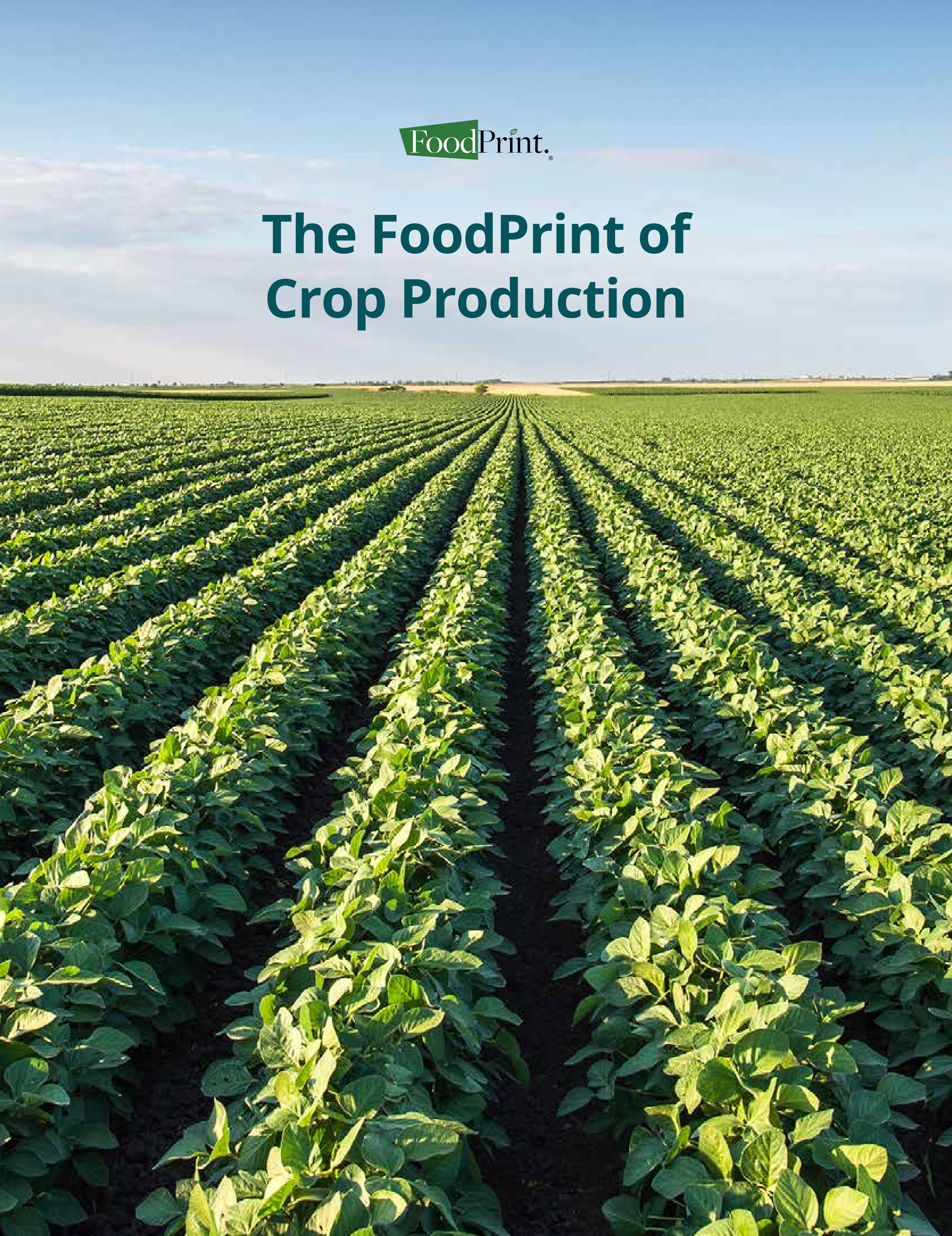
FoodPrint.

The FoodPrint of Crop Production



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When consumers think about the crops grown in this country they probably think about the spinach, tomatoes, onions, carrots and apples that fill their plates. But what they may not realize is that corn and soy account for 50 percent of all of the crops grown in the United States.[1] And, the great majority of these two crops primarily supply animal feed for factory farms.

As hard as it is to believe, crop production is one of the most polluting industries on Earth.[2] Growing conventional fruits and vegetables releases billions of pounds of synthetic pesticides, fertilizers and other farm chemicals into the environment. Virtually no one escapes exposure to these toxins, found in the water we drink, the air we breathe and the food we eat — even food we think of as the healthiest, like oranges, kale, broccoli and beets. There are enormous health and environmental costs from our present industrial crop production practices: their foodprint is unsustainable.

The good news is that, since the 1940s, farmers, scientists and public interest organizations have been working together to create an alternative, sustainable, organic food system that eschews the use of synthetic, toxic pesticides and fertilizers. Organic agriculture enhances nature's ecology to fend off pests and diseases and to boost soil nutrients that support resilient plant development. Consumers are, in ever greater numbers, choosing to buy sustainably grown food, and joining the growing movement of people who support farming practices that tread lightly on the earth and help revitalize ecosystems and farming communities.

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What Sustainable Crop Production Should Do

- Grow healthy and nutritious food
- Maintain and improve the overall environmental quality of the farm
- Maximize soil health
- Increase biodiversity
- Manage pests and weeds without toxic pesticides
- Minimize topsoil runoff and water pollution
- Develop crop resiliency and adaptability to climate change
- Support small, medium and non-corporate family farms
- Provide a healthy work environment with jobs that pay a living wage

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How Crops Are Produced Determine Their Environmental Impact

How crops are grown largely determines the environmental impact of what it takes to bring food to the table. Seed choices, soil fertility and pest and weed management strategies all influence whether a farming system will positively or negatively affect the environment, worker and public health and local economies.

GROWING CONVENTIONAL, INDUSTRIAL CROPS

Conventional, non-sustainable systems of food production cause the most long-lasting health and environmental damage because they employ toxic chemicals at each stage of production. They aim to wipe-out the natural ecosystems in which crops are grown, to create an artificial environment for growing produce.

These types of systems:

- Depend upon regular doses of insecticides to kill plant-eating bugs, herbicides to kill weeds and soil fumigants and fungicides to kill soil-borne diseases.
- Use synthetic fertilizers to boost yields.
- Rely upon pesticide-coated seeds to fight pests, disease and fungi.
- Incorporate the planting of genetically modified (GMO) seeds to produce plants that can withstand repeated sprays of highly toxic pesticides.

Bigger is better for this crop production method, where vast stretches of a monocrop dominate the same landscape year-after-year. Machines and chemicals substitute for farm labor, which is in high demand and short supply.

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GROWING SUSTAINABLE CROPS

Sustainable crop production systems, which include organic and regenerative organic agriculture, aim to maintain and enhance the natural ecosystems in which crops are grown, using inputs primarily derived from nature to support plant growth. These types of systems:

- Depend upon composted animal manure and plant material to bolster biodiversity above and below ground and the planting of cover crops to add nitrogen to soils, an essential plant nutrient.
- Employ regular crop rotations with varied deep and shallow-rooted plants to improve soil's water infiltration and holding capacity and to prevent topsoil erosion.
- Rely on flowering plants sown between rows and on field edges to attract beneficial insects that fight pests and disease and to entice pollinators that fertilize crops.
- Use densely planted cover crops to add nitrogen to soils and to shade and crowd out weeds so as to prevent their re-emergence.

Sustainable systems also facilitate biodiversity — the protection of many types of species — in all stages of agricultural production. Crops grown in this manner demonstrate superior resiliency during times of extreme drought and floods.[3] While sustainable systems can be scaled-up to support large farms, they are well suited for small, medium-sized and non-corporate family farms.

Certified Organic Crop Production Systems

What distinguishes certified organic agriculture from all other forms of agriculture is that its system of production is governed by law — the Organic Foods Production Act (OFPA) of 1990. OFPA and its regulations require adherence to principles and practices that "foster cycling of resources, promote ecological balance and conserve biodiversity."[4]

To verify compliance with OFPA:

- Independent third-party certification agencies annually inspect all organic farms.
- Certifiers also review each farm's organic system plan (OSP), which documents the materials used and procedures followed for organic crop management.

The organic label and United States Department of Agriculture (USDA) organic seal on produce signals to consumers that the food has been grown and handled in accordance with a strict, legally binding system of organic crop production. Organically grown fruits, vegetables and grains are the healthiest food you can buy, and your food dollars go to support environmentally-sound farming practices.

Unique to the US National Organic Program (NOP) is the legally-mandated, 15-member National Organic Standards Board (NOSB) of stakeholders. It meets bi-annually in locations around the country to discuss critical concerns of the organic community and to make recommendations to USDA on issues affecting industry growth and development.

The NOSB, consisting of representatives from the farming, science, retail, certification and public interest sectors, solicits public input to inform its decisions, particularly those pertaining to allowed and prohibited substances. This transparent system of public participation in government decision-making was the deal struck between organic stakeholders and the government when they collaborated to create OFPA, with the mutual commitment to continuously improve organic agriculture.

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Regenerative Crop Production Systems

Regenerative organic agriculture contributes to the overall health of ecosystems and human communities by strengthening their interconnections. It builds upon USDA's organic standards by ecologically and holistically managing land, enhancing practices that increase soil health, decreasing soil erosion and ensuring the humane treatment of farm animals. Regenerative goes beyond certified organic by establishing social justice provisions that facilitate economic stability and fair and safe working conditions for everyone engaged in farm-related activities.

While no specific regenerative organic standard, certification program or label currently exists, the Rodale Institute, which pioneered organic production practices beginning in the 1940s, is leading efforts to develop a Regenerative Organic Certification label, currently in the pilot phase.

US Produce and Grain Industry: An Overview

Farmers from just three states — California, Washington and Florida — produce 87 percent of the fruits and nuts grown in the country and about half of the vegetables.[5] California ranks as the nation's top, year-round producer of over 200 crops, growing more than 90 percent of US artichokes, walnuts, kiwis, plums, celery and garlic.[6]

But farmers in the United States don't just grow fruits and vegetables. The US produces an enormous amount of grain and soybeans, the large majority of which is grown for animal feed and not for human consumption.[7, 8] The US is also a net agricultural exporter of grains and soybeans, primarily used for animal feed abroad,[9] which means that we are not only increasing our foodprint with those additional miles of shipment, but we are foisting those disastrous environmental and public health consequences on the whole world.

Here is a snapshot of crop production in the US:

- Forty-three percent of all of the country's land is farmland — 915 million acres total.[10]
- Corn and soybeans account for more than 50 percent of all harvested cropland, the vast majority of which is grown from GMO seeds.[11]
- Two thirds of the total fresh vegetable production, by volume, comes from just three crops: potatoes (44 billion pounds), tomatoes (22 billion pounds) and lettuce (8.5 billion pounds).[12]
- Grapes, including wine grapes, dominate fruit production, grown on 1.1 million acres and constituting 52 percent of the non-citrus fruit acreage. Oranges account for 76 percent of the nearly 900,000 acres devoted to citrus production.[13]
- Wheat is the principal cereal grain grown in almost every state, totaling 1.7 billion bushels and grown on 37.6 million acres.[14]
- Organic food accounts for just over five percent of the food sold in US retail markets, with fruits and vegetables making up the largest share of organic food sales.[15]

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FRUIT AND VEGETABLE IMPORTS

"Buy Fresh, Buy Local" educational campaigns, "Farm to School" food sourcing programs and school and community gardens have all contributed to a revitalized interest in the health benefits of fresh, locally grown food. Farmers markets have also sparked renewed interest in buying local produce — their presence in communities has increased by an astounding 76 percent nationwide over the past 10 years.[16] Yet, even with this heightened awareness of the advantages of eating fresh and locally, fresh fruit and vegetable imports dominate the US marketplace by far, as evidenced below:[17]

- More than half of the fresh fruit and almost a third of the fresh vegetables purchased in the US come from other countries.[18]
- Imported fresh fruit increased from 23 percent to 53 percent between 1975 and 2015.[19]
- Fresh vegetable imports grew from 5.8 percent to 31 percent during that same time period.[20]

Year-round demand for fresh produce has risen along with a national taste for tropical varieties native to the countries of many of our immigrant communities. Big food distributors such as Walmart, Trader Joes and Costco cater to this demand by taking advantage of the economies of scale afforded by purchasing high volumes of low cost produce from overseas.

More and more US-based food processing companies have moved some of their processing activities offshore because labor is cheaper there. They import higher-priced, value-added products, like dried fruit or jam, to the US for sale at higher profit margins.[21]

Many wonder if imported food is as safe as US-produced. The answer is probably not, according to a US Food and Drug Administration (FDA) study published in 2015. It found that:

- 9.4 percent of imported fruit samples violated federal standards for pesticide residues as compared with 2.2 percent of US-produced fruit samples.[22]
- 9.7 percent of the imported vegetable samples did not meet US standards as compared with 3.8 percent of US-produced vegetables.[23]

SOY, CORN AND FACTORY FARMS

Rising consumer demand for animal protein domestically and abroad is a main driver behind corn and soybean production.[24] Confined animal feeding operations (CAFOs), also known as factory farms, exclusively rely on manufactured livestock and dairy feed because their systems of production do not allow animals to roam and forage for food.

Both the corn and soy industries are highly consolidated and vertically integrated, supplying raw materials for nearly every processed food on the market. A handful of billion-dollar-net-worth, multinational corporations control distribution chains and markets of soy and corn.[25] This system squeezes out local farmers and processors and gives these companies the power to dictate and even limit choices farmers can make about what to grow, where to grow it and how.

Soy in the US: From Plastics to Animal Feed

Tofu, tempeh and soymilk are the most popular foods made from soybeans. Soy oil is refined for cooking, biodiesel and used in industrial products such as polyurethane foam, plastics and paint. Soy is found in consumer products such as detergents, candles and cosmetics. The high-protein by-product of soy oil processing is sold for animal feed. [26]

Here are some facts about the soy industry in the US:

- 70 percent of soybeans grown in the US supplies the animal feed industry.[27]
- The poultry industry is the top soybean consumer, followed by hogs, dairy, beef and aquaculture.[28]
- The US is the world's leading soybean producer.[29]
- Soybeans account for about 90 percent of oilseed production with peanuts, sunflower seed, canola and flax making up the rest.[30]
- Until April 2018, China was the largest importer of US soybeans, but the country canceled its 62,690 metric tons order for the year in the face of trade disputes with the US.[31]
- 94 percent of soybeans planted are GMOs, most of which are engineered to withstand multiple applications of glyphosate, the active ingredient in the "RoundUp" herbicide.[32]

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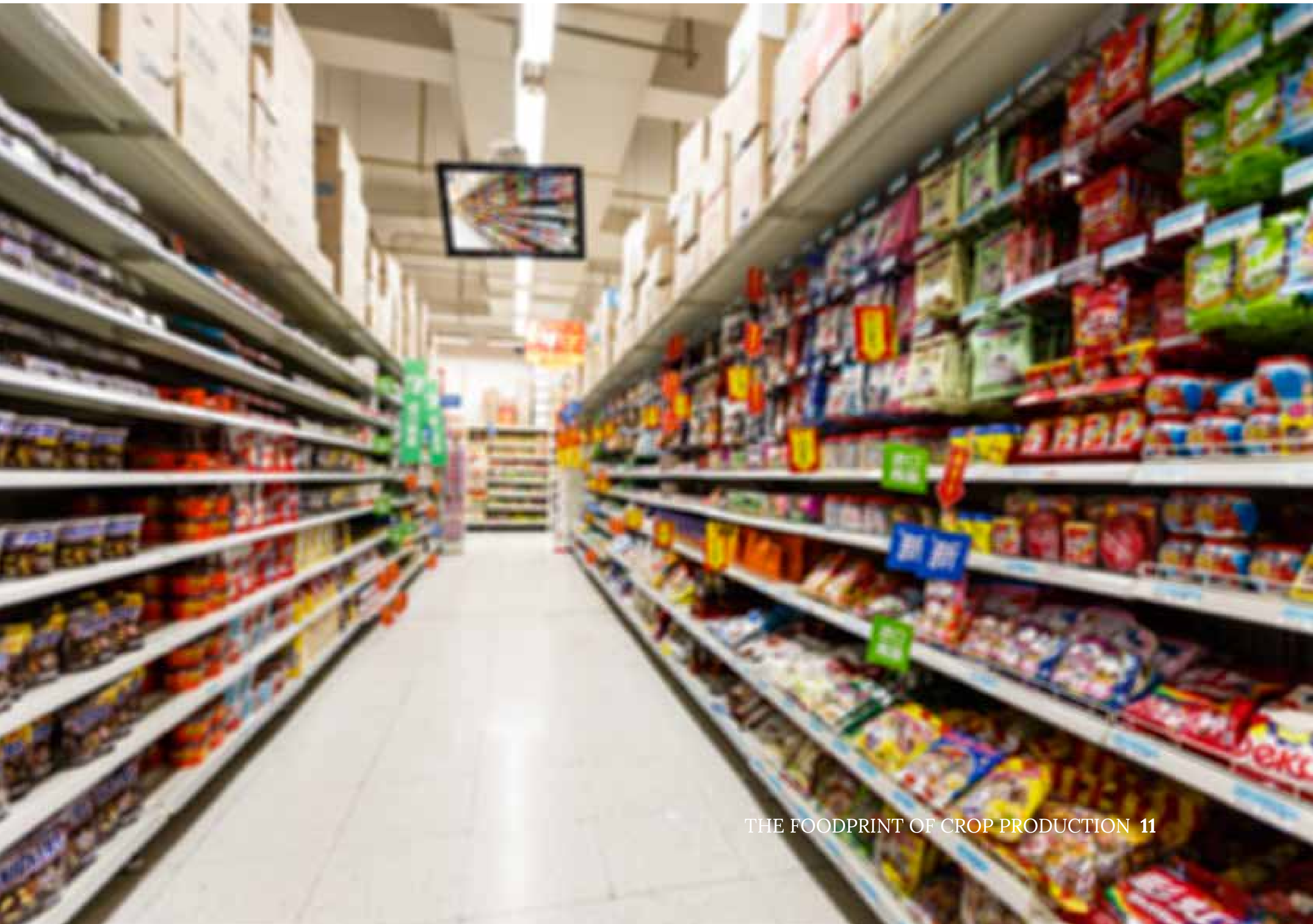
Corn in the US: For Processed Food and Cheap Meat

Processed corn products such as corn syrup and corn starch are ubiquitous ingredients in packaged foods, ranging from cookies and bread to breakfast cereals, baby food, beverages, salad dressings and tomato sauces. Products such as industrial alcohol, fuel ethanol, paints, dyes, crayons and linoleum also are derived from corn.

Corn is also the primary feed grain for animals, accounting for more than 95 percent of total feed grain production and use in the US.[33]

Here are some facts about the US corn industry:

- The US is the world's largest corn producer, exporting 10 to 20 percent of its annual production.[34]
- Mexico is the largest importer of US corn, importing 14.7 million tons in 2017.[35]
- Eight percent of corn is used in candy and non-diet soda.[36]
- Herbicide resistant GMO corn constitutes 89 percent of the total corn acreage planted.[37]
- Over 50 percent of the nation's corn is produced in Iowa, Illinois, Nebraska and Minnesota.[38]



Environmental Impact of Conventional Growing Methods

“Uncertainty” is the name of the game when it comes to crop production: from unpredictable and devastating weather events, to widespread insect infestations and whole crop failures. That is why strategic management of the complex web of bugs, weeds, soil microorganisms and wildlife on farms determines the overall economic viability of agricultural systems.

For conventional farmers, insecticides, herbicides, fungicides and fumigants are their tools of choice for overcoming the challenges inherent in growing food in the natural environment. These toxic chemicals, collectively referred to as “pesticides,” are designed to kill and eliminate the difficult-to-control elements of nature that threaten crop success.

But toxic pesticides do not recognize fence lines or biological boundaries. They wreak havoc on human and environmental health as they spread and accumulate in our bodies, plants, animals, insects, air, soil, water and ultimately our food, as discussed in subsequent sections of this report.

SEEDS, FUNGICIDES AND FUMIGANTS

All plant life begins with seeds. The type of seeds planted can make a big difference in terms of the environmental impact of the crop, particularly on pollinators, like bees and butterflies. Conventional farmers often increase their pest-fighting arsenal by choosing seeds coated with fungicides or insecticides to protect against seed loss and soil-borne pests during planting and germination.

A group of pesticides collectively known as neonicotinoids increasingly has been used as a seed treatment to control sap-feeding insects and root-feeding grubs. These chemicals (commonly called “neonics”) have garnered worldwide attention because of their role in triggering colony collapse disorder of beehives and the threat they pose to the future survival of wild and honey bee pollinators.[39]

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"Neonics" and Pollinator Health

In just 20 years, neonicotinoids have become the world's most widely used insecticides.[40] As "systemic" poisons, they spread throughout the entire plant from the roots and stems to the leaves, flowers and eventually to the nectar. They protect the plant by disrupting the feeding insect pest's central nervous system, causing paralysis and eventual death.

But neonicotinoids do not just selectively target pests. Bees, birds, butterflies and invertebrates feast on the sugary, pesticide-contaminated nectar while performing their critical role as crop pollinators. This spells disaster for their ability to fertilize plants.

Neonicotinoids have been shown to disrupt the foraging, homing, communication, brooding behavior and larval development of bees when exposed to contaminated pollen and nectar.[41] Exposure weakens pollinators' immune systems and can make them more susceptible to parasites and disease. Since honey bees pollinate an estimated 95 percent of fruits and nuts, from almonds to apples, their noticeable decline and death has caused the European Union (EU) to ban the three most notorious pesticides in this class — clothianidin, imidacloprid and thiamethoxam.[42] The US has not followed suit.

Scientists have found that plants take up only about five percent of the active chemical ingredient, while the remainder gets dispersed into the environment.[43] Low levels of neonicotinoids can persist in soils and remain bioavailable and toxic for several years, threatening biodiversity. They cause lethal and sublethal effects on a variety of terrestrial and aquatic animals and soil beneficial microorganisms that are essential to healthy functioning ecosystems.[44] Increasing evidence shows that "neonics" can reduce important aspects of healthy ecosystems, such as nitrogen fixing, pollination and nutrient recycling.[45]

GMOS, GLYPHOSATE AND SUPERWEEDS

Genetically modified organisms (GMOs) were introduced as seeds and crops in the mid-1990s, as the industry-acclaimed panacea for combating weed problems in agriculture and for reducing pesticide use. GMO seed and pesticide companies are one in the same. They have developed signature GMO seeds that require the use of their signature pesticides to manage pests and yields.

Monsanto developed herbicide tolerant soybeans (1996) and corn (1998) to resist repeated applications of its glyphosate-derived RoundUp herbicide. These crops are often referred to as “RoundUp Ready” crops. Twenty years later, glyphosate-tolerant crops account for more than 80 percent of the nearly 300 million acres of GMO crops grown annually, worldwide.[46]

Despite industry claims that GMOs would be the solution for combating weeds, herbicide resistant “superweeds” have arisen instead.[47] These hardier and difficult-to-kill superweeds, which did not exist prior to the introduction of RoundUp Ready GMO crops, are forcing farmers to more frequently apply even more toxic herbicides to eradicate weeds.[48]

By 2012, US farmers reported a 44 percent decline in the effectiveness of glyphosate in killing resistant weeds in soybean fields.[49] This has stimulated a huge upsurge in glyphosate use. By 2014, farmers had sprayed enough glyphosate to spread nearly one pound of the herbicide on each acre of cultivated cropland in the US — and that figure is increasing.[50,51]

Herbicide overuse with GMO crop production is cause for concern:

- Scientists have identified 25 species of weeds resistant to herbicides in the US alone.[52]
- Newly developed GMO crops now require the application of even more toxic herbicide combinations to fight resistant superweeds, including 2,4,-D, a component of Agent Orange, which was used as a jungle defoliant in the Vietnam War and is linked to birth defects and lower sperm counts in men.[53]
- RoundUp Ready crops have nearly eradicated the monarch caterpillar’s sole source of food, milkweed, in its Midwest butterfly breeding ground.[54]
- Rotating the use of different herbicides to combat weed resistance is not working and may be even exacerbating the weed problem due to an evolved resistance in farm fields.[55]

Don’t Be Fooled by These Misleading Seals

Irradiated Food

This logo is the international symbol for food irradiation, a process in which food is exposed to high doses of radiation in the form of gamma rays, X-rays or electron beams, in order to extend its shelf life. The label is legally required to appear on the packaging of irradiated food in the US unless it has multiple ingredients. FDA has approved irradiation for conventionally grown fresh fruits, vegetables and seeds used for sprouting. Studies have shown that irradiation creates objectionable odors, flavors and textures in meat and oysters.[143]

If you do not want to eat irradiated food, buy organic, because irradiation is prohibited.

GMO Food

Below is USDA’s proposed seal to notify shoppers that the food is grown from GMO seeds or contains GMO ingredients. Instead of using the well-recognized “GMO” moniker, however, USDA has changed the name to “bioengineered.” This does more to confuse than clarify and the seal is misleading. The happy sun suggests that there is no need for concern about eating “bioengineered” food.

If you want to avoid eating GMOs, buy organic because GMOs are prohibited.

FUNGICIDES ON THE RISE AND LARGELY UNMONITORED

Across the country, researchers and regulators are witnessing an unprecedented upsurge in fungicide use by farmers who want to squeeze higher yields from crops, including wheat, corn, soybeans and citrus.[56]

As discussed earlier, fungicides are increasingly used to treat seeds. But fungicides are also being promoted as beneficial for general plant health and to increase yields, even when disease pressure is low.[57] Conventional farmers preventively apply "contact fungicides" to kill fungi and prevent root rot and mold. They apply "curative" or "eradication" fungicides to halt the spread of disease infection in plants. Farmers also apply fungicides on an array of stone fruit trees and berries and more often in wet climates.

The surge in fungicide use comes with several environmental costs, including:

- Increasing pollution in waterways and untold risks to aquatic and terrestrial ecosystems.
- Disruption of bee foraging behavior and harm to flower stigmas, causing reduced pollination and yields.[58]
- Toxicity to bee larvae and adult bees.[59]
- An increase in amphibian mortality[60] and deformity and disruption of their lifecycles.[61, 62]
- Damage to fish DNA[63] — the genetic instructions essential for the healthy development and functioning of cells.

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SOIL HEALTH AND FERTILITY

Plants, like people, need food to survive and thrive. Scientists have identified as many as 18[64] essential nutrients for plant growth, reproduction and vitality. But most agree that the big three — nitrogen (N), phosphorus (P) and potassium (K) — are the most important. These fundamental nutrients, known together as NPK, play a key role in plant nutrition and compose the building blocks of most synthetic fertilizers. Nitrogen is considered the most critical nutrient that plants absorb. To obtain optimum crop yields, nitrogen must be added in a natural or synthetic form to soils before planting.

Synthetic fertilizers used in conventional agriculture are produced from petroleum. Their manufacture contributes to climate change by releasing greenhouse gases during the extraction, refinement, transport and incorporation into fertilizer.[65] Researchers have found that fertilizer use is responsible for an enormous rise in atmospheric nitrous oxide, a major greenhouse gas and contributor to global climate change.[66] Synthetic fertilizer also contributes to water pollution (see Water Impact section).

Animal Pathogens in Produce

Food-borne illness outbreaks reported by the media usually focus on two main pathogens — *Salmonella* and *E. coli (Escherichia coli)*. *Salmonella*, which comes from animal feces, is most often associated with food poisoning, causing an estimated one million foodborne illnesses in the US each year.[144]

E. coli are mostly harmless bacteria found in the intestinal tract of healthy people. Some types of *E. coli* bacteria, however, cause disease, and *E.coli* 0157:H7 is the one most commonly identified during food-borne illness outbreaks.[145]

Pathways of produce-related contamination:[146]

- Direct contact between crops and feces after livestock have grazed in fields and the pathogens in the feces have had an insufficient time to break down.
- Wildlife, farm animals (chickens, ducks, pigs, herding dogs, etc.) can wander onto farm fields and their feces can contaminate a water source used for irrigation.
- Improper management of raw livestock or chicken manure used as a crop fertilizer can allow pathogens to remain, particularly when the manure has not been composted to the required temperature of 131 degrees for at least 15 days.
- Water runoff from animal feedlots, compost and manure piles and air blown dust, all of which can contaminate irrigation water.
- Pathogens in sediments in ponds, creeks, lakes, canals, etc. can get stirred up and contaminate irrigation water.

Research has shown that pathogens often do not survive in organic systems for long because the biologically active community of microorganisms present in organic soils either competes effectively with them or consumes them.[147] The more biologically rich the farm soil is, the less likely that pathogens will be a problem.

Fumigants: Damaging to Living Soils and People

In addition to synthetic fertilizers being added to soil, certain pesticides are soil-specific. Soil fumigants, for example, are specifically designed to obliterate living organisms in the soil before planting crops and orchards. Fumigation involves injecting a mix of potent pesticides, 12 to 14 inches underground, and covering the fields with plastic tarps until soil sterilization is complete. Fumigants kill nearly all soil organisms — not just the harmful ones — including beneficial bacteria, fungi and other organisms that help maintain healthy soils. Even though fields are immediately covered with plastic, 50 to 95 percent of the pesticides escape into the atmosphere,[67] traveling far distances and exposing workers and entire communities to pesticidal gases.[68]

Once extensively used to grow strawberries, tomatoes, nuts and stone fruit, methyl bromide was the dominant soil fumigant used since its introduction in 1960.[69] But, as a major ozone-depleting chemical with five times the global warming potential of carbon dioxide, countries around the world agreed to ban it in 2005, under the Montreal Protocol on Substances that Deplete the Ozone Layer.[70] The US, however, remains one of the only countries still receiving "critical use exemptions" for the post-harvest fumigation of imported and exported produce to control invasive and non-indigenous pests.[71, 72]

The most frequently used, non-ozone depleting fumigant substitutes, chloropicrin and metam sodium, are even more acutely dangerous. They fall into the class of restricted-use pesticides (RUPs), requiring applicator training and licensing to protect workers and communities.[73, 74]

Chloropicrin, the World War II vomit gas, was re-purposed for agricultural use in the production of strawberries, raspberries, almonds and other crops. Humans, particularly pesticide operators, are the species most at risk from exposure to chloropicrin because it is an extreme pulmonary irritant with no specific available antidote. Exposure to high concentrations is fatal.[75] It is also very toxic to aquatic organisms and algae.[76] Metam sodium, applied on the same crop types, is a mutagen that has been documented to cause birth defects and fetal death. It is also toxic to fish and aquatic organisms.[77]

Fruits and vegetables are projected to be the fastest growing market for toxic fumigants to curtail pest infestations on imported and exported produce.[78]

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WATER IMPACT FROM CROP PRODUCTION

Agriculture is the single greatest source of non-point water pollutants, including sediment, salts, synthetic fertilizers, pesticides and animal waste.[79] Salinization (increased salt content) of soils is a huge problem for irrigated agriculture, as salinized soil runs off into streams, lakes, rivers and estuaries. Chemical pollution in drinking water linked to agriculture is also a problem. As many as one million Californians, for example, mostly living in the farming communities of the Central Valley, have dangerous levels of unregulated chemicals linked to cancer in their drinking water, according to California's State Water Board.[80]

Synthetic fertilizer use contributes to water pollution. Since conventional agriculture focuses on feeding plants rather than building the soil's capacity to retain water and plant nutrients, excess fertilizer mixed with rain and irrigation water often flows off the farm, polluting surface, ground and ocean waters. This nutrient-rich run-off stimulates algae blooms that spread quickly and can render waterways impassable. When the algae die and decompose, they remove oxygen from the water, creating "dead zones" like one in the Gulf of Mexico, which has grown to the size of New Jersey (8,776 square miles).[81] Fish and other aquatic organisms can no longer live there, forever disrupting the marine ecology and fishing economy of the region.

Pesticides and Human Health

Conventional crop production in the US releases more than a billion pounds of active pesticide ingredients into the environment each year.[82] This figure does not include "inert" ingredients, many of which are highly toxic and sometimes constitute up to 99 percent of a pesticide product. (See sidebar on "inerts.")

The toxicity of a given pesticide depends on a host of factors, including the dose and duration of exposure, the synergistic interactions with other chemicals and route of exposure (inhalation, skin, ingestion, etc.). Pesticides can persist indefinitely in the environment and travel through the wind and water, via animal feces and on the bodies of terrestrial animals, birds, bats, insects and marine life to remote locations as far as Antarctica.[83] They can also bioaccumulate (increase in concentration) as they travel through the food web. No one escapes exposure, although the level and regularity of exposure depends upon where you live, work and play; your livelihood; and even the pesticide residues in foods you eat.[84]

Research has conclusively demonstrated that exposure to pesticides is cause for alarm due to their impact on organ systems, human reproduction and child wellness and development. A healthy endocrine system is key to normal hormone production, sexual function and reproductive and developmental success in humans and wildlife, but endocrine-disrupting pesticides are interfering with these processes in women, men and wildlife. Hormone-related problems that begin in utero due to high levels of pesticide exposure may not be evident until later in life. The adverse effects are often irreversible.[85]

Warning Note About "Inerts"

When you look at a container of pesticides, the only toxic chemical disclosed on the label is the biologically or chemically "active" ingredient designed to combat insects, weeds or fungus pests. Yet, the "inert" carrier or adhesion ingredients — which may be equally or even more toxic — in many cases — constitute most of the final pesticide product.

Chemical companies are not required by law to list these so-called "inerts" on the label, even though they constitute 85 to 99 percent of the final product. A can of roach spray, for example, contains five percent of the active ingredient, permethrin, but the remaining 95 percent consists of undisclosed inert ingredients.[139]

Like active pesticide ingredients, inerts can be biologically or chemically active. But, they are minimally tested even though many are known to be hazardous to human health. In fact, a study by the New York State Attorney General reported that the over 200 inerts in pesticides meet the definition of hazard pollutants in federal air and water quality laws.[140]

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SCIENTISTS AND DOCTORS CALL FOR ACTION

Mounting scientific evidence continues to demonstrate the extreme public health consequences of acute and chronic toxic pesticide exposures. A landmark report by the President's Cancer Panel (PCP) in 2010, which extensively examined the peer-reviewed literature on agricultural, occupational and environmental exposures to pesticides, concluded that pesticides are associated with a full range of cancers.[86] They include: brain; central nervous system; breast; colon; lungs; ovarian; pancreatic; kidney; testicular and stomach; Hodgkin and non-Hodgkin lymphoma; myeloma; and soft tissue sarcoma.

In light of such damning evidence, doctors and scientists on the PCP recommend that serious attention be paid to the far-reaching health impact of toxic pesticide exposure and that immediate action should be taken to minimize risks. They urged the President to use the power of his office to:

> "...remove the carcinogens and other toxins from our food, water and air that needlessly increase health care costs, cripple our Nation's productivity, and devastate American lives."[87]

This sentiment was echoed in a subsequent European Parliament (EP) study on the "Human Health Implications of Organic Food and Organic Agriculture" which concluded that:

> "...while the intake of fruit and vegetables should not be decreased, existing studies support the idea of reduced dietary exposure to pesticide residues, especially among pregnant women and children."[88]

Even with this compelling evidence and so many other studies, the US government has been excruciatingly slow to act and prefers to call for more research instead.[89]

PESTICIDE IMPACTS ON FARMWORKERS

No one carries a higher body burden of toxic chemicals than those who work in conventional agriculture, due to repeated, high levels of exposure to pesticides. Farmworkers are exposed in the fields or in greenhouses where they work and then again in their homes when pesticides drift from farms that border their neighborhoods.

The fact that the average life expectancy of farmworkers is 49 years of age,[90] as compared with in the mid-70s to low 80s in the general population, is cause for concern and reason to suspect that toxic pesticide exposure plays a key role in limiting their life expectancy.[91, 92]

While the US Environmental Protection Agency (EPA) estimates that 10,000 to 20,000 acute pesticide poisonings occur annually across the country,[93] in reality, that figure is much higher. Substantial underreporting occurs among farmworkers due to fear of job loss or deportation of undocumented workers.[94, 95]

EPA acknowledges that long-term chronic effects of pesticide exposure are unlikely to be recorded in poisoning databases but stresses that "associations between pesticide exposure and certain cancer and non-cancer chronic health effects are well documented in the peer-reviewed litera-

Photo credit this page: by romanets_v/ Adobe Stock; Opposite page: by Adobe Stock ture."[96] Chief among the health effects that the agency cites are non-Hodgkin's lymphoma, prostate cancer, Parkinson's disease, lung cancer, bronchitis and asthma.[97] Reproductive impairments and impeded childhood development represent other troubling consequences documented in scientific studies, as discussed in the following sections.

Beyond chronic, lethal illnesses, farmworkers also experience day-to-day symptoms from pesticide exposure, including reoccurring skin rashes and eruptions, irritated eyes and nasal membranes, headaches, hand dermatitis, nausea, asthma and flu-like symptoms.[98]

The Workers Who Harvest Our Produce

Much of the produce we eat requires people (as opposed to machines) to harvest and process it. This labor is physically difficult work that comes with many hazards, from heat stroke to toxic pesticide exposure. Plus, most farmworkers are paid less than minimum wage.

- Immigrants produce most of our food, from farm to processing plant. Currently, 68 percent of farmworkers are immigrants from Mexico. Farmworkers' median annual farm incomes in the previous year were just over $17,000.[148]
- Farm work is backbreaking labor. Planting and harvesting crops involve repetitive motions, often being stooped or bent for many hours, lifting heavy buckets of produce and operating heavy machinery such as tractors that can lead to injuries.

The work is performed outdoors in hot weather, often without shade or adequate water. Heat stroke is the leading cause of farmworker death.[149]

"Sustainable" food must be produced in a way that takes not only the environment and consumers into account, but also the people who grow, harvest and process it.

IN UTERO IMPACT OF PESTICIDES

Even before children are born, they are repeatedly bombarded with a wide variety of dangerous pesticides."[99] Exposure to agricultural pesticides during pregnancy can trigger developmental neurotoxicity and has been linked to childhood autism.[100] During pregnancy, even low levels of exposure to pesticides such as chlorpyrifos can impair learning, change brain function and alter thyroid levels of offspring into adulthood.[101] Chlorpyrifos detected in the umbilical cord blood of pregnant women has been correlated with a decrease in psychomotor and mental development in three-year-old children.[102]

Other adverse effects of pesticide exposure in utero are well documented and include pre-term birth,[103] neurodevelopmental delays,[104] male reproductive development and genital problems[105, 106] and ASD (autism spectrum disorder).[107]

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PHYSICAL ABNORMALITIES AND DEVELOPMENTAL PROBLEMS IN CHILDREN FROM PESTICIDES

The developing organs of children reveal early windows of significant vulnerability when exposed to pesticides, which can cause severe and long-lasting damage.[108] They possess a unique susceptibility to toxic chemicals because they drink more liquids, breathe more air and consume more food per pound of body weight than adults. Research has shown that children who live in rural communities where conventional agriculture dominates suffer a host of health problems.

Farmworker children are the most at risk. They receive a double dose of pesticides from neighboring farm fields and then again when their relatives return from work with pesticides on their clothes, shoes and in their hair and skin.[109] Because farmworkers often lack child care, parents are forced to take their children with them to the fields where they become exposed to toxic pesticides at an early age.[110]

Research on developmental disorders has incited deep concern and a call for government action by doctors and scientists, as discussed in the previous section. These studies have shown that pesticide exposure at a young age is associated with childhood cancers, decreased cognitive function and behavioral problems such as attention deficit disorder,[111] as well as reduced birth weights, slowed cognitive development and other neurodevelopmental problems.[112]

While studies on the health impact of pesticide exposure is bleak, scientists studying endocrine disruption have observed some positive changes. When bans and restrictions were put into place, such as the US residential ban on chlorpyrifos, decreases in the frequency of human and wildlife disorders were seen.[113]

HEALTH IMPACT FROM PESTICIDE FOOD RESIDUES

Diet represents an important route of pesticide exposure. People who eat fruits and vegetables containing pesticide residues can suffer from a range of health effects, including cancer, lung damage, neurological disorders and a host of endocrine dysfunctions.[114] Dose, duration and type of pesticides contained in the food residue are key to understanding pesticide risks and effects.[115]

The studies below show that dietary exposures to pesticides, within the range typically found on conventionally grown food, can have notable adverse health consequences.

- Researchers tracked 325 women for two years, who regularly ate high or low levels of pesticide-treated fruits and vegetables while undergoing in vitro fertilization, to assess the association between pesticide residues in produce and infertility treatment success. They found that the women experienced a lower probability of getting pregnant with in vitro fertilization when they consumed greater amounts of produce with high pesticide residues.[116]
- A study of 155 men and 338 semen samples showed that those who ate more fruits and vegetables with high levels of pesticide residues had 49 percent lower sperm counts and a 32 percent lower percentage of normal sperm than men who ate less fruit per day. The men with lower sperm counts, also had lower ejaculate volumes and lower percentages of normal sperm.[117]
- Researchers measured the dietary exposure to pesticides of 23 elementary school children by taking urine samples taken twice daily and measuring concentrations of malathion and chlorpyrifos pesticide metabolites. The metabolites (chemicals created as the body breaks down pesticides) immediately decreased to non-detectable levels after children switched to an organic diet and remained undetectable until conventional diets resumed.[118]

Top Domestic Pesticide Offenders You Should Know by Name			
PESTICIDE	**MAJOR ISSUES OF CONCERN**	**BANNED OR RESTRICTED**	**USE ON CROPS**
GLYPHOSATE (Herbicide)	• Most widely used with GMO, RoundUp Ready crops, worldwide • Suspected carcinogen • Linked to non-Hodgkin's lymphoma, kidney disease, ADHD and hormone disruption • Causes spontaneous abortions and decreases in sperm count	• Sri Lanka and El Salvador banned • Netherlands and Belgium banned non-commercial use • Bermuda banned commercial sales • Italy restricted use • Portugal banned in public spaces	• Corn • Soybeans • Alfalfa • Sugar beets • Wheat • Canola
NEONICS — CLOTHIANIDIN, IMIDACLOPRID, THIAMETHOXAM (Insecticides)	• Implicated in honey and wild bee die-offs and colony collapse disorder • Lethal to birds, invertebrates and beneficial microorganisms • Impairs immune and reproductive systems of insects and crustaceans	• EU banned	• Corn • Soybeans • Canola • Sorghum • Sugar beets • Canola
CHLORPYRIFOS (Insecticide)	• Causes reduced birth weights, mental and physical developmental delays and IQ deficits in children • EPA says "no safe use" • Linked to lung and prostate cancer • Harmful to 1,800 critically threatened or endangered species	• Hawaii banned • US banned for residential uses; full ban pending	• Corn • Soybeans • Cauliflower • Broccoli • Brussel Sprouts • Fruit and Nut Trees
ATRAZINE (Herbicide)	• Persistent, hormone-disrupting chemical, causing low birth rates and birth defects • In 90 percent of US drinking water • Major cause of global amphibian declines from chemically-castrated and feminized adult males	• EU banned	• Corn • Sugarcane • Sorghum
PARAQUAT (Herbicide)	• Linked to Parkinson's disease, kidney, liver and heart failure • Causes lung sores, scarring and seizures • Lethal to birds • One sip kills — used in farmer suicides in many parts of the world	• EU, China, Korea, Brazil • and Switzerland banned	• Corn • Soybeans • Peanuts • Vegetables • Potatoes

Sustainable Crop-Farming Techniques

Sustainable, organic agriculture promotes the use of naturally occurring substances to combat pest problems and to promote plant health. They also eschew the use of synthetic, toxic chemicals. However, the organic standards do allow limited exceptions for some non-persistent, synthetic inputs that do not have comparable natural substitutes, but only after public and government scrutiny of their potential health and environmental impact. Exceptions, such as installing pheromone traps to confuse insect pests or the application of copper micronutrients when a documented soil deficiency exists, are a far cry from the highly toxic and persistent chemicals routinely used in conventional agriculture — glyphosate, "neonics," chloropicrin, etc.

Organic cropping systems rely on the strategic management of natural ecosystems and pest/predator relationships to combat pests, weeds and diseases. These systems bolster soil fertility and plant vigor by enhancing interdependent soil microorganisms, plants, fungi, insects and animals. The minimization of synthetic toxic inputs in organic production also helps facilitate important ecosystem services, such as the conservation of declining species, increasing biodiversity, protecting waterways from agricultural runoff and maintaining soil fertility for future generations.[119]

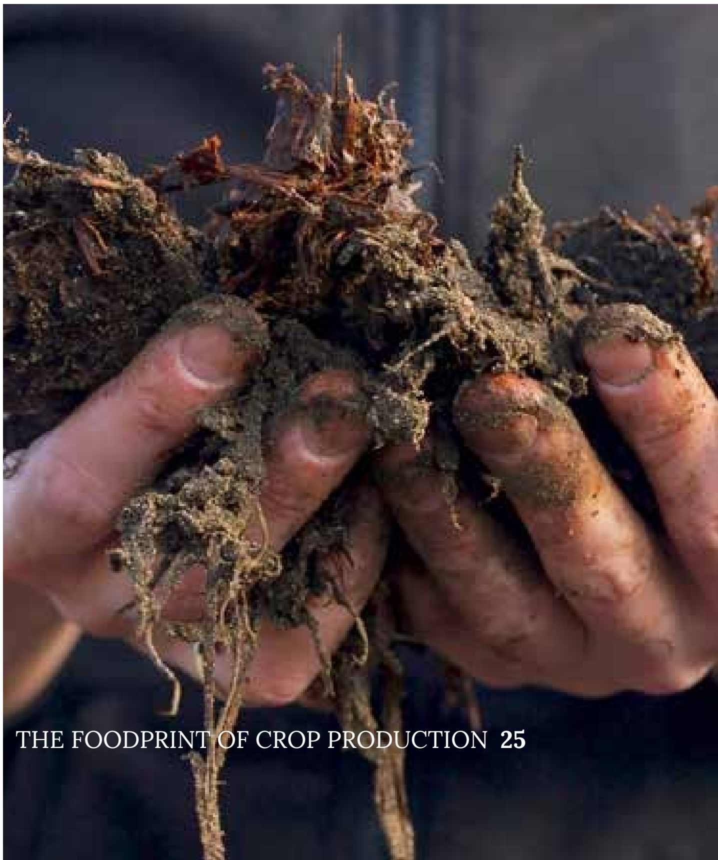
COMPOST AND LEGUMES FOR SOIL HEALTH

In contrast to conventional agriculture, sustainable cropping systems rely upon natural sources of NPK and other essential nutrients to produce healthy plants and optimum yields. The fertilizer of choice for sustainable organic farmers is composted animal manure, plant compost and cover crops.

Compost refers to the biological decomposition of organic matter (green plant matter and animal manure) by bacteria, fungi, worms and other insects that bite suck, tear, chew and slime manure into a humus-type material. Heat generated during the composting process kills and suppresses most weeds, seeds and pathogens. When the compost is "cooked," it generates a nutrient-rich fertilizer ready for spreading on crop land.

Farmers plant leguminous "cover crops," like hairy vetch and red clover, primarily to protect and improve soil quality and not to harvest. Legumes increase soil fertility by storing nitrogen and other nutrients essential for plant and microorganism development. Growing cover crops as part of a regular crop rotation cycle:

- Enhances soil water holding capacity and filtration
- Increases soil biological activity
- Improves overall plant health and productivity
- Suppress weeds
- Prevents soil erosion
- Breaks pest and disease cycles by reducing bacterial and fungal diseases in a soil[120]



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EMBEDDED DEFENSES OF ORGANIC PLANTS

The use of chemical-coated and GMO seeds is strictly prohibited in organic agriculture. Organic seed companies have been exploring natural, biological agents, such as neem oil, to treat seeds and prevent fungus damage, but research is still in its infancy. Since organic seed development is ongoing, and not all seed varieties are available in an organic form, organic farmers can use conventional seeds but without any embedded pesticides.

Research has shown that organic plants defend against pest attacks by producing more phenols and polyphenols.[121] In humans, these micronutrients help prevent diseases triggered or promoted by oxidative-damage like coronary heart disease, stroke and certain cancers.[122] A natural phenol called resveratrol, for example, found in high concentrations in certain grape varieties, can starve cancer by inhibiting the actions of a key protein that helps feed cancer cells.[123]

PREDATORS, NOT PESTICIDES

Some innovative farmers have discovered that predator birds and bats can protect orchards and crops from fruit-eating birds, insects and rodents without the use of toxic chemicals.[124] With the aid of landscape enhancement strategies, such as the creation of nest boxes, native vegetative habitats and high bird scouting platforms, farmers lure target predators into their fields and successfully control pests. This has the added environmental benefits of reintroducing native species on farms, improving ecosystem complexity and reducing the effects of so called "invasive species."

BENEFICIAL INSECTS AND FLOWERING PLANTS

Beneficial insects on farms provide invaluable ecosystem services such as keeping pest populations in check and pollinating crops. Intercropping flowering plants between crop rows entices beneficial insects to feed on pests. They can also repel insects from feasting on crops.[125] Planting native, flowering bushes or hedgerows on the edges of fields has the added benefit of blocking and filtering pesticide drift as well as attracting pollinators.[126] Some farmers release beneficial insects such as ladybugs, wasps and green lacewings to feed on pests and control their populations.

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NATURAL SOIL FUMIGATION

Researchers at the University of California, Santa Cruz, have been conducting farmer-led field trials of a natural soil treatment process called anaerobic soil disinfestation (ASD) — a non-toxic method of controlling soil-borne pathogens in strawberry fields. By incorporating a carbon source like rice bran and/or molasses into topsoil, covering it with a tarp, and flooding plant beds with water, ASD creates anaerobic conditions that are toxic to pathogens.

ASD has been effective in suppressing soil-borne pathogens, which include viruses, bacteria, fungi and nematodes (worms) and maintaining yields comparable to those of fumigated fields.[127] Yellow and white mustard seed meal also have been successfully used as a pre-plant soil treatment to combat pests and reset the microbiology of soils when replanting apple orchards.[128]

Farmers Choose Organic for Life

Conventional farmers experience first-hand the dangers associated with toxic pesticide use. Debilitating side effects of regular pesticide exposures have led many farmers to adopt organic practices. A recent study found that 86 percent of the 1,800 organic farmers surveyed switched to organic because of health concerns for themselves and their family.[141]

In his article, "Farmers Switched to Organic after Pesticides Made Them Sick," Ken Roseboro relays the experiences of farmers who switched to organic as a matter of survival.[142]

Below is a sampling of those stories:

- "The doctor told me to leave agriculture. If you don't you probably won't live 10 years," said Blaine Schmalz after he inhaled pesticides from his sprayer, passed out and was hospitalized for several months. Since he refused to quit farming, Schmalz transitioned to organic and his symptoms vanished.
- Tim Raile, a Kansas farmer, witnessed his farmer father regularly spraying malathion, 2,4-D and other pesticides. He suspects that caused his father's death from chronic leukemia. Raile is switching to organic because he found that "inevitably you get sprayed and eventually it will cause a problem."
- Levi Lyle, an Iowa farmer, thinks that his father's lung and groin cancer was caused by pesticides used on his farm. Lyle admits that "my passion for organic farming was inspired by my Dad overcoming cancer."

CONSERVATION TILLAGE

For millennia, sustainable and organic farmers have tilled the soil by turning it over with a plow, breaking up clumps and mixing in soil amendments, such as compost and worm castings, to prepare the field for planting. But the down-side to tilling is that it kills soil organisms like earthworms that naturally aerate and fertilize soils. It stirs-up weed seeds, which can then germinate and reproduce. Tilling also releases stored soil organic carbon, which contributes to global warming.[129]

Conservation tillage emerged as a strategy for preserving microbial communities, fungi and worms, using little or no plowing and leaving the soil surface covered with existing crop residues when planting.[130] Research has shown that conservation tillage helps retain soil moisture, minimize erosion and limit the release of stored carbon and nitrous oxide (a potent greenhouse gas) during planting.[131]

In practice, farmers leave at least 30 percent of the previous year's crop residue on the farm field surface for mulch and, when it is planting time, they drill holes through the mulch to sow seeds and fertilize.[132] While this method of farming is not unique to sustainable agriculture, the ecosystem-based approach that accompanies the practice substantially differs from chemical-based methods of conventional agriculture.

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Let’s Fix This: Moving to Support Sustainable Crop Production

To safeguard public and environmental health now and in the future, it is imperative that the US makes a dramatic shift away from chemical-intensive methods of food production, as this report demonstrates. Organic production systems and the USDA’s organic certification program have provided a solid foundation for sustainable crop management for nearly three decades. Pioneers of the organic movement have been at the forefront of agriculture innovations that have made organic by far the fastest growing agricultural sector for decades.[133] Yet even despite organic’s notable contribution to the US economy — $45 billion in sales[134] — the government has been lukewarm in its commitment to promoting the benefits of organic.

In fact, recently USDA’s NOP has been reneging on its original commitment to facilitate continuous improvements in organic. Most notably, it has shelved critical animal welfare regulations supported by the large majority of stakeholders to appease large-scale poultry and livestock interests.[135] This decision has fueled widespread dissatisfaction within the organic community and has led to several lawsuits which argue that the action threatens organic integrity and undermines consumer confidence in the organic label.[136, 137]

WHAT NEEDS TO CHANGE

USDA needs to step up to the plate and embrace organic’s multiple environmental and health benefits by funding programs that facilitate the transition to organic and away from chemical-intensive, industrial agriculture. A nationwide, farmer outreach campaign, complete with detailed technical information and hands-on technical assistance is needed to help farmers change their mindset and farming practices to ecologically-based, organic systems and to help them comply with rigorous organic certification requirements.

Since that is unlikely in the near-term, two new certification programs, the Rodale Institute’s Regenerative Organic Certification (ROC) and the Real Organic Project (ROP) have emerged to pick up where USDA has left off. They are creating add-on labels to the existing USDA seal to reward farmers for improving their organic systems and going beyond the foundational organic standards. Both labels and certification programs are in the early developmental stages, soliciting input from organic stakeholders. Pilot projects to the test standards will take place in 2018.

While each program is distinct, both require two critical areas of improvement in organic farming systems — soil health and animal welfare. Crops must be grown in the soil; hydroponic production is prohibited, and conservation tillage is a must. The humane-treatment-of-animals standards require that animals roam, forage and express their natural behavior and also that they are free of confinements in feedlots.

ROC’s certification also addresses social justice and fairness by requiring that labor practices ensure safe and respectful working conditions, pay a living wage and allow the right to unionize.[138]

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Let’s Boost the Demand for Sustainable Produce

There are many ways that you can help increase the demand and supply of sustainable and organically produced food.

Here are a few suggestions to get you started:

EAT ORGANICALLY GROWN FOOD

- Begin with purchasing organic fruits, vegetables and grains to reduce toxic pesticide residues on the food you eat. If your budget is tight, use your food dollars to avoid buying conventional produce on the “Dirty Dozen” list and buy organic instead.
- Avoid eating the “Dirty Dozen” fresh fruits and vegetables identified by the Environmental Working Group as containing the highest levels of pesticide residues.
- Check out Consumer Reports’ “From Crop to Table Pesticide Report” and its “Guide to Residue Risk” to learn about the residues and toxicity of pesticides in your food.
- Check for the “Non-GMO Project Verified” label on food packages to ensure that you are not buying food containing GMOs.

KNOW YOUR FARMER, KNOW YOUR FOOD

- Shop at farmers’ markets whenever possible, where you can buy the freshest, tastiest seasonal fruits and veggies at the best prices.
- Learn more about how your food is grown by talking to the local farmers there.

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JOIN A CSA

- Join a CSA (community supported agriculture) or an organic buying club where you can support local farms and receive an array of seasonal, freshly picked, locally grown, organic produce and locally produced artisanal food each week.
- Attend open farm days and tours to learn about the diverse produce grown in your community so you can be prepared to cook the season's bounty.

GROW YOUR OWN FOOD

- Become a backyard or urban organic gardener. That way, you know that the food you are eating is the best that it can be. Find resources on how to grow food in any space on our website.

SUPPORT FARMWORKERS

By looking for the Food Justice Certified or Fair Trade label, you are contributing to production that mandates standards and protections for workers on a farm, including fair wages, and in some cases, other protections like health insurance. Check out our Food Labels Guide for more information.

BECOME A PESTICIDE-FREE, BEE-FRIENDLY COUNTY, CITY OR TOWN

- Communities are organizing to prohibit the use of pesticides on schoolyards and on public property. You can do it too. For tips and assistance with how to make it work, visit Beyond Pesticides' website at www.beyondpesticides.org.

Eating sustainably grown organic and regenerative organic food is good for you and the planet. It is the healthiest food you can buy, produced in a farming system that ensures food security for future generations because it builds soil fertility and biodiversity to keep crops growing. When you see an organic label on produce or packaged foods, you can feel confident that it has been inspected by a third-party certifier in accordance with a strict, legally binding system of crop production.

By buying organically grown food you are intentionally supporting sustainable organic systems of production. You are helping to change our country's food system and make the world a healthier place to live. Your food dollars go towards the preservation of soils, ecosystems, farmworker and community health, and the ability of future generations to grow their food.

Optimize Your Organic Dollars

Shoppers often consider the cost of their purchases above all else when buying food. But the many public health and environmental costs from growing pesticide-intensive, cheap food discussed in this report are borne by us all. Here are some ideas about how to optimize your organic dollars:

- Download the Seasonal Food Guide App to find out what's in season; in-season produce is often cheaper than out-of-season produce.
- Buy locally grown produce in season from your nearest farmers' market.
- Buy dried nuts, beans and whole grains from the bulk bin.
- Cook fresh vegetables and whole grains at home.
- Freeze fresh fruits and veggies right away after purchasing, during the height of the growing season. Store in glass containers to preserve their flavor and to help prevent freezer burn.
- Dry or dehydrate fresh fruits yourself at the peak of the growing season to maximize taste for future use.

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Our challenge as a society is to find ways to facilitate access to sustainably grown organic food for everyone. That means paying a fair wage to those who work in the organic food supply chain so that they can enjoy the bounties of their labor by eating fresh, organic produce. It means ensuring that sustainably grown organic food reaches underserved communities that have limited access to fresh food choices. It also means ensuring that organically grown food is served as a matter of course in our school cafeterias — because all children deserve to eat healthy, fresh, organically grown food, every day.

It is up to all of us to use our knowledge and collective power to fix our broken, toxic food system and secure a healthy, organic and regenerative food future for generations to come.

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