogenic to humans," while EPA concludes that glyphosate is "not likely to be carcinogenic to humans." The main difference between the IARC and EPA findings (and others, including EFSA (the European Food Safety Authority), is that IARC considers glyphosate-based formulations in its assessment, whereas EPA does not. Glyphosate is never used alone in any pesticide product, but is always formulated with "other" or "inert" ingredients (co-formulants). It is notable that in EPA's ecological assessment for glyphosate the agency highlights the differences in toxicity to nontarget organisms between glyphosate and its formulated products, and determined that formulated glyphosate products are more toxic than the active ingredient alone. EPA states, "[T]he ecological effects of the pesticide-surfactant combination may differ from that of the single pesticide or the single surfactant," and, "One class of surfactants used in glyphosate formulations are the polyethoxylated tallow amines (POEA) and this class has been shown to be more toxic to aquatic animals than glyphosate alone." In evaluating the potential risk to nontarget organisms, the agency states it estimated exposure risks from (1) glyphosate only, (2) glyphosate formulations, and (3) surfactant only (POEA). However, this same due diligence was not afforded to the human health assessment—even though formulated glyphosate products are known to be more toxic to human cells than glyphosate alone.

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NUTRITIOUS FOOD

Because nutrition is essential to good health, it is of note, that in addition to lacking the toxic residues of conventional foods, organic food is more nutritious. In particular, vegetables grown in a chemical-intensive system are higher in nitrates, pesticides, and cadmium, and lower in antioxidants; milk produced in a chemical-intensive system has a less desirable fatty acid composition, is lower in tocopherol and iron, and higher in iodine and selenium; and meat produced in a chemical-intensive system has a less desirable fatty acid composition.

Detoxification Pathways. Nutrients from food support detoxification pathways in the body. Nutrients that have been identified as important in detoxification include a wide variety of antioxidants, amino acids, vitamins, and minerals. Their deficiency leads to increased toxicity from drugs, carcinogens, allergens, and environmental pollutants. This may manifest itself as cancer, Parkinson's disease, fibromyalgia, and chronic fatigue/immune dysfunction syndrome. Consumers eating food grown in a chemical-intensive system require a healthy body to detoxify the resulting pesticide residues because the food produced in this system is deficient—in comparison to organic food—in certain key elements supporting detoxification, such as total antioxidant capacity, total polyphenols, quercetin, and kaempferol. This means that any assessment that does not take into account the total system will grossly underestimate pesticide risks.

Omega 3's. Studies have also shown that dairy products from organically raised animals are more beneficial than dairy products from chemical-intensive systems. One large-scale, nationwide study of fatty acids in U.S. organic and non-organic milk found that, averaged over 12 months, non-organic milk contains a 2.5-fold higher omega-6 (linked to higher blood pressure) to omega-3 (linked to improved cardiovascular health) ratio compared to organic milk. All individual omega-3 fatty acid concentrations are higher in organic milk—linolenic acid, eicosapentaenoic acid, and docosapentaenoic acid—as is the concentration of conjugated linoleic acid.

No Antibiotics. Animals raised organically are not given antibiotics and are required to be grazed on organically managed pastureland or fed organically grown feed. Antibiotics used in chemical-intensive animal production systems can exacerbate the problem of antibiotic resistance, which the Centers for Disease Control and Prevention (CDC) calls "one of the world's most pressing public health problems." Antibiotics used in agriculture contribute to antibiotic resistance not only through antibiotic residues on food, but also by antibiotics released into the environment. Perhaps most importantly, antibiotic resistant microorganisms proliferate in the environment—particularly waterways—where their genes for resistance can be passed on to pathogenic microorganisms.

Protecting Microbiota. A human being contains more cells in and on the body that belong to microbes—and contains more microbial DNA than that originating from human genes. In fact, only 10% of human cells are genetically human, and only 1% of the DNA in the human is "human." The 90% of human cells that are microbial in origin are not (mostly) pathogenic, nor are they (mostly) just along for the ride. They are (mostly) symbionts that help the body function as it should. The human body, rather than being a distinct organism, should be thought of as a biological community, or "superorganism," truly the product of coevolution.

In addition to interfering with digestion, exposure to antibiotics can disturb the microbiota, contributing to a whole host of "21st century diseases," including diabetes, obesity, food allergies, heart disease, antibiotic-resistant infections, cancer, asthma, autism, irritable bowel syndrome, multiple sclerosis, rheumatoid arthritis, celiac disease, inflammatory bowel disease, and more. Of particular interest in the current context, the human immune system is largely composed of microbiota.

Preventing Autism and 21st Century Diseases. Autism spectrum disorder (ASD) arises from a complex interaction between genetic and environmental factors. ASD severely affects social functioning and self-sufficiency. The dramatic rise in the incidence of ASD in recent decades points to the importance of environmental factors, and there is strong evidence for the role of pesticides in causing autism. In addition, nutrition and gut microbiota can play a role in both causing and managing ASD. Since chemical-intensive agriculture is implicated in a loss of nutrient density and dysbiosis of gut microbiota, the autism epidemic is strongly linked to the use of pesticides.

There are, therefore, other ways—in addition to toxicity—that pesticide use within the context of the chemical-intensive food production system, interferes with human health. It interferes with detoxification, hinders digestion, disrupts the immune system, contributes to antibiotic resistance, and (through its impact on gut microbiota) contributes to the list of 21st century diseases above. Food produced in this system does not promote health; it destroys health.

The human body, rather than being a distinct organism, should be thought of as a biological community, or "superorganism," truly the product of coevolution.

HEALTHY LIVING AND WORKING ENVIRONMENT

In contrast to the risk assessments that allow pesticides to be used, acute effects in the real world are seen by those doctors who treat pesticide poisonings. The EPA manual, *Recognition and Management of Pesticide Poisonings,* catalogs signs and symptoms that would not be reported by rats and mice. Agricultural poisonings are a direct effect of the agricultural system in which they occur—without a system dependent on toxic chemical inputs, there would be no poisoning. The EPA manual notes that replacement of one pesticide by a "less toxic" one does not solve the problem:

> "The relative frequency of cases generally reflects how widely a product is used in the environment. Organophosphate (OP) insecticides have historically topped the list of most commonly reported exposures. . . . In the United States, pyrethroids have largely replaced the OPs in terms of widespread usage. As such, they now account for the most human case reports in the United States."

BOX 3

Antibiotics Prohibited in Organic Production

About 80% of all antibiotics, and 70% of antibiotics of medical importance to humans are used in animal agriculture—including cows, poultry, hogs, and fish. Antibiotic residues are carried over into manure, which is then applied to crops that would otherwise not be exposed to antibiotics, in some cases organic crops. Such residues may be taken up by crops. While conventional agriculture has no restriction on the use of manure, organic standards require that, if used on crops for human consumption, it must be either composted or incorporated into the soil 90–120 days before harvest, which may reduce concentrations of some antibiotics and populations of antibiotic-resistant microbes. Organic producers must also "manage manure in a manner that does not contribute to contamination of crops, soil, or water by plant nutrients, heavy metals, or pathogenic organisms and optimizes recycling of nutrients and must manage pastures and other outdoor access areas in a manner that does not put soil or water quality at risk."

While the use of antibiotics in animal agriculture is widely acknowledged as harmful, the use of antibiotics in chemical-intensive crop production also poses unnecessary risks. Glyphosate, while marketed as a weed killer, is also patented by its manufacturer, Bayer (Monsanto), as an antibiotic. It is the most widely used antibiotic in agriculture—attacking the shikimate pathway, part of the mechanism for producing certain amino acids in both plants and microbes. The use statistics cited above do not include glyphosate. When use of glyphosate is included, it accounts for 87.6% of all antibiotic use, animal agriculture accounts for 10.0 percent, and use for human illness accounts for 2.6%.

Protecting Vulernable Population Groups. Three groups of people face higher risks from pesticide exposure because of occupation and/or developmental susceptibility—farmworkers, children, and women of reproductive age. The one million to 2.5 million hired farmworkers—especially Latinos—are the workers most often affected by pesticides.

Children represent another population of concern as they may be at greater risk from pesticide exposures because they are growing and developing. Women of reproductive age and pregnant and nursing women may also be more vulnerable because of the effects of pesticide exposures on fetuses and infants.

In the case of farmworkers, all of these groups converge because, "Farmworkers often reside in agricultural communities where they and their family members may be further exposed in their homes because of pesticide drift from spraying of nearby fields or orchards and drinking contaminated water. Para-occupational exposure factors, such as pesticide residue on workers and their clothing, shoes and vehicles and lack of adequate facilities to clean pesticide-contaminated work clothes may increase the risk of pesticide exposure for other household members as well." (EPA, 2013)

Looking only at pesticide residues in food as a measure of pesticide exposure ignores the fact that many foods that do not end up with high pesticide residues nonetheless involve toxic chemicals in production that put workers' health at risk. Pesticide use in production and farmworker exposure is a necessary consideration in looking at the whole pesticide problem. A shift to organic agriculture is the only way to eliminate toxic pesticide exposure for everyone.

Although other labor practices may not be uniformly protective on organic farms, workers are not exposed to nearly all toxic chemicals if the farm is certified organic. Thus, this dangerous working and living environment must be factored into any assessment of pesticide hazards.

HEALTHY ENDOCRINE SYSTEM

The endocrine system consists of all the glands in the in the body that produce hormones, including adrenal glands, parathyroid gland, pituitary gland, thyroid gland, ovaries, pancreas, and testes. The endocrine system controls the functions of organs, tissues, and cells in the body. The proper functioning of the endocrine system is essential to maintaining homeostasis and is therefore important to health. An endocrine disrupting chemical (EDC) is a xenobiotic chemical that mimics or interferes with the natural functioning of hormones.

LEARNING AND DEVELOPMENT

Developmental disabilities affect roughly one in six children in the U.S., ranging from a learning disability to a serious behavioral or emotional disorder. Science shows that toxic chemicals in the environment contribute to the rise of physical and mental effects in children. Children's developing organs create "early windows of great vulnerability" during which exposure to pesticides can cause great damage. Requirements for testing pesticides and other chemicals in the U.S. for potential developmental and learning disorders are minimal.

Children at Risk. During development, the brain undergoes a highly complex series of processes at different stages that makes the developing brain much more susceptible to the effects of toxic chemicals than an adult brain. Interference from toxic substances that disrupt these processes can have

permanent consequences. The higher level of vulnerability extends from fetal development through infancy and childhood to adolescence. Research has shown that low levels of exposure to environmental toxicants, such as pesticides, can have important adverse effects, such as decreases in intelligence or changes in behavior, that may not be clinically apparent.

Children may be exposed to pesticides at any time from conception onward. Children of farmworkers and those who live or play where chemical-intensive management of indoor or outdoor spaces is used are likely to be exposed during a window of developmental vulnerability because pesticides are nearly always present in those environments. It is therefore not surprising that the most significant results come from the CHAMOCOS study in the Salinas Valley of California, which links pesticide exposure with attention deficit and hyperactivity disorder (ADHD), decreased Mental Development Index scores, reduced IQ, and other developmental and cognitive effects.

A STABLE CLIMATE

Climate affects many factors that have an impact on human health. As climate changes, the distribution of plants and animals changes, leading to exposure to different allergens, disease vectors, and the chemicals used to control them. There are many influences on climate, and not all can be blamed on chemical-intensive agriculture. However, the climate is affected by the loss of carbon sequestration in fields that lay bare half the year and contain minimal plant and microbial diversity during the growing season. In addition, nitrous oxide is both a long-lived greenhouse gas with a global warming potential of about 300 times that of carbon dioxide and an ozone depleter. It is now known that the recent rise in atmospheric nitrous oxide levels is largely the result of an increased reliance on nitrogen-based fertilizers. Costs associated with the multitude of health, environmental, and economic impacts of global climate change tied to chemcial-intensive agriculture must be assessed.

BOX 4

Organic Practices Protect Farmworkers

The number of farmworkers injured each year is unknown because there is no national reporting system for farmworker pesticide poisonings and no system for tracking chronic illness related to pesticide exposure. Although 30 states require health professionals to report suspected pesticide poisoning, many incidents go unreported. In spite of factors leading to underreporting—such as rising health care costs that have heightened reluctance to seek medical attention, misdiagnosis from medical professionals, and the failure of insurance companies to forward reports to proper authorities—EPA estimates that 10,000-20,000 farmworkers are poisoned on the job due to pesticide exposure. This number does not include the many workers who suffer chronic health problems such as cancer, infertility, and neurological disorders, including Parkinson's disease, as a result of exposure to pesticides.

Pesticide exposure can have devastating effects on pregnant women and their children, who are at great risk of health effects because of their high susceptibility to pesticides. Pesticide exposure is linked to higher rates of birth defects, developmental delays, leukemia, and brain cancer among farmworker children. The severe developmental effects of pesticides on children are graphically demonstrated in a study by Elizabeth Guillette, PhD on children in an agricultural area of Mexico.

MISDIAGNOSIS OF POISONING

Farmworkers receive the highest pesticide exposures. The risks associated with those exposures are compounded by the difficulty of receiving adequate medical attention. EPA's manual, *Recognition and Management of Pesticide Poisonings* (6th edition), states,

> One important factor contributing to under-diagnosis occurs if the exposed person does not, or is unable to, seek medical attention. A pesticide applicator, for example, may not perceive the incident as significant enough to seek care, particularly if he or she has been accustomed to low-level exposure scenarios on the job. Some agricultural workers are unable to readily address a pesticide poisoning because of a complex set of socioeconomic factors including inability to take off from work, transportation problems, language and cultural barriers, lack of health insurance, scarcity of available community health services and fear of losing employment. Another scenario is the exposed person may simply not recognize his or her symptoms as pesticide related.

The same manual points out that, "Few healthcare providers are adequately trained in environmental medicine," and that the existing education system does little to address this need. It is not only farmworkers who experience these problems. Access to adequate affordable health care is a major public health issue. Minor impacts can become major when the body's defenses are under assault and adequate treatment is not available.

BIODIVERSITY

Biodiversity supports human health by maintaining ecosystem functions, including a balanced ecological community that eliminates the need to control "pests." It also provides potential sources of health-protective nutrients—some of which are yet undiscovered.

The requirement for organic farmers to "maintain or improve the natural resources of the operation, including soil and water quality" has been clarified by National Organic Program policy to mean that "the producer must initiate practices to support biodiversity and avoid, to the extent practicable, any activities that would diminish it." The guidance states,

> The conservation of natural resources and biodiversity is a primary tenet of organic production. For instance, native vegetation interspersed throughout a certified organic operation provides food, cover, and corridors for beneficial organisms such as pollinators, slows water down for erosion control and groundwater recharge, and filters pollution. Using practices that attract or introduce beneficial insects, provide habitat for birds and mammals, and provide conditions that increase soil biotic diversity serve to supply vital ecological services to organic production systems. Advantages to certified organic operations that implement these types of production practices include: 1) decreased dependence on outside fertility inputs; 2) reduced pest management costs; 3) more reliable sources of clean water; and 4) better pollination.

Chemical-intensive agriculture, which does not adhere to these tenets, not only threatens the environment, but also threatens human health. It is the elimination of biodiversity, which on organic farms delivers fertility and pest control, that results from the dissemination of toxic pesticides and fertilizers. Conservation of biodiversity is not only the basis of organic farming it is also a prerequisite for maintaining human health.

CONCLUSION

To protect human health, the effects of pesticides on complex human biology are currently not evaluated by EPA when permitting pesticide products on the market. At the same time, the agency ignores the viability of organic systems for land management that eliminate both the known adverse effects and the uncertainties that arise from inadequate evaluations and risk assessments. With the rise in serious health problems—from cancer to Parkinson's, diabetes, reproductive failures, to developmental disorders, including autism, as well as the steep decline in biodiversity and threat of global climate change—it is time to embrace an urgent transition to organic management systems.

Jay Feldman, executive director of Beyond Pesticides, contributed to this article. A fully cited version of this report is available at www.bp-dc.org/humanhealth.

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BOX 5

How Organic Reduces Climate Change

- Agricultural emissions of nitrogen fertilizers account for 80% of the growth in global air concentrations of nitrous oxide (NO_2), a greenhouse gas with global warming potential of 265-298 times that of carbon dioxide.
- Chemical-intensive agriculture promotes climate change by reducing (in comparison to undisturbed land or organic production) the sequestration of carbon in the soil.
- The climate is affected by the loss of carbon sequestration in fields that lay bare half the year and contain minimal plant and microbial diversity during the growing season.
- Industrial agriculture and subsistence agriculture account for 80% of the deforestation between 2000-2010, while the National Organic Standards Board has, in contrast, adopted a policy on "Eliminating the Incentive to Convert Native Ecosystems to Organic Production" to discourage such deforestation.
- Organic production relies less on fossil fuel inputs, including synthetic pesticides and fertilizers, leading to a reduction in greenhouse gas emissions.

Pushing for Organic Cannabis as Industry Grows

Pesticides being found to contaminate marijuana, as states struggle with public protections

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DEBRA SIMES

As medicinal and recreational marijuana continue to be legalized in numerous states, concerns about the safety of the burgeoning industry—how the substance is grown, harvested, processed, distributed, sold, and used—have emerged. Colorado's recent experience is a case in point: In early December, the state's Marijuana Enforcement Division (MED) announced two recalls on cannabis products out of concern about their contamination by pesticide residues.

In both cases, the recall announcements from the Colorado Department of Revenue, in conjunction with the Colorado Department of Agriculture (CDA) and the Colorado Department of Public Health and Environment, said that the state agencies "deem it a threat to public health and safety when pesticides that are not on the list of approved pesticides for marijuana use as determined by CDA are applied in a manner inconsistent with the pesticide's label." Three off-label pesticides were listed in the recall announcement. Pyriproxyfen was found in samples tested from Colorado Wellness Centers LLC (dba Lush), and bifenthrin and diuron were found in samples from Crossroads Wellness LLC (dba Boulder Botanics). None of those compounds is approved by Colorado for use on marijuana; two are listed as possible carcinogens by the U.S. Environmental Protection Agency (EPA).

At roughly the same time came news out of California of a decidedly human glitch in that state's recreational cannabis rollout: when the state's new, mandated, and rigorous cannabis testing protocols became operational on July 1 of 2018, a lab director—at Sequoia Analytical Labs of Sacramento—allegedly began to falsify analyses of hundreds of batches of cannabis that went out to retailers. The alleged fraud continued for some months, without the knowledge of anyone else at the company, until—suspicious because of an unusual format of test reports that were submitted to it—the Bureau of Cannabis Control conducted an unannounced inspection of Sequoia's laboratory. Reportedly, the lab director acknowledged that he'd falsified the reports, saying that some testing equipment was not functioning, and that he "just kept thinking [he] was going to figure it out the next day," according to Sequoia's general manager. The lab director was fired the day after the inspection, and the company voluntarily surrendered its cannabis testing license for 2018, although it hopes to regain it for 2019.

MECHANISM OF TOXICITY

Pesticide contamination of medical cannabis is important not only because it introduces toxic chemicals into a medicine, but also because medical cannabis can interfere with the detoxification of those pesticides via interference with cytochrome P450 enzyme system. Cytochrome P450 enzymes play an important role in the metabolism of chemicals, including pharmaceuticals and pesticides. This metabolism often helps to detoxify the chemicals (but it may, in some cases, make them more toxic). Among the pesticides detoxified by cytochrome P450 enzymes are pyrethroids, organophosphates, and carbamates. Cannabinoids have been shown to inhibit the activity of cytochrome P450 enzymes, which can make those pesticides more toxic.

CONTAMINATION CONCERNS GROWING

New Frontier Data CEO Giadha Aguirre de Carcer, pointing to California residue testing results, cites a threat to the medicinal cannabis market. She notes that 84% of 2016 product batches tested were found to harbor pesticide residue; and that in the recent California round of assays 20% failed established standards due to contamination from pesticides, bacteria, or processing chemicals, and in some cases, inaccurate labeling.

Ms. de Carcer, speaking to attendees at the Benzinga Cannabis Capital Conference in Toronto recently, said that cannabis producers must reduce the pesticide contamination in their products, at the very least because of consumer concerns that will translate to the marketplace. At that conference, she said, "Those are troublesome figures. . . . When we talk about people taking cannabis for medicinal use, we probably should do something about that." Beyond the health implications of tainted marijuana products, consumer concerns about purity of those products will no doubt affect the success of the developing industry, which Ms. de Carcer predicts will be a $20 billion market by 2025.

PESTICIDES ARE NOT REGISTERED FOR USE ON CANNABIS

Colorado's recalls appear to represent a relatively cautious approach in response to the discovery of the three prohibited pesticide residues. However, there is a broader issue of public health concern, given that no pesticides registered by EPA have been evaluated for use in cannabis production. In fact, the concerns extend beyond the three pesticides at issue in Colorado. John Scott, of the CDA's Pesticide Division, remarked, "No one's done the risk assessments to determine that this specific parts per million on cannabis would still be safe. . . . That's really the unknown and why we've taken the approach—a very precautionary approach." He also noted that MED may issue more recalls if its enhanced mandatory pesticide testing for growers evidences the need. As increasing numbers of states were legalizing medical marijuana, Beyond Pesticides laid out the concerns—health and safety, and environmental—related to contamination of cannabis with pesticides, as well as a survey of what states were doing by way of regulation, in its report *Pesticide Use in Marijuana Production: Safety Issues and Sustainable Options*. (2015)

There are multiple (and confusing) layers to the legal cannabis landscape. For starters, the federal government continues to designate marijuana as a Class I illegal substance. Legal, legislative, and regulatory scrambling in the states—to catch up to a growing industry with which legislation and regulation have not kept abreast—arises in part from this federal conundrum.

Beyond Pesticides has maintained that pesticide use on cannabis is illegal. Because cannabis is not a legal agricultural crop under relevant federal law (FIFRA, the *Federal Insecticide, Fungicide, and Rodenticide Act*), EPA has not evaluated the safety of any pesticide on cannabis plants. EPA has established no allowances for pesticide use in cannabis production, and no tolerances, nor any exemptions from tolerances, for pesticide residues on cannabis.

As Beyond Pesticides wrote in 2015, "In the absence of federal regulations governing pesticides in cannabis production, the use of pesticides not registered by [EPA] is understood to be illegal. Several states have codified this understanding by adopting policies that prohibit all federally registered pesticides. Other states have taken the position that state policy is unnecessary, since EPA has not registered any pesticides for cannabis production and registered pesticide use is illegal. A review of state laws conducted by Beyond Pesticides finds a patchwork of regulations with varying degrees of protection for consumers and the environment."

Beyond Pesticides wrote to the Colorado Department of Agriculture in 2015 to detail its objection and highlight the nature of the problem with the agency's March 2015 issuance of its memo, Criteria for Pesticides Used in the Production of Marijuana in Colorado—a document that set out the parameters of permitting for use of certain pesticides on cannabis crops. Subsequently, then-Governor John Hickenlooper issued an Executive Order "directing state agencies to address public safety concerns related to pesticide-contaminated cannabis. The next day, the state of Oregon adopted new rules strengthening its requirements for laboratory testing of cannabis for pesticides."

Colorado, Washington, and Oregon have all taken steps to list "allowable" pesticides for marijuana cultivation. However, by law, states cannot label pesticides that do not have a federal pesticide registration, which cannot be accomplished because of cannabis' illegal federal status. California began in June 2018 to set out parameters for testing of cannabis; at this juncture, all cannabis for medical and recreational use must be tested for 66 different proscribed pesticides, as well as for other contaminants, such as *E. coli*, feces, mold, insect and rodent parts, mycotoxins, terpenoids, and heavy metals. The regulatory matrix in the states is dynamic, and events such as Colorado's recalls and California's fraudulent lab reporting may spur further adjustments.

ESTABLISHING ORGANIC PRODUCTION STANDARDS

A genuinely precautionary approach would go well beyond catching prohibited pesticide (and other) contaminants in cannabis. Because of the absence of thorough federal testing of potential effects of the use of pesticides on cannabis for consumers, producers, and the environment, states should provide clear rules for sustainable production practices that will protect public health and the environment. The illegal federal status of cannabis and, therefore, the inability of EPA to register pesticides for use in cannabis production, offers a window to force the industry to embrace only those inputs exempt from federal registration and adopt true organic soil management practices. Beyond Pesticides recommends that states establish laws and/or regulations that mandate an organic systems approach to cannabis production. A requirement, for example, that growers and processors follow the dictates of national organic soil management standards would be prudent, precautionary, and a positive trajectory for the cannabis industry.

ANALYSIS

Wins and Losses in the Farm Bill

TIME FOR A GREEN NEW DEAL

As the dust still settles on the final 2018 Farm Bill, which passed the U.S. Senate and House of Representatives in December, it is clear that neither the substance nor the process on a range of issues meet the urgent need to address key sustainability issues that put the future in peril.

We must not allow this Farm Bill to be the final word on a number of critical environmental and public health issues facing the nation and world. That is why it is absolutely critical that we get to work immediately, with the new Congress, to set a new course that transforms the institutions of government that are holding back the urgently needed transition to a green economy.

On the Farm Bill, our victories were mostly measured in terms of what we were able to remove from the legislation—not the standard of achievement that we need to face critical environmental threats.

The good. Our major victory in the Farm Bill does not move us forward, but simply protects the status quo of our democracy—protecting the power of states and local government to adopt pesticide restrictions that are more stringent than the federal government. With a grassroots effort and a broad network of local officials nationwide, a preemption provision was pulled from the bill and not inserted in the federal pesticide law. Although the victory was in defeating this provision, the chemical industry has awakened a new front in the pesticide reform movement. As a result of this provision, there is new momentum to reassert the rights of local governments and repeal state-level preemption of municipalities. Other environmental setbacks to the *Endangered Species Act, Clean Water Act,* and farmworker protection were taken out of the final bill, due to those who participated in this important process.

The bad. Retained in the final bill is an amendment to organic law that introduces confusion on the mandate to *sunset* all synthetics used in organic agricultural production and processing, forcing the National Organic Standards Board (NOSB) and USDA to reassess the science and necessity of these inputs with the most rigorous scrutiny by requiring a super-majority vote of the board every five years to allow continued use of these synthetics—the same standard used when synthetics are initially petitioned. The growth of organic is essential to solving key environmental challenges, from the dramatic decline in biodiversity to global climate change. Therefore, the integrity of the organic standard setting process is critical. Additionally, new language in the organic law allows farmer, handler, and retailer positions on the NOSB to be filled by employees of these stakeholders, making the decision making process less robust.

The ugly. The Farm Bill sets policy on food and farm issues for the next five years and should not be the result of backroom negotiations in Congress, as it was this round. Important and controversial issues deserve public hearings in which all members of Congress and the public can participate, and all perspectives can be heard.

More on organic. There were some "wins" for organic in continued funding for programs important to organic production and research, and necessary improvements to oversight and enforcement of organic imports.

New leadership. Increasing support is being shown for a proposal to form a House Select Committee for a Green New Deal that addresses economic and environmental reforms while ensuring a functioning democracy. A Green New Deal must provide a framework for supporting organic agriculture that helps farmers, consumers, and the environment. In the words of commentator and former Texas Agriculture Commissioner Jim Hightower, "Everybody does better when *everybody* does better." We need new food and farm policy that benefits all farmers and consumers.

Beyond Pesticides intends to work with the new Congress on a range of critical issues that have gotten unsatisfactory attention in the Farm Bill and in other legislation and regulations.

TRACKING BIODIVERSITY

AVIAN INSECTIVORES

TERRY SHISTAR, PHD

Focus on Biodiversity

Why focus on biodiversity. In her book, *Silent Spring,* Rachel Carson alerted the public and government regulators to the importance of protecting complex biological communities. The interrelationship and interdependency of organisms is critical to ecological balance and human survival. With broad spectrum pesticide use, and indiscriminate poisoning with systemic pesticides, an ecological imbalance is created, sacrificing the benefits of nature and escalating pest problems.

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We all know about the appetite of purple martins for mosquitoes, but most songbirds eat insects at some stage of their life. Organic farmers have long appreciated the "ecosystem services" that birds provide on the farm. North Carolina organic farmer, Neill Lindley, told Beyond Pesticides National Forum participants, "We call [purple martins] our organic insecticide. These birds fly around and eat their body weight in insects in half a day." Even birds who eat seeds or nectar feed insects to their young. Some of these insectivorous birds eat caterpillars, like cabbage worms and cutworms that feed on our food plants. Others eat flying insects that may be bothersome—like mosquitoes or flies. To get a good idea of the number of insects eaten by baby birds, stake out a nest and watch the parents come in with food for their young.

Altogether, birds consume as many as 20 quadrillion individual insects, totaling 400–500 million metric tons per year. This consumption of insects makes birds an important part of biological systems, including agroecosystems. In Central America, the coffee berry borer, which is considered to be the most damaging insect pest in coffee, is controlled by insectivorous birds. Benjamin Franklin reportedly observed, "In New England they once thought blackbirds useless, and mischievous to the corn. They made efforts to destroy them. The consequence was, the blackbirds were diminished; but a kind of worm, which devoured their grass, and which the blackbirds used to feed on, increased prodigiously . . . they wished again for their blackbirds."[1]

On the other hand, insectivorous birds are threatened directly by pesticide use and indirectly by the loss of their prey. In 1962, Rachel Carson drew attention to the poisoning of songbirds in her book *Silent Spring.* Despite restrictions on the organochlorines used in 1962, an estimated 672 million birds are exposed each year to pesticides used in agriculture, resulting in the death of about 10%—67 million birds per year.[2]

Meanwhile, the world is experiencing an insect Armageddon. Recent research has found dramatic drops in overall insect abundance, with leading entomologists identifying steep declines in insect populations. Various studies have found reductions of up to a factor 60 over the past 40 years—there were 60 times as many insects in some locations in the 1970s. Over 75% of insect abundance has declined over the last 27 years, according to research published by European scientists last year.

Insectivorous birds are an essential part of global food webs that bring balance to ecological communities. The loss of insects is seen in protected natural areas, and the resulting loss of their avian predators can cause disruptions in agricultural areas as well. It is important to protect both insects and birds to promote ecological stability.

"We appear to be making vast tracts of land inhospitable to most forms of life, and are currently on course for ecological Armageddon," study coauthor David Goulson, PhD of Sussex University, UK, told *The Guardian* (2017). "If we lose the insects, then everything is going to collapse."

Footnotes

1 Glacken, C.J., 1967, Traces on the Rhodian Shore: Nature and Culture in Western Thought from Ancient Times to the Eighteenth Century, University of California Press, Berkeley.

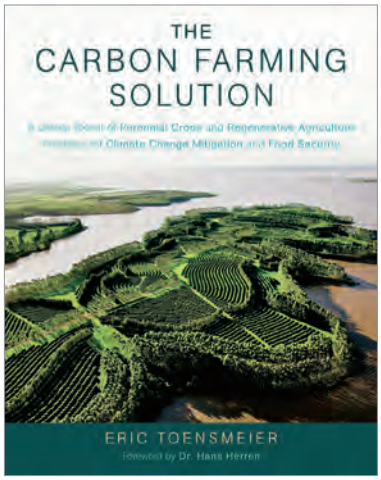
2 *https://nationalzoo.si.edu/migratory-birds/news/when-it-comes-pesticides-birds-are-sitting-ducks.*

Resource

Supporting Beneficial Birds and Managing Pest Birds, Baumgartner et al., Wild Farm Alliance, Winter 2019, *wildfarmalliance.org/bird_resource.*

Reviewed by Terry Shistar, PhD

Attacking Climate Change with Agricultural Practices



The Carbon Farming Solution, Eric Toensmeier, Chelsea Green Publishing, 2016

Farmers and researchers have recently discovered the many values of "carbon farming"—farming in a way that removes carbon from the air, where it contributes to climate change, and stores it in the soil, where it benefits soil ecology and crops. Eric Toensmeier, backyard farmer, permaculturist, and climate activist, has created a toolkit for both farmers and activists.

Like the two volumes of *Edible Forest Gardens,* which Mr. Toensmeier co-authored with Dave Jacke, *The Carbon Farming Solution* is a large volume that serves as both a reference and a guide. As a reference, it examines and catalogs recent research about which practices most successfully sequester carbon in the soil. As a guide, it provides information for farmers seeking to adopt carbon farming practices, especially in growing staple and industrial crops.

It is not surprising that the permaculturist Toensmeier concentrates on perennial crops. He presents mountains of evidence showing that perennial crop and livestock systems sequester carbon more effectively than annual cropping systems—which are the basis of industrial-scale agriculture today. He shows first that agriculture is a leading cause of climate change. Then, while considering a reduction in agricultural emissions of carbon dioxide, methane, nitrous oxide, and volatile organic compounds (VOCs), as well as sequestering carbon in the soil, he evaluates the carbon sequestration potential of a number of different agricultural systems. Those systems fit into the categories of woody polycultures, woody crop monocultures, woody biomass monoculture, tree intercropping, herbaceous monocultures, livestock silvopasture, livestock grazing, and annual cropping systems.

Some generalizations emerge—the greatest carbon sequestration potential is in woody polycultures, and the smallest is in annual cropping systems. Within each category, however, studies point to differences, as well as trade-offs between soil carbon and emissions. Although annual cropping systems rank low altogether, regenerative organic agriculture may outstrip some perennial woody systems, especially monocultures. Because of emissions from livestock and manure, an analysis of the impact of livestock systems requires a balancing of emissions and sequestration potential. Some grazing systems are no better than the best regenerative organic annual cropping systems, but when trees are added (silvopasture), the potential for reducing greenhouse gases becomes nearly as high as for woody polycultures.

Mr. Toensmeier told *Living on Earth:* "Productivity per acre is very high and that's great because that allows us to minimize deforestation to clear land for more agriculture. And many would argue that more fertilizer and pesticides would help us do that. My personal approach that I advocate in the book is that there are agro-ecological practices that also intensify, grow more on the same land, without increasing those less environmentally friendly aspects of agriculture as we know it today."

This review offers only an overview of Mr. Toensmeier's encyclopedic treatment of the subject. There are no easy answers, as hinted by the complications mentioned above. What works well in one location may not work well in another. More than half of the body of the book is devoted to information about specific perennial staple and industrial crops. He does not cover in detail perennial fruits, vegetables, or pasture species because they are covered elsewhere—some in Mr. Toensmeier's other books.

While stressing the encyclopedic and detailed nature of this book's treatment of the subject, it should be noted that it is also very readable. Whether you are interested in growing food with minimal negative environmental impacts or saving the world from the impacts of global climate change, *The Carbon Farming Solution* provides an extensive toolkit and thought-provoking reading.

[The author] shows first that agriculture is a leading cause of climate change. Then, while considering a reduction in agricultural emissions of carbon dioxide, methane, nitrous oxide, and volatile organic compounds (VOCs), as well as sequestering carbon in the soil, he evaluates the carbon sequestration potential of a number of different agricultural systems.

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Jeff Pettis, PhD, former research leader, USDA's Bee Research Laboratory, groundbreaking researcher on the behavior and chemical ecology of honey bees; principal, Pettis and Associates, LLC; president, Scientific Commission on Bee Health, Apimondia (International Association of Beekeeper Associations); Salisbury, MD.

Virginia Rauh, ScD, deputy director, Center for Children's Environmental Health, Columbia University; professor, Population and Family Health, Columbia University Medical Center; research on effects of toxic chemicals and conditions on developmental outcomes; New York City, NY.

Maida Galvez, MD, associate professor, Department of Environmental Medicine and Public Health and Department of Pediatrics, Icahn School of Medicine at Mount Sinai; Director, Region 2 Pediatric Environmental Health Specialty Unit (PEHSU); Founding Director, New York State Children's Environmental Health Center (NYSCEHC).

Routt Reigart, MD, professor emeritus, former director, Division of General Pediatrics, Medical University of South Carolina; co-author, *Children's low-level pesticide exposure and associations with autism and ADHD: A review;* co-author, *Recognition and Management of Pesticide Poisoning,* U.S. Environmental Protection Agency (EPA); former chair, Children's Health Protection Advisory Committee, EPA; Charleston, SC.

Sarah Evans, PhD, assistant professor, Environmental Medicine and Public Health, Children's Environmental Health Center, Institute for Exposomic Research, Icahn School of Medicine at Mount Sinai, New York City, NY.

Rella Abernathy, PhD, integrated pest management coordinator, City of Boulder, CO.

Caroline Cox, research director, Center for Environmental Health**,** Oakland, CA.

Paula Dinerstein, Esq, senior counsel, Public Employees for Environmental Responsibility (PEER); Washington, DC.

Jay Feldman, executive director, Beyond Pesticides; former member, National Organic Standards Board; Washington, DC.

Melinda Hemmelgarn, RD, registered dietitian, investigative nutritionist, advocate; host, nationally syndicated Food Sleuth Radio, Columbia, MO.

Joel Kupferman, Esq, executive director and senior attorney, New York Law and Environmental Justice Project, New York City, NY.

Chip Osborne, president, Osborne Organics, Inc.; chair, Recreation and Parks Commission; Marblehead, MA.

Warren Porter, PhD, professor, Zoology and Environmental Toxicology, University of Wisconsin Madison; Madison, WI.

Urvashi Rangan, PhD, chief science advisor, GRACE Communications Foundation; principal, Rangan Consulting LLC, New York City, NY.

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Ling Tan, co-chair, public health committee, Maryland Chapter, Sierra Club; steering committee member, Safe Grow Montgomery; Montgomery County, MD.

Peggy Shepard, executive director, WE ACT for Environmental Justice, New York City, NY.

Patti Wood, founder and executive director, Grassroots Environmental Education; author, *The ChildSafe School;* Port Washington, NY.

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