Food & the Environment

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It is hard not to get emotional about your food. It is our most intimate and primary contact with the outside world. Our culture is distracted by the mythhood that our food is raised with regulated purity. Yet our American diet is laced with toxic chemicals routinely, arrogantly, and carelessly injected into our food by our industrial agricultural system.

Anger, indignation, and outrage arise from the seeming impunity of the machine. Alarm, dread, and worry orbit around fear of the pervasive danger, not only to consumers, but the greater environment as well. The average person seeking to protect themselves and their families often seems overwhelmed, exhausted, and intimidated by inability to defend themselves due to the immensity of the problem. It is hard not to get emotional about your food.

• You cannot even leave a grocery store before you are exposed to toxins from receipts. Americans use 640,000 tons of receipt paper per year, much of it found in food stores, using toxins that disrupt the endocrine system.

• You cannot even begin to eat your food without being exposed to heavy metals, plastics, and toxic chemicals leaching into it from containers, cookware, and dishes.

• About half of U.S. agricultural topsoil has eroded, and our country loses it 10 times faster than it is replenished. America compensates by using about 23 million tons of synthetic and mineral fertilizers annually, which create ozone air pollution, greenhouse gas emissions, and huge "dead zones" in the ocean from fertilizer run-off into rivers. Human sewage sludge contaminated with pharmaceuticals, flame retardants, and other toxins is also used as fertilizer.

• About 900 million pounds of agricultural pesticides are used annually, not including their "inert ingredients" which are sometimes more toxic than their "active ingredients."

• Many people believe that since most pesticide food treatments are not acutely toxic, they do not hurt you. In fact, many pesticides are endocrine disrupting chemicals that can cause harm in levels at parts per billion and even parts per trillion. These substances can cause, or contribute to: asthma; attention-deficit/hyperactivity disorder; autism; birth defects; cancer; diabetes; heart and vascular disorders; infertility; obesity; and thyroid malfunctions. Developing fetuses, infants, and small children are especially vulnerable.

• Organic food, once ridiculed by critics as ineffective and impractical, is now purchased by 82% of American consumers. Though it represented 15% of produce sales and 6% of all food sales in 2018, it is still far from the norm.

• The $7 billion a year domestic baby-food market exposes the most vulnerable population to pesticides, heavy metals, plastic residue from packaging, and acrylamide, a toxic chemical produced during cooking.

• In 2017, 60% of food, fiber, and fuel crops grown in the U.S. were genetically engineered, creating medical and environmental problems, while causing financial losses to farmers whose crops are contaminated by these new genes.

• Americans eat more animal food per capita than almost any other country. In 2018, America consumed 93 billion eggs, 34 million cattle, 110 million pigs, 7.7 billion chickens, and 26 billion gallons of milk, enough to fill Lake Austin 4 times! Most of this food is contaminated or tainted with toxic chemicals and antibiotics. The sheer amount of land needed annually to raise feed, forage, and hay for American livestock is equal to the state of California.

• Between 1970 and 2012, global marine life declined 52%. Due to dwindling supply and increasing demand, roughly half of fish eaten by people are "farmed" in captivity rather than caught in the wild. This presents a host of medical and environmental challenges, including chemical contamination, sewage disposal, and harm to other wildlife.

This article of the *Directory* dedicated an immense amount of time to research and evaluate the toxins in conventional food, and carefully details how we can best avoid them. The reader will be hard-pressed to find another publication in Austin that has gone to these levels of detail.

And if there is a positive emotion that can surmount the anger, fear, and lack of security, it would be *hope* based on the existence of healthy alternatives. Organic food provides an oasis to the nutritional desert of industrial agriculture. If we work hard, in 30 years, it can grow to a rainforest.

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Before We Dine
Toxins in Food Purchase and Preparation

Every effort to find food free of hazardous chemicals and adulterants will go unrewarded if the environment you purchase and prepare the food in is laced with toxins. And it is: from the toxins in receipts before you even leave the grocery store; to the containers and wrappings that leach contaminants food is stored in; to cooking vessels with toxic metals and coatings.

This story will advise conscientious consumers on these hazards, *and specific ways to avoid them*, as a prerequisite to protect the purity of the food products discussed throughout this article.

Toxic Grocery Receipts[1]

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The first thing you can do to lower your chemical exposure from food is to stop receiving receipts from grocery stores. The U.S. consumes about 640,000 tons of receipts every year. Most modern paper receipts contain chemicals impregnated in the seemingly blank paper. When heat is applied to the paper by the register, chemical "developers" transform another seemingly transparent color-forming chemical into images.

Most of these developers are, to some degree, toxic, and can enter peoples' bodies through simple contact with the skin. Even if you refuse to take or handle receipts, they are on the hands of the grocery store checkers, who (to a limited degree) expose you to the chemicals by handling and bagging your food and giving you change. Studies have shown that trace amounts of receipt chemicals contaminate the cash currency around the world.

The most infamous developer chemical used in receipts is Bisphenol A, more commonly referred to as BPA. The chemical is similar to the female hormone estrogen, and reacts in our bodies as an endocrine disruptor, developmental toxin, and reproductive toxin.

Various scientific studies have linked BPA to: attention deficit/hyperactivity disorder; heart disease; reproductive impairment (infertility, miscarriages, premature deliveries in women/reduced sperm count in men); type-2 diabetes; thyroid conditions; asthma; breast and prostate cancer; impaired liver and kidney function; and obesity.[2] In some cases, it is believed to alter genes that can cause inherited health problems in future generations.

Because of BPA's particular danger to infants, the U.S. Food and Drug Administration banned its use in baby bottles and sippy cups in 2012, and banned its use in infant formula packaging in 2013.[3] Japan banned BPA in thermal paper in 2001.[4] The European Union will ban it in 2020.[5] The states of Connecticut and Illinois have banned the use of BPA in thermal paper, and the state of California is considering such a ban.[6]

While not prohibited in other U.S. states, widespread health concerns have caused a significant voluntary decrease of its domestic use. A 2018 survey of thermal paper showed that only 18% of receipts contained BPA.[7] Unfortunately, most of the balance contained its chemical cousin BPS, which can cause many of the same health concerns.

While thermal paper may expose purchasers to chemical dangers, they create a much greater risk to grocery checkers who are constantly exposed to them. Studies have found that retail clerks that handle receipts have elevated levels of these chemicals in their bodies. Hand sanitizers commonly used by clerks increase absorption of BPA through the skin; one study stated the magnification of absorption was 185 times greater.[8]

Skeptics to this potential for chemical harm would argue that avoidance of thermal paper receipts for the average person (i.e., not a retail clerk) is overly cautious. Most studies have determined that BPA and BPS are not bioaccumulative, and if reexposure does not occur, much of the chemical is eliminated from the body in a few days. Further, a single exposure is not lethal, and in the case of these chemicals, skeptics would argue that the dose makes the poison (that higher doses are more dangerous).

This ignores: 1) the risk to fetuses, infants and young children, who are more susceptible because of lower body weight; 2) the risk to pregnant women who may also be more susceptible; 3) that receipts are one of several contributing sources of BPA contamination. (Other sources include food containers, house dust, and carbonless copy paper.) There is also a countervailing opinion from some scientists that there is no safe threshold for phenol chemicals.

To avoid toxic thermal paper, consider the following steps.

1. Wash hands with water quickly after handling receipts. (More than 4 minutes is too late.)
2. Keep away from children. Receipts are not a toy.
3. If you need to handle receipts with phenol chemicals

repeatedly, wear gloves, and do not use sanitizers.

4. Avoid paper receipts whenever possible, either by asking the clerk not to hand you one, or receiving it electronically.

5. If you get one, fold the print side in, since the back is not usually coated with developers.

6. Keep receipts in a separate bag or envelope to keep them from exposure to people, objects, or materials.

7. Many experts recommend throwing away phenol receipts rather than recycling them because the chemicals can, to some degree, contaminate the recycled paper supply.

8. If you are unsure if a receipt has phenol in it, scratch it with a coin or sharp edge. If a dark streak is left, this shows that a phenol chemical is present.

Another thing you can do, assuming you have the time, is influence businesses and services that you frequent to use electronic receipts and/or alternative thermal-paper products free of toxic phenol chemicals. A list of alternative products is below.

Phenol-Free Thermal Receipt Paper	
Appvion – POS Alpha Free	appvion.com
Iconex 2ST	iconex.com
Koehler– BLUE 4EST	koehlerpaper.com
Koehler KT 48PF	koehlerpaper.com
Pergafest® 201	products.basf.com

Contaminated Containers, Cookware, & Dishes

The history of human nutrition is scarred with examples of people contaminating food by storing and cooking it in contact with toxic heavy metals.[1]

Hazardous effects of lead have been observed through much of recorded history. An Egyptian text thousands of years old noted lead could be fatal. The Greek physician Hippocrates described symptoms of lead poisoning as early as the 5th century BCE, including lost appetite and weight loss, colic, pallor, fatigue, and nervous spasms. Damaged vegetation was observed near ancient smelting sites. It was also observed that cows and horses could not be pastured near lead mines without increased illness and death.

History of the Roman Empire described acute toxicity to lead miners and metal smiths. In the aristocracy, loss of intelligence, insanity, sterility in men, and infertility and stillbirths in women were all attributed to lead consumption, with some historians believing lead eventually contributed to the fall of the Empire itself.

During the Roman Empire, lead had many uses. It provided plumbing conduits for some of the first and largest modern water supply systems in the world. Lead-based pigments were employed in cosmetics for the aristocracy. However, one of its other fundamental uses was to cook wine in lead containers; this was preferred to other materials because "lead sugar" (lead acetate) acted as a sweetener. And other Roman lead-containing cookware and pottery used for food were common.

Pewter tableware was made of tin and copper, often mixed with other metals antimony, zinc, bismuth, and in lower-quality versions, lead. Pewter was used by the Egyptians and Romans before the Common Era. In Middle-Age and Renaissance Europe, and later in the American colonies, pewter tableware, mugs, and tankards were widely employed. According to one source, lower-grade Medieval European pewter could contain between 10 and 75% of this toxic heavy metal, which would leach into food that came in contact with it.[2]

Bronze cookware from before the Common Era directly exposed food cooked in it to the metals it was made with. Bronze is a copper alloy. Its predominant co-metal is tin, but it often appeared with other metals, either intentionally to enhance its quality, or as contaminants. These included lead.

Copper from bronze could leach into food cooked in it (particularly salty or acidic food). While copper is essential for human nutrition in small quantities, it is harmful if over-consumed. It could also carry a bad taste into food. Verdigris, the greenish oxidation that taints copper, is outrightly poisonous, and would also find its way into food from unclean cookware.

Brass was another copper alloy sometimes used for cookware; its main additive was zinc. Some versions included other metals though, such as lead and arsenic.

As copper food vessels became more common in the 18th century, they were lined with tin to prevent problems associated with copper leaching. However, poor quality tin could also be contaminated with lead. Further, the tin lining would eventually wear away, and the cookware would have to be retinned, again sometimes with lead contaminant.[3]

Lead solder was heavily used as a sealant for the first tin cans, circa 1810, which also leached into food.[4] Evolving canning technology greatly reduced, but did not eliminate, lead used in can sealing until the late 20th century. In the U.S., metal solder in cans was not consciously targeted for removal until 1979.[5] Over the next 12 years, the domestic canning industry voluntarily switched to lead-free technology. By 1991, the industry had completely eliminated lead use. Even then though, lead-tainted cans were used for about 10% of canned-food imports. The U.S. Food and Drug Administration did not actually outlaw lead solder in cans until 1995.[6]

Food-containing pottery was, by necessity, manufactured with glazing to render it non-porous. In many cases, lead-based glazing (that could leach into food) was the material of choice, and lead pigments were also used as colorants. Toxic colorants other than lead in frequent use included: cadmium; copper oxide and copper carbonate; chromium oxide; iron chromate; manganese dioxide; selenium; and

uranium oxide (which is radioactive as well as poisonous). "Potter's disease" was a common name given for chronic lead poisoning to clay workers who used lead glazes.[7]

Chronic exposure to lower doses of lead was not really understood until the 20th century. Manifestations can include: high-blood pressure, heart disease; death; cancer; lowered intelligence, attention-deficit/hyperactivity disorder, and behavioral problems in children; increased levels of low birth-weight babies, premature births; spontaneous abortions; lowered fertility; and increased kidney dysfunction.[8] Lead is a persistent bioaccumulative toxin, and there is no completely safe dose.

While these foolish past risks of toxic metal exposure can be condemned, they can to some extent be understood by the lack of scientific knowledge. Such rationalizations cannot be made today. One would assume that with these tragic precedents, our society would be wary. However, lead and other heavy metals are still found in some modern containers and cookware, as well as legacy ware and antiques. Worse, other potentially dangerous metals, chemicals, and plastics have also found their way into most modern kitchens.

Containers

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Ceramics and Glass – This class of food containers can be rated as both the best and worst. At their best, ceramics and glass are inert and contain no harmful substances that can leach into food. However, for thousands of years, lead glazing and heavy-metal pigments have been used worldwide in ceramic dishware, serving ware, and pottery used for food storage.

The U.S. Food & Drug Administration has enforced ceramic safety regulations for lead since 1971, with even more advanced regulations in place since the late 1980s. These rules still allow the metal to be used in the glazings and pigments, but require the metal to be 'baked in' to the material so that it does not leach into food in more than minute quantities.

California's "Proposition 65" regulations (initially started in 1986 by an initiative election to make knowledge about toxic chemicals in consumer products available to the public) have even stricter criteria for lead leaching. State rules address dishware, glass, and ceramic mugs for lead content in the material *as well as* in exterior decorations. Either lead levels must be prescriptively low, or the product or product packaging must carry a (yellow-triangle) warning that the product does not meet Prop 65 standards. Since California is the largest consumer market in the U.S., its lead regulations are the de facto standard in America. Some manufacturers go even further to manufacture no-lead and low-lead products due to health concerns.

CHART F1 – RATINGS FOR FOOD CONTAINERS, DISHES, AND WRAPPING
(From Best/Green to Worst/Red)

Ceramics & Glass
Stainless Steel
Silicone
#5 – Polypropylene Plastic (PP)
#2 High Density Polyethylene Plastic (HDPE)
#4 Low Density Polyethylene Plastic (LDPE)
Bioplastics
#1 Polyethylene Teraphthalate (PET)
Metal Cans & Containers Lined with Polyester and Plant-based Resins
Aluminum Foil
Metal Cans & Containers Lined with BPA, PVC, & Styrene Resins
#3 Polyvinyl Chloride Plastic (PVC)
#6 – Polystyrene Plastic (PS)
#7 Other Plastic (Including Polycarbonate with BPA)
Black Plastic
Fluoropolymers

However, legacy and antique materials that are more likely to be contaminated still exist in large quantities. These older products, as well as some hand-made products, have a higher chance of leaching lead, sometimes at dangerous levels.

The bottom line is: unless you purchase low-lead/no-lead products, there are increased levels of risk for lead intake.

Stainless Steel – This is another relatively benign food-compatible material. However, it is not inert. While less of a concern than metal materials such as aluminum, stainless does not rust because it contains chromium (18%) to prevent rust, as well as nickel (up to 16%) to make it shinier. Both can leach into food, particularly under the stress of lengthy heat cycles or acidic food.

While the amount is rarely if ever acutely toxic, about 10% of the public is allergic to nickel, with dermatitis being the most common reaction. This reaction is more prevalent in women.

A 2013 study by Oregon State University showed that nickel from stainless cookware leached into (naturally acidic) tomato sauce at levels that could affect people sensitive to it when it was cooked for 6 hours.[9] Chromium also leached, though at levels not expected to be harmful.

AVOIDING LEAD IN CERAMICS AND GLASS

1. *Buy no-lead and low-lead products.* Even if you buy new products made to U.S. safety standards, if they have high amounts of lead, they can still eventually leach more than the standards allow due to chips, silverware scratches, and wear. Sourcing the right products at the beginning is your best option. The term low-lead generally means 90 to 100 parts per million or less. Even if chipped, scratched, or worn, there is not much lead there to harm people.

2. *Lead testing offers clues.* But it is not always cost effective.

Lead test kits purchased in hardware stores are sometimes helpful. However, they only offer clues and are not definitive. They will measure positive at no lower than 600 parts per million, and will not measure the amount of lead actually embedded in the product.

There are expensive X-ray fluorescence (XRF) analyzers that measure the lead and other metals embedded in a product, but these devices cannot ultimately tell how much of the embedded metal has leached or will leach in the future.

There are also laboratories that can actually measure the lead that has leached into a vinegar solution that has been sitting on or in products for several hours. However, testing numerous dishes numerous times over the years can be costly and time consuming.

3. *Avoid products that are generically suspect.* Though every single product is different, there is a greater probability of finding lead in the following items:

- Traditional glazed terra cotta made in some Latin American countries (such as Mexican bean pots) unless labeled lead-free;
- Highly decorated traditional dishes used in some Asian communities;
- Home-made or hand-crafted tableware, unless the maker uses a lead-free glaze;
- Bright colors or decorations on the dish surfaces that touch the food or drink. This includes the upper rim of a cup or bowl;
- Decorations on top of the glaze instead of beneath it;
- Legacy tableware purchased before the late 1980s, or antiques (second-hand stores are china roulette);
- Products with corroded glaze (that might release lead), or a dusty or chalky grey residue on the glaze after washing the product (which may indicate released lead).

4. *Limit kitchen practices that increase risk.*

- Do not heat food on stoves or in microwaves in dishes that might contain lead. Heat speeds up the leaching process.
- Do not store foods in dishes that might contain lead. Time enhances the leaching process.
- Do not eat food in dishes that might contain lead with highly acidic foods or drinks. Acid enhances the leaching process.
- Do not wash dishes that might contain lead in a dishwasher. This can degrade the glazing and make leaching more likely.

Still, the study noted that exposures from these metals in cookware could combine with metal exposure from other sources to contribute to a higher level of ingestion.

To avoid nickel in stainless cookware and eating utensils, look for the rating that notes the percentage of metals in the product. You will see the number 18 (standing for 18% chromium), followed by /16, /10, /8/ or /0 (standing for the percentage of nickel). The 0% nickel rating really means no more than 0.75%, but this is still a dramatic reduction compared to other products with the same material. A 0% nickel product will generally not shine as bright as products with a higher percentage, but this should not diminish it functionally.

Silicone – Food-grade silicone products are smooth, lightweight, water- and impact-resistant, and can be manufactured to be air tight and easy to clean. They can include: bottles; dishes and cups; storage containers; and even sealable bags similar to plastic. Most studies show silicone either does not leach its constituent chemicals into food, or that such leaching is not significant or dangerous.

Some molded products contain cheap fillers that have been known to smell when heated. This is indicated by a white gel-like substance that appears when the products are squeezed. So purchasers of silicone cookware should look for higher-quality products. Also note that though products are in widepread use, some chemically sensitive people react negatively to them.

Metal Cans and Containers – BPA is not just in receipts. It is also in the resin that lines many canned products, as well as the plastic liners in many metal bottle lids. While these linings prevent metal exposure to food, they leach phenols instead.

Some food manufacturers have changed to alternative resins for can liners. However, they are either not safe, or their safety is unknown. More dangerous resins include vinyl (with PVC) and acrylics (with styrene), both of which are carcinogens. While other alternatives such as polyester and plant-based resins are more benign, they may include toxic additives that are not listed because of the proprietary nature of these commercial products.[10]

The following suggestions will help you more safely use container products.

1. Limit the canned food that you eat. Live food is healthier than processed food anyway.

2. Find out if products that you purchase have phenol in the containers. This may require phoning the companies or referring to their Web sites. The state of California has compiled a Web site list of processed food companies and their container policies (see the Sidebar in this story).

3. Rinse canned foods, which will limit phenols and other liner chemicals that leach into them, as well as undesirable nutritional additives such as salt and sugar.

4. *Never* heat food in a can. Transfer it to a proper cooking container.

Aluminum Foil – Aluminum is neurotoxic, and excessive amounts of aluminum can adversely affect health. Cooking with foil can leach aluminum into food cooked in it, particularly if the food is spicy or acidic.[11] Using foil to store cold food has less risk, but even then, acidic foods and foods stored for longer periods of time are vulnerable to leaching if they are wrapped in it.

Plastic Containers and Film – There are 7 main types of plastics that food and liquids are commonly sold and/or stored in. Many of these have toxic additives that can leach into the products, even if the plastic resins themselves are relatively safe. In most cases, the additives are not disclosed, as they are trade secrets of container and film manufacturers. Below is a quick review of the major plastic types, with their recycling codes that make reuse easier, their respective concerns regarding leaching, and which ones to avoid whenever possible.

1 Polyethylene Terephthalate (PET) – Common uses include: soda, condiment, and sports-drink bottles; and single-use water bottles. The toxic metal antimony, which can cause anemia, gastrointestinal and heart problems, and muscle and joint pain, is used in this material's production, and can leach into food products, particularly in the presence of heat or sunlight.[12] Also, the longer a product is stored in PET containers, the more likely that leaching will occur.

Reuse of PET containers should be avoided, as the more degraded this plastic becomes, the more likely it is to leach.

2 High Density Polyethylene (HDPE) – Common uses include: milk jugs; food and beverage containers; detergent bottles; cosmetic bottles; cereal-box liners; and many kinds of bags. While generically considered one of the safer plastics, additives can leach estrogenic chemicals into food under certain conditions.[13]

3 Polyvinyl Chloride (PVC) – Uses include some types of food wrap such as shrink wrap, and clear food packaging. PVC is considered the most toxic of all common plastics. It is a developmental and respiratory toxin, and can be toxic to internal organs. When used as food packaging, it usually contains phthalate softeners that are endocrine disruptors. Even though some PVC packaging has a recycling arrow on it, do not recycle. It can contaminate other plastics in batch recycling programs. *Avoid whenever possible.*

Environmental Food Rating Information
BPA Packaging Database

Jan Schneckenhaus /Shutterstock.com

Proposition 65 BPA
kellydigital.com/q-store/store/prop65bpa.asp
Under the "Proposition 65" law in the state of California, food product companies are required to list products that have BPA in their food containers. This Web site has a downloadable list for consumers who want to avoid them. In some cases, the list also states when the company intends to switch to BPA-free containers.

4 Low Density Polyethylene (LDPE) – Common uses include: produce bags; wrap; plastic trays; and snap-on lids. Similar to its chemical cousin HDPE, it is generically considered one of the safer plastics, but it can leach estrogenic-chemical additives under certain conditions.

5 Polypropylene (PP) – Common uses include yogurt, margarine, and deli containers. This material is generically considered the safest of common plastics for food storage because it has a high tolerance to heat, but there is no certainty of what additives have been used without transparency from the manufacturer.

6 Polystyrene (PS) – There are two types of this plastic used to package food. Extruded polystyrene creates more rigid containers used in applications such as yogurt cups. Expanded polystyrene foam is used in a wide array of applications such as: self-insulating coffee cups; disposable plates; take-out trays; and supermarket meat trays. Among its more toxic constituent chemicals are styrene and (to a minimal degree) benzene, both carcinogens that can leach from the material, particularly in the presence of heat.[14] *Avoid whenever possible.*

7 This catch-all category for uncommon plastics. The most common of these uncommon plastics used for food storage is polycarbonate (PC). The material is frequently employed to manufacture durable (reusable) water bottles, and BPA is used as a constituent chemical in

many PC products. PC leaching is even more pronounced in the presence of heat. However, some PC products are made without BPA. *Unless #7 plastic can be sourced and/or tested for its chemical content, it should be viewed with suspicion regarding leaching of hazardous substances.*

Bioplastics – Deriving plastic from plant-based sources instead of petrochemicals has become more common over the past two decades. While food packaging made from bioplastics is generally more biodegradable in commercial composting operations than conventional containers, bioplastics still might contain toxic additives.[15] If product suppliers do not disclose this information, do not assume bioplastics are immune to concerns about chemical leaching.

Black Plastic – In 2018, a study conducted in the U.K. found that products manufactured with "black plastic" were frequently made with resin sourced from recycled electronics.[16] This resin is frequently contaminated with bromine fire retardants, heavy metals, and may also contain phthalates. And sometimes this feedstock is used in products exposed to food, including single-use coffee cups, coffee-cup lids, eating utensils, and food trays. *Unless black plastic can be sourced and/or tested for its chemical content, it should be viewed with suspicion regarding leaching of hazardous substances.*

If you do use plastic storage containers, consider ways to use them more safely. They are more likely to leach toxic additives:

- when they are heated (including by hot stored food and in hot cars);
- when exposed to sunlight;
- when they store acidic foods (such as tomato sauce) or fatty foods (such as meat and cheese);
- if they have abrasions and scratches from repeated use;
- if cleaned in dishwashers.

Also, keep in mind that older containers are more likely to leach than newer ones.

Fluoropolymers – Though they are not used everywhere, chemicals similar to Teflon™ are frequently applied to food packaging because they make the food less likely to stick or make food grease less likely to spill. Unlike Teflon™, which some of its defenders claim is an inert substance, these chemicals have been proven to leach into food.[17] Food-package applications that might use fluoropolymers include fast-food wrappers, French-fry boxes, single-use plates, bakery bags, microwave popcorn packages, and pizza boxes. Consuming junk food has its own inherent risks; they can only increase with exposure to these chemicals.

Health effects associated with exposure to this class of chemicals include learning and developmental problems in children, low-sperm counts in men and fertility problems in women, high cholesterol, increased liver enzymes, decreased vaccination response, thyroid disorders, pregnancy-induced hypertension and preeclampsia, and testicular and kidney cancer.[18]

Cookware

JShaiith /Shutterstock.com

Inert Mineral-Based – Cookware made with inert minerals include non-coated glass (such as Pyrex), glass-ceramic (such as Corningware, and total ceramics (such as Xtrema and Emil Henry). They can withstand high amounts of heat without leaching toxic chemicals or metals into food or liquids being heated.

They are not as resilient to fast temperature changes as other materials. Cracks can sometimes occur due to abrupt temperature changes (e.g., from oven temperatures to cold wash water). And they are breakable if dropped.

Also keep in mind that products made of borosilicate can tolerate sudden temperature changes better than those made with soda lime silicate.[19] Because of this, they are much less likely to shatter under this kind of stress.

Older ceramic cookware (including antiques), as well as some imported products, may have lead, cadmium, and other toxic heavy metals in the glazes and pigments. It would be prudent to test them before use.

Titanium – Titanium is one of the strongest metals ever manufactured, and one of the least impactful on human health. It does not leach or provoke allergic reactions in people. There are 3 types of cookware made with it.

Camping cookware uses this metal in pure form because it is light weight, though these implements do not heat evenly and are not appropriate for common kitchen use. Some cookware has its cooking surface lined with scratch-resistant titanium, while the underlying metals of stainless steel and / or aluminum allow even heat distribution. And there are other hybrid products with steel or aluminum bases below a titanium-ceramic cooking surface.

Cast Iron – Unlike mineral-based materials that can break if dropped, it is more likely that cast-iron cookware will break whatever it falls *on*. It can literally last a lifetime if properly cared for. This class of materials needs to be seasoned by heating oil in it, which seals the pores and makes the cookware much easier to clean.

CHART F2 – RATINGS FOR FOOD COOKWARE (From Best/Green to Worst/Red)
Inert Mineral-Based
Titanium
Cast Iron
Carbon steel
Copper
Stainless Steel
Silicone
Porcelain Enamel
Non-Stick Ceramics WIthout Fluoropolymers
Aluminum
BPA
Fluoropolymer Coatings

It can leach iron into food, particularly if the food being cooked is acidic. Iron in acidic foods like tomato sauce can also carry an unflavorful metallic taste. Leached iron might be a health problem to people sensitive to the mineral, but it is not a danger to most of the general public.

Carbon steel – Carbon steel has the same benefit of durability as cast iron, but is much lighter, less brittle, and heats more evenly. It still must be seasoned though, will still leach iron, and is still not optimal for cooking acidic foods.

Stainless Steel – As discussed in the container section, this is a relatively benign material, but it can leach nickel and chromium, particularly with prolonged cooking or acidic food. About 10% of the public is allergic to nickel, with dermatitis being the most common reaction. To avoid nickel in stainless containers, cookware and eating utensils, look for the rating that notes the percentage of metals in the product.

Silicone – Silicone rubber is used to make molded cookware, or to coat metal cookware. It is valued for its non-stick qualities. Most studies show it either does not leach chemicals into food, or that such leaching is not significant or dangerous.

Products with silicone *coatings* on metal do wear over time. Consumers should also note that some molded products contain cheap fillers in the rubber, which have been known to smell when heated. This is indicated by a white gel-like substance that appears when the products are squeezed. So purchasers of silicone cookware should look for higher-quality products.

Porcelain Enamel – This generic type of cookware uses baked enamel over a metal substrate of cast iron, aluminum, or stainless steel. The enamel on the inside of most products is inert and safe. While some products are incredibly durable, harm can occur if the enamel wears away or is chipped. Food can be exposed to the metal (particularly worrisome for an aluminum substrate), and the chips are not something people want to swallow. Consumers may want to discard the products at that point.

Copper – Older copper cookware (such as antiques) can leach unacceptable amounts of copper into food and should be avoided. Most copper cookware sold in the U.S. today is a hybrid with a copper base and a stainless steel, ceramic, or tin cooking surface, and is safer.

However, that assumes the surface is not scratched to allow food to come in contact with the base. Once steel or ceramic linings are damaged, they cannot be restored and the vessel cannot be used safely. While gourmets love copper cookware with tin coatings because of its precise flow of heat, the additional time and money for retinning will usually be spent only by dedicated chefs and foodies.

Aluminum – Though aluminum is benign in small quantities, it can be neurotoxic in larger doses. This concern is one reason that much of the aluminum cookware in the U.S. is now anodized. While this may reduce its leaching into food, there is evidence that it will not eliminate it.[20] And if the anodized coating is scratched because of cleaning or wear, leaching will become more pronounced.

BPA – It is common for certain cookware and appliances such as coffee makers and blenders to be partially made with clear polycarbonate, which often has BPA in the resin. There are alternative products on the market that boast being "BPA-free." However, unless the manufacturers are stating what the alternative resin is made of, it is better to find alternatives made of glass, ceramic, or stainless steel.

Fluoropolymer Coatings – Polytetrafluorethylene (PTFE) is more commonly known by one of its trade names Teflon™, and is added to cookware as a non-stick coating. Its manufacturers and proponents try to portray the material as inert and not dangerous if used properly and not overheated. However, things do not always go right in a kitchen. (In 2019, 49% of house fires in the U.S. were related to cooking.)[21]

Overheating an empty pan coated with PTFE above its recommended level for safety can take place in 2 to 5 minutes, causing the coating to smoke and emit toxins.[22] The smoke has been known to kill pet birds and cats, while being strong enough to give people flu-like symptoms. [23] The long-term health effects for people contracting "Teflon Flu" are unknown.

PTFE coatings on cookware will also eventually wear off. Some of this goes into washwater, but it is inevitable that some of the coating molecules are ingested. The accumulation of fluorocarbons in food has not been widely studied. Avoiding this type of cookware is, at the least, a precautionary measure. And once the material does flake off, the underlying surface is usually aluminum, with its own inherent toxicity from leaching.

Courtesy Pixabay/ Alexas_Fotos

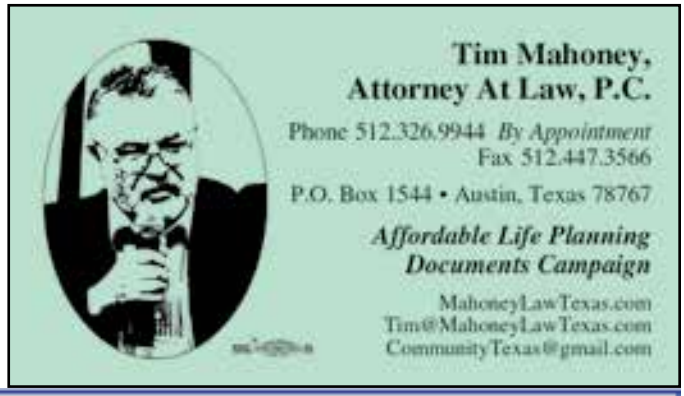
Consumers should beware that in the past, fluorocarbon PTFE coatings were made with the chemical PFOA. The base chemical has now changed, but it is not clear that the replacement is better than the old ones. So if you see a pan labeled non-stick but "PFOA Free," it is quite possible it is using a replacement fluorocarbon and not a safer technology.

Other reasons to avoid this cookware are its upstream production and downstream disposal concerns. Production of fluoropolymers is extremely toxic, with documented contamination to neighbors and the environment surrounding manufacturing sites. Cleaning treated cookware, accidental fires, and ultimate disposal of worn cookware create further pathways for PTFE to be released into the environment.

Non-Stick Ceramics Without Fluoropolymers – This class of cookware uses a ceramic surface over a metal base of aluminum or steel (or a hybrid of the two). A non-stick coating made without fluorocarbons is applied to the surface.

While some consider this cookware a safe alternative to Teflon®, many of these products use coatings made with nanotechnology. These coatings are relatively new and unstudied, and may pose harm to consumers. For instance, a 2016 study showed that rats consuming food-grade titanium dioxide nanoparticles developed immune disruption and precancerous lesions in their colons.[24]

Consumers looking for safe cookware might want to exercise the precautionary principle and wait until the safety of these products is more proven.



Pesticides on Plant Food

In 2016, about 15% of all fruits and vegetables sold in the U.S. were organic.

Critics of organic food often use the argument that since the residues are so minute, the dangers from conventional pesticide treatment are inconsequential. This greatly oversimplifies that debate.

1. Many hazardous ingredients in pesticides are not measured for residues.

"Inert" or "other ingredients" including toxic solvents and adjuvants that make pesticides more lethal make up anywhere from 0 to 99.9% of a retail product. In 2014, a French study on the hazards of various pesticides on human cells proved that the whole products, including solvents and adjuvants, were, on average, several hundred times more toxic than the limited residues of active ingredients they were tested for.[1]

2. Pesticide combinations are never analyzed for harm.

When pesticide restrictions are set by the U.S. federal administrative process, the thresholds of harm are estimated by human exposure to one active pesticide ingredient at a time. In the real world, several pesticides can be applied during different cycles of a food crop's cultivation, with multiple measurable residues upon harvest.

In 2018, the U.S. Department of Agriculture pesticide residue monitoring program found almost 30% of fresh and processed fruit and vegetable samples contained at least two different types of pesticide residues.[2] An extreme case was kale, where about 10% of samples contained at least 10 different types of pesticide residue. The worst kale sample showed 17 different pesticides.

Not only can these harmful pesticides be additive, they can also be synergistic, with a pesticide "cocktail" being more potent and damaging than the original ingredients themselves.

3. Current Limits Do Not Reflect Harm from Endocrine Disrupting Chemicals.

That pesticides cause acute and chronic harm at certain thresholds is beyond dispute. These products cause illness from extreme exposures, and chronic diseases such as cancer, when exposed to elevated levels over a period of time. However, even much smaller doses can affect the endocrine system, contributing to related diseases and maladies such as asthma, diabetes, obesity, heart disease, infertility and reproductive problems, and learning disabilities in children.

Unlike acute poisoning, human hormone interactions take place at levels in the parts per million, billion, and trillion range, similar to what can be found in pesticide residues on food.

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Imported Pesticides on Imported Foods

In 2017, about 32% of the fresh vegetables and 55% of the fresh fruit were imported.[3] The U.S. Food and Drug Administration also conducts an annual residue monitoring program. To some degree, the program concentrates on foods and countries that have repeated violations. Thus they are not statistically valid. Still, it is alarming that in 2017, the violation rate for samples that exceeded tolerance was 3 times higher for foreign food products than domestic ones.[4]

The following imported foods had high rates of violations. While not every product from every foreign country is suspect, the high rates for certain imported products provide another reason to buy American and buy local.

2017 Import Commodities With High Percent of Pesticide Limit Violations[6]

Commodity	Violation Rate (%)
Persimmons	80%
Celery	39%
Cilantro	37%
Raisins	29%
Radish	29%
Rice	24%
Figs	24%
Pepper, hot	23%
Spinach	23%
Carrot	21%
Pineapple	18%
Peas	17%
String beans	16%
Dates	15%

Avoiding Food Pesticides on a Budget

There are at least two strategies that can allow you to stretch your food budget farther and still avoid some if not most of the pesticides you are exposed to with conventional foods.

The first is to buy organic food selectively. Not every kind of produce accumulates pesticide residues at the same rate. Leafy vegetables such as spinach and kale, and soft fruits such as strawberries, cherries, and apples have higher average residues than crunchy vegetables like broccoli and cauliflower, as well as melons and pineapples.

Every year, the U.S. Department of Agriculture conducts pesticide residue tests on samples of produce. Several organizations have analyzed these tests to determine the relative contamination of different kinds of food.

The most current ranking of this kind is the *Shopper's Guide to Pesticides in Produce* by the Environmental Working Group.[5] The group divides the worst offenders ("The Dirty Dozen") from the least-contaminated varieties ("The Clean Fifteen").

The 2020 rankings are listed here, though these are generally updated annually each spring, and accessed on the Web site: **www.ewg.org.**

Spinach and kale were considered the most contaminated, with 10 to 80% more pesticide residue per weight than any other produce item. Over 90% of apples, cherries, kale, nectarines, spinach, and strawberries contained the residues of two or more pesticides. 70% of these cleaner produce samples had no residues at all. Only 6% of the samples detected two or more pesticides.

Environmental Working Group Shopper's Guide 2020

Worst Offenders	The Cleanest Produce
1. Strawberries	1. Avocados
2. Spinach	2. Sweet corn
3. Kale	3. Pineapples
4. Nectarines	4. Onions
5. Apples	5. Papayas
6. Grapes	6. Frozen Sweet Peas
7. Peaches	7. Eggplants
8. Cherries	8. Asparagus
9. Pears	9. Cauliflower
10. Tomatoes	10. Cantaloupes
11. Celery	11. Broccoli
12. Potatoes	12. Mushrooms
	13. Cabbage
	14. Honeydew Melons
	15. Kiwi

A second strategy goes further than simply washing food. While one should always wash produce, the effectiveness of many retail food-wash products at reducing pesticide residues any better than plain water lacks proof. However, a 2017 study from the University of Massachusetts proved that soaking apples in baking soda mixed with water (1 teaspoon to 2 cups) was effective at removing 2 different pesticides from the surface of apples in time periods of 12 and 15 minutes (depending on the pesticide).[6] The effectiveness of this technique is not universal. Some pesticides are systemic, and this baking-soda method could not go past the surface of the fruit in removing them.

4. Pesticides add to toxic exposure from other sources.

In the toxic world we live in, exposure to pesticides in food is added to exposures to toxins throughout the environment: air and water pollution; pesticides used to treat buildings and landscapes; and toxins in building materials, clothing, furniture, and personal care products. Avoiding pesticides in food limits the cumulative "body burden" of poisonous substances to which people are exposed.

5. There are outright violations of pesticide limits.

Even if you take the allowable residue limits the government administers at face value, and ignore the valid problems with them discussed above, there are violations. In 2018, the violation rate of federal pesticide tolerance limits on produce sold in the U.S. was 0.8%, and detections of pesticides with no established tolerance was 6%.[7]

This is all in addition to the more direct harm that befalls people that live in agricultural areas or that work in pesticide-related professions: farmers and farm workers; horticultural workers; people that live near farms exposed to pesticide "drift;" and pesticide applicators. Children and pregnant mothers carrying children can be exposed directly, or when family members bring home pesticide residues on their work clothes. Pesticides can also affect groundwater and municipal water supplies in agricultural areas.

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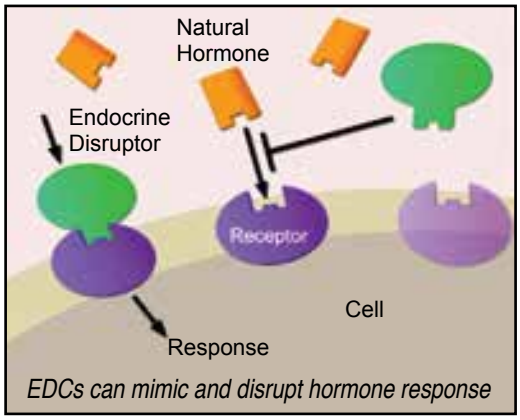
Pesticides Are Endocrine Disrupting Chemicals



EDCs can mimic and disrupt hormone response

© European Union. Source: European Parliamentary Research Service

Pesticides are acute toxins, causing illness and even death at high exposure levels. However, they can also cause long-lasting and even lifelong harm at extremely low doses that appear on food and in water because they are Endocrine Disrupting Chemicals (EDCs).

EDCs can have adverse effects on hormones that regulate metabolism, weight, and reproductive health. Their chemical structures are similar to hormones and mimic them, disrupting the natural signals and functions, sometimes speeding them up, while other times blocking their effectiveness. Still other EDCs act to change normal hormone levels or responses. This can occur even if EDCs appear in parts per million, billion, or trillion. EDCs can be the cause of, or contribute to: asthma; attention deficit/hyperactivity disorder; autism; birth defects; cancer; diabetes; heart and vascular disorders; infertility; obesity; and thyroid malfunctions. Prenatal infants and small children are especially vulnerable to EDCs because of their small size and developing bodies.

These hormone disruptors are not unique to pesticides. They are also present in many other common products such as building materials, cleaners, food preservatives, furniture, personal care products, and many things made with plastic. However, pesticides can be a common pathway because of how common it is to encounter them on (and in) food.

Control mouse and obese mouse. Obesogens can also affect succeeding generations.

Georgejason /Shutterstock.com

Obesity – Obesity in the U.S. has become pandemic. In children 12 to 19 years old, it quadrupled from 5% between 1966-70 to 21% in 2015-16.[1] Adult obesity has trebled from 13% in 1960-62 to 40% in 2015-16.[2]

While diet and lack-of-exercise play a role, so do EDCs known as "obesogens." Fat storage is controlled by hormones, which EDCs can alter. In the case of obesity, the problem compounds itself, because fat itself stores EDCs. The more fat caused by EDCs, the more EDCs stored in the fat. And EDC's toxic substances stored in fat cells can cause more harm than just obesity, including arthritis, cancer, cardiovascular disease, diabetes, gallbladder disease, sleep apnea, and reproductive and respiratory problems.[3] EDCs can also alter the normal body signals that control hunger, leading to more food consumption.[4]

This chemical-caused obesity can be transgenerational. In studies of mice that became obese after being exposed to EDCs, the trait was carried on in the next two generations.[5] This is believed to occur because DNA related to metabolism is enabled in the original parent and passed to the offspring.

U.S. health care costs for overweight and obese persons were $148 billion (2008 dollars), over 6% of total medical expenses.[6]

Impaired Intelligence and Development – In 2019, about 17% of U.S. children had developmental problems, including attention deficit/hyperactivity disorder (ADHD), autism, hearing loss, intellectual impairment, and vision loss.[7] Incidence of children with ADHD grew 71% between 1997-2018, from 5.5% to 9.8%.[8] Childhood autism more than doubled between 2000-2016, from 0.7% to 1.9%.[9]

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Pesticide-sourced EDCs affect thyroid function and nervous system transmission.[10] Studies have found links between exposure to organophosphate pesticides and ADHD and autism.[11] While some of these studies point to more harm at increased doses, some pesticides can be harmful at any level.

A review of various assessments estimated that the direct and indirect costs of ADHD in the U.S. ranged from $143-266 billion annually (in 2010 dollars).[12] The cost for autism is between $236-262 billion annually (in 2012), with about 3/4 of this being for adult (as opposed to children's) care.[13] This amounts to an average lifetime cost of $2 million per case. This does not account for the uncalculated stress on affected families.

Some scientists have attempted to calculate the cost to society for collective loss of intelligence. If one person loses 5 IQ points, it has a minor effect compared to 5 IQ points lost for every child. In a population of 260 million, it is the difference between 6 million and 9.4 million functionally disabled children, or a decrease in the number of gifted children from 6 million to 2.6 million.[14] A 2016 study estimated that organophosphate pesticides would cause $44.7 billion (2010 dollars) a year in damage due to 1.8 million collectively lost IQ points from 7,500 additional children with intellectual disability.[15]

Asthma - Between 2001-2018, 12-14% of children and teens under the age of 18 had developed asthma in their lifetime, with about 8-10% having active ("current") cases.[16] Teens 15 to 19 had a lifetime occurrence rate of 14-20%, while adults (18+) experienced a lifetime occurrence rate of 10-14%.[17] While active and lifetime occurrence asthma rates have been high but steady among children in this time period, the rate of asthma in teens 15 to 19 and adults has trended upwards.[18]

Asthma can be caused, triggered, or exacerbated by chemicals, including pesticides. It is caused by multiple mechanisms, including: irritation; immunosuppression; and endocrine disruption. Fetuses, babies, and young children are particularly vulnerable because their respiratory systems, endocrine systems, and bodies are in very early stages of development. The mechanisms of harm from EDCs are not all understood at this point. However, at least one clue is that obesity and Polycystic Ovary Syndrome sometimes triggered by EDCs are associated with increased asthma rates.[19]

The estimated cost of asthma in the U.S. was $81.9 billion in 2013, including $50.3 billion in medical costs, $3 billion in missed work and school days, and $29 billion in increased mortality.[20]

Cancer – People in America have a 4 in 10 chance of contracting cancer in their lifetime, and a 2 in 10 risk of dying from it.[21] The most common forms are breast cancer in women (1 in 8 chance of contraction and 1 in 38 chance of death); and prostate cancer in men (1 in 9 chance of contraction and 1 in 42 chance of death).[22]

About 1.7 million new cancer cases were expected in the U.S. in 2019.[23] About 17 million of the country's population alive in the same year had a history of the disease.[24]

The ways that EDCs cause or affect cancer are varied and sometimes multifaceted. Some of these chemicals "mimic" or resemble male ("xenoandrogen") and female ("xenoestrogen") sex hormones, and cause or contribute to development of cancer of the breast, prostate, or other reproductive organs. Some have "epigenetic" effects that enable or accelerate harmful traits in existing DNA, while others can damage developing prenatal, infant, and even adult organs, or mutate DNA.

In 2018, about $150.8 billion was spent in the U.S. on cancer-related health care.[25]

Reproductive Problems – About 13% of all women in the U.S. between the ages of 15 and 49 are believed to have infertility.[26] As many as 9% of men with these partners are also hampered with this problem.[27] If one overlooks this first hurdle to having children, consider the rate of: *miscarriage* –12.5%; *preterm births* – about 10%; *low-birth weight babies* – 8% (30% were not preterm); and *birth defects* – 3%.[28] These conditions have multiple causes, but they include EDCs.

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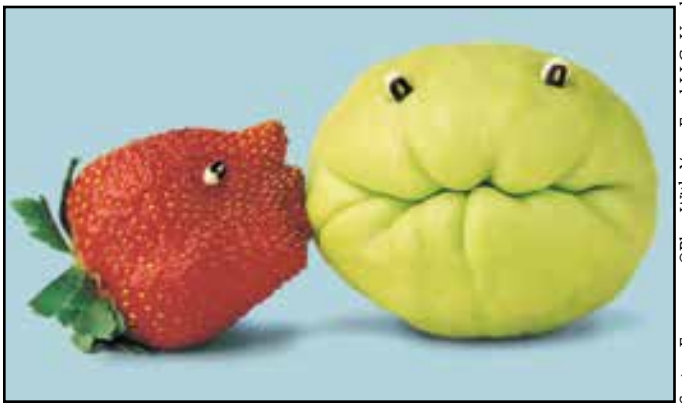
Infertility can be triggered by pesticides and other EDCs that alter sex organ weight and hormone function in both women and men. These chemicals can also lead to reduced sperm count and potency in men and early menopause in women.

Several scientific studies have linked increased incidence of preterm birth and low-birth weight babies to pesticides and EDCs. Preterm and low-birth weight babies are more prone to health problems and developmental delays than babies born full term or with average weight. Miscarriages can be triggered by obesity, diabetes, polycystic ovary syndrome, and thyroid problems, which can all be related to endocrine system irregularities.[29] And in one study of an herbicide, positive association with 11 birth defects was seen at a rate of less than 1 part per billion in potable water.[30]

The cost of preterm births was estimated to be $26 billion a year in 2005 dollars.[31] The cost of birth defects in 2013 was about $23 billion, with $6 billion alone for heart-related problems, resulting in 5% of total hospital costs.[32]

Organic Food



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Purchasing food that is labeled organic is a main way that American consumers can not only avoid ingesting toxins, but also enhance the nutritional value of their food. Organic food employs natural materials and processes to the greatest extent possible, and only falls back on pesticides and additives when other methods have failed. Even then, the pesticides and additives are the least-toxic chemicals available.

For several decades, organic food was ridiculed by critics as an ineffective, impractical, countercultural reaction to industrial agriculture. This has not stopped growing consumer acceptance. In 2016, 82% of Americans would admit to purchasing organic food and beverages.[1] An estimated 15% of produce sales and 6% of all food sales were organic, amounting to $52.5 billion in sales.[2]

Following is a brief description of the damage that our industrial agriculture system has created, and how organic agriculture can change it to be more sustainable.

Soil: Erosion and loss of nutrients from agriculture is one of the world's most pressing dilemmas. Without an adequate topsoil base, agricultural production sufficient to feed humankind could not occur.

Under natural conditions, topsoil that can support crops is created at the rate of about one inch every 500 years. [3] Due to erosion and degradation from nutrient and soil microorganism depletion, the U.S. has lost over 50% of its topsoil.[4] In 2015, U.S. cropland eroded at a rate of 4.62 tons per year, while natural soil formation occurred at a rate of only about 0.5 tons per year.[5] And while the U.S. loses soil almost 10 times faster than it is produced, China and India are losing it at a rate 30 or 40 times faster.[6] By one estimate, the world only has about 60 years of topsoil left.[7]

The bottom line is that the world's soils will produce substantially less food while demanding more water, fertilizers, and pesticides for the food that the deteriorating soil can still support. Meanwhile, the world's population is predicted to soar 47%, from 7.7 billion in 2019 to 10.9 billion by 2100.[8]

For industrial agriculture, soil is viewed as a kind of chemical sponge to which fertilizers are applied through intensive ploughing. Because of this, soil loses much of its: 1) carbon content; 2) nutrient value; 3) beneficial microorganisms; 4) ability to hold water; and 5) ability to support plant life without continued chemical and mineral inputs. Often the soil lays bare and unprotected after harvest, making the cropland more vulnerable to erosion from wind and precipitation. It is also common to burn or remove crop residues that could prevent some of this erosion or be used as a natural fertilizer. And it is common practice to plant the same crop for years at a time on the same land, simultaneously draining it of the nutrients the particular crop requires while allowing pests of the particular crop a better chance to establish themselves.

In contrast, organic agriculture fertilizes and builds soil quantity and quality with plant compost, manure, plant and crop waste (a.k.a. "green manure"), cover crops that simultaneously boost nitrogen and nutrient content while protecting from soil erosion, and crop rotation which can balance nutrients from different crops in different years. Crop rotation also makes it more difficult for pests to proliferate, since pests for one plant may not thrive on a different crop.

In the process of building the soil, several other beneficial things occur. One of these is greenhouse gas reductions, because organic agriculture adds carbon to the soil.

How much carbon can be stored in the soil will vary with crop, soil type, and climate. However, one analysis based on data from California estimated that if all of the state's cropland was farmed organically (instead of the 4% of cropland that was organic in 2017), the state's annual net emissions would decrease by 36.4 million metric tons of carbon dioxide equivalent gases, about 9% of the state's 2017 total greenhouse emissions.[9]

Soils high in organic matter are also better at retaining water. While 40% of rainwater falling on dry, uncovered soils is lost due to runoff, soils on organic farms can retain 90% of their weight in water.

Fertilizers: America used over 23 million tons of commercial crop fertilizers (nitrogen, phosphate, and potash) in 2014.[10]

As much as 1% of U.S. energy in that year was used to manufacture and utilize them, most of it in the manufacture of nitrogen.[11] Some of the nitrogen embedded in agricultural fertilizers is released into the atmosphere in the form of nitrogen oxides (NOx). Since NOx is a powerful greenhouse gas with a global warming effect 298 times the intensity of carbon dioxide, 4% of U.S. man-made greenhouse gas emissions were from fertilizers.[12]

NOX is also a major air pollutant, combining with Volatile Organic Compounds in the presence of sunlight in the atmosphere to form ozone that can aggravate heart and lung disease. About 17% of U.S. nitrogen dioxide emissions in

Differences Between Conventional and Organic Food in U.S.[13]	
CONVENTIONAL	**ORGANIC**
SOIL	
Synthetic Fertilizers (Nitrogen–Phosphorus–Potassium).	No Synthetic Fertilizers.
	Compost, Manure Fertilizers, Plant Waste, & Cover Crops used as alternatives.
	Natural sodium nitrate restricted to 20% of total N requirement.
Crop rotation to reduce pests and disease and increase fertility optional.	Crop rotation required.
Sewage Sludge Allowed.	Sewage Sludge Prohibited.
SEEDS	
No prohibitions.	Organic seeds preferred unless they are unavailable. Genetically Engineered (GE) seeds prohibited.
PESTICIDES	
900 substances approved.	25 substances approved.
Most major classes of synthetic pesticides allowed.	Most classes of conventional pesticides except chlorine (e.g., bleach) prohibited.
.	Highly toxic nonsynthetics also banned, including arsenic, lead salts, rotenone, strychnine, and tobacco dust.
	Non-toxic methods such as mulch barriers and beneficial insects preferred. Least-toxic controls (e.g., elemental copper, boric acid, and alcohols) used as last resort under controlled conditions.
PESTICIDE BUFFERS & WILDLIFE PROMOTION	
No promotion of other wildlife.	Hedgerows required as haven for pollinators and beneficial insects.
GENETICALLY ENGINEERED (GE) CROPS	
Allowed. Most/all U.S. canola, corn, cotton, soy, and sugar beets are GE. A small percentage of apples, papayas, potatoes, and yellow squash are also GE.	Prohibited.
IRRADIATED FOOD	
Allowed.	Prohibited.
LIVESTOCK	
More than 550 drugs approved.	22 drugs approved.
Usually raised in large Concentrated Animal Feeding Operations away from pasture, fresh air, sunlight, space for exercise, and sometimes clean drinking water. Conventional and/or GE feed, external growth hormones, and non-therapeutic antibiotics to healthy animals common.	Raised with access to pasture, fresh air, sunlight, space for exercise, and clean drinking water, as well as shelter and shade when required for health. Grain, when used, must be certified organic. GE grains, external growth hormones, and non-therapeutic antibiotics to healthy animals prohibited.
Grain is a staple of diet, supplemented by other sources. Some of these include chicken litter, plastic pellets, and rendered meat.	Ruminants required to graze on pasture at least 120 days a year. Grass, pasture, and plant-based bedding must be certified organic.
Parasiticides common due to unsanitary conditions in Concentrated Animal Feeding Operations.	Parasiticides prohibited in slaughter stock and used only as a last resort otherwise. Grazing management, proper sanitation, and disease prevention are the preferred strategies.
No requirements for how young animals are raised.	Most livestock labeled organic must be raised organically for the last third of gestation. Poultry labeled organic must be raised that way from the 2nd day of life.
PROCESSED FOODS	
3,000–10,000 synthetic chemical preservatives, additives, processors, colorings, and flavorings can be added.	40 synthetic chemicals can be used in organic food processing, and cannot be used as preservatives, colors, or flavors.
	Small number of approved pesticides can be used as last resort, but must never come into contact with food.

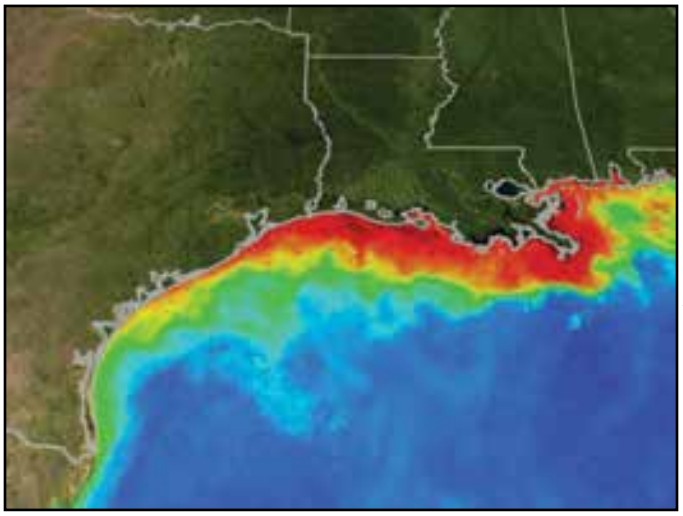
2017 came from synthetic fertilizers.[14] A 2018 study of the state of California estimated that between 20 and 51% of total state NOX air emissions came from synthetic fertilizers.[15]

Excessive levels of nitrogen can also severely pollute water. Agricultural fertilizer and manure run-off in food-producing regions of the U.S. have contaminated drinking water with high levels of nitrates. This has been statistically associated with increased levels of cancer, premature births, and birth defects. A 2019 meta-analysis of studies of nitrate pollution in the U.S. estimated that almost 13,000 increased cases of cancer, as well as 4,700 preterm or low-birth weight babies occur annually due to the pollution.[16] A 2013 study proved that mothers who consumed elevated levels of nitrates compared to a reference group of low-nitrate consumers were 80 to 100% more likely to have children with certain birth defects.[17]

Major "dead zones" line the Gulf and Eastern Coasts of the U.S., and have encroached on large parts of the U.S. Pacific Coast as well. In these areas, nitrogen and phosphorus fertilizers carried by rivers into the oceans cause excessive algae growth. When the algae die, the decomposition process removes oxygen from the water, causing most or all sea life to die.

The largest American example is the Gulf Coast dead zone surrounding the mouth of the Mississippi River. This dead zone grows seasonally as fertilizers from the Midwest Grain Belt run-off into the River and eventually make their way to the Gulf. Its record size (in 2017) was 8,776 square miles, about the area of New Hampshire.[18] About half of the nitrogen water pollution comes from crop fertilizer run-off and Combined Animal Feeding Operations.[19]

These commercial fertilizers are prohibited in organic food production.



NASA Goddard Space Flight Center

Depiction of Gulf of Mexico dead zone

Sewage Sludge: About 7.2 million tons of human sewage solids from wastewater treatment plants are created every year in the U.S.[20] Theoretically this would seem like an ideal fertilizer. However, this sludge is contaminated with Persistent Biologic Toxins, including Pharmacy and Personal Care Products, perfluorocarbons (a.k.a. Teflon™ and associated chemicals), PBDE flame retardants, alkylphenol surfactants, dioxins, and furans. These toxins make up about 0.1% of total sludge volume.[21] In addition, some sludge can retain harmful bacteria and viruses that were not removed by the treatment process. In some cases, it can also contain concerning levels of heavy metals. About 50% of sewage sludge in the U.S. is applied to land as a fertilizer.[22]

However, sewage sludge may not be used in organic production.

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Pesticides: In 2012, 899 million pounds of pesticides were used for agriculture in the U.S.[23] There are 900 approved products, and these are just the active ingredients. They do not include the solvents, adjuvants (toxicity enhancers), and "inert" ingredients that in some cases can be as or more harmful than the pesticide itself. These products can be carcinogenic, neurotoxic, acutely toxic, cause developmental and reproductive harm, respiratory distress, and endocrine disruption. Some of these pesticides are used after the plants are harvested as chemical "dessicants" to dry moisture from the plant and make plants easier to process.

Organic agriculture currently only allows about 25 pesticide ingredients, which are the least toxic that could be found, and used only when other pest eradication methods are insufficient.

Seeds: Conventional seeds are often coated with a (neonicotinoid) pesticide, which is toxic to pollinators and beneficial insects, which in turn support birds. All of these animals serve as natural pest control on organic farms. In 2011, about 5 million pounds of poisonous seed coatings were used.[24] In 2015, between 79 and 100% of corn seed and 34 and 44% of soybean seeds had this coating.[25] In the soil, this pesticide breaks down slowly, so it can theoretically be active for years.

Toxic seed coatings are prohibited. Organic seeds are preferred. GE seeds are prohibited.

Pesticide Buffers and Wildlife Promotion: If a neighboring farm or tract is treated with pesticides, organic farms are usually required to maintain a buffer to protect from pesticide drift via air or water. Though there is no set size, buffers are often 25 to 30 feet in width.[26]

These buffers can take the form of hedgerows, wind breaks, field borders, and stream / river buffers. When these buffer strips are planted with the appropriate grasses, forbs (flowering herbs), shrubs, and trees, they provide habitat and food for pollinators (bees, butterflies, birds), as well as beneficial insects and natural predators that can assist in non-toxic pest management. At the same time, they serve as a barrier to wind and water erosion, dust, weed migration, and noise. They prevent run-off of sediment and organic material. They mitigate temperature extremes for wildlife and livestock. They are also sometimes used to grow saleable crops or timber, though buffer food crops cannot be labeled organic.

In contrast, buffers are not required for conventional farms.

Mikhail Melnikov/Shutterstock.com

Genetically Engineered (GE) Crops: About 60% of food and fiber acreage grown in the U.S. in 2017 was genetically engineered.[27] This includes most or all domestic canola, corn, cotton, soy, and sugar beets, and small percentages of apples, papayas, potatoes, and yellow squash.

GE foods carry a host of health and environmental problems, including harm to consumers from the altered nutritional structure of the plant and increased pesticide residues on food, increased resistance of insects and weeds to the GE pesticides bred into food, and disruption of ecosystems by GE plants that have unintentionally become invasive species. (A complete article on this subject begins on page 27.)

GE products are prohibited in organic food, both fresh and processed, including feed for organically raised livestock.

Irradiated Food: Exposing food directly to gamma radiation kills pathogens and fungi that can cause harm to consumers. In imported produce, it can also eliminate the spread of insects and parasites that arrive from other countries.

However, the ionizing radiation destroys important nutrients (Vitamins A, B, C, E, beta-carotene, enzymes) and can also create "unique radiolytic products" (including benzene and formaldehyde) on and in food that may adversely affect the long-term health of consumers.[28] And killing bacteria has problems as well as benefits, as they sometimes create foul odor that signals food spoilage, an important safety warning that may be lost with irradiated food.

Irradiation cannot kill all bacteria, nor can it stop pathogens from evolving to survive time-limited doses of irradiation. (Treating food for longer periods of time may increase nutrient destruction and radiolytic products, while creating bad flavor.) It can also become a technological crutch to compensate for not using better sanitary practices in the first place.

A number of generic foods are approved for irradiation in the U.S., including spices, tea, beef, pork, poultry, eggs, shellfish, crustaceans (e.g., shrimp), fruit, and vegetables (in particular, lettuce and spinach). However, the process is generally used in niche markets and applications at this time. Irradiated food must be labeled with a "radura" symbol like the one shown here, though spices, manufactured food, and food served in restaurants, do not require this label.

Irradiation of organic food, both fresh and processed, is prohibited.

Livestock: Almost all conventionally raised animals are raised in Concentrated Animal Feeding Operations, deprived of exercise, fresh air, sunlight, and sometimes even clean drinking water. They are usually fed GE grain, and usually given hormones and antibiotics to boost growth. In 2018, U.S. livestock consumed 13.3 million pounds of antibiotics to promote growth or prevent or treat diseases that, to a great degree, were avoidable with better hygiene.[29]

In contrast, organically raised livestock are required to be raised with access to exercise, fresh air, sunlight, and clean drinking water. GE feed is prohibited. Ruminants are required to graze on pasture at least a third of the year. Only 22 drugs are approved for use in organic animal raising, and only for treating illness, not as growth boosters. Growth hormones are prohibited.

While organic meat (cattle, hogs, poultry) in the U.S. is barely a niche market, organic dairy consumption is at least noticeable. In 2016, less than 0.3% of meat came from animals that were organically raised, but about 2% of milk and 5% of eggs were organically produced.[30]

Processed Foods: Experts estimate that as many as 10,000 chemicals can be used in the manufacture of conventional processed food. These include preservatives, colorings, emulsifiers, texturizers, leavening agents, flavorings, and transfats.

In contrast, only 40 synthetic chemicals can be used in organic

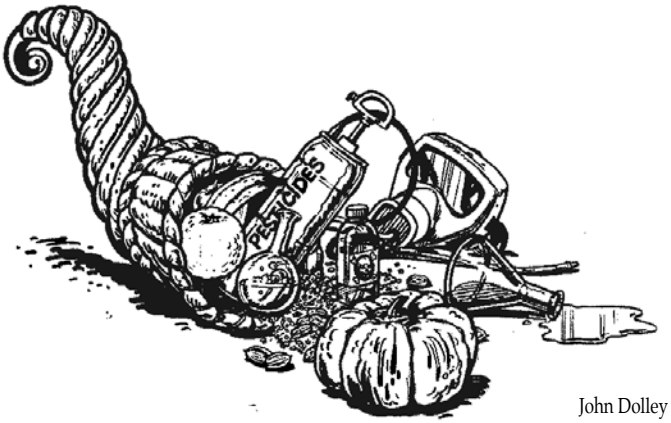
food processing, and cannot be used as preservatives, colorings, or flavorings.[31]

Consumers who seek out organic processed food need to be conscious of the definitions.

Organic – In multi-ingredient products, at least 95% of ingredients, excluding salt and water, are certified organic.

Made with Organic – In multi-ingredient products, at least 70% of ingredients are certified organic.

Organic Ingredients – If less than 70% of a multi-ingredient product is certified as organic, the product may not be labeled as Organic or Made with Organic, but the ingredient list can designate specific ingredients that are organic.



John Dolley

Nutritional Quality

One of the most important aspects of organic food is its nutritional quality compared to conventional food. This has been documented through numerous scientific studies.

One of the most influential and comprehensive of these is a meta-analysis of 343 peer reviewed publications conducted by European scientists in 2014.[32] It showed a pattern of increased antioxidants in organic plant-based foods (between 19 and 51% increase depending on the chemical) that were linked to reduced incidence of heart disease, neurodegenerative disease, and certain types of cancer. The same review determined that the appearance of the toxic metal cadmium (often found in phosphate fertilizers) was 48% lower in organic food, and pesticide residues were 4 times higher in conventional food.

Another influential meta-analysis of 41 studies of plant-based foods by an American scientist showed organic crops contained significantly higher levels of Vitamin C (27%), iron (31%), magnesium (29%), and phosphorus (14%), as well as significantly less (toxic) nitrates (15%) than conventional plant-based foods.[33]

These two analyses partially conflict with a somewhat controversial 2012 meta-analysis by scientists at Stanford.[34] However, even this paper that shed doubt on enhanced nutritional quality pointed out that children consuming organic food had lower levels of pesticide in their blood, and consumers of organic chicken and pork were less likely to be exposed to antibiotic resistant bacteria.

Regarding organic animal food products, a meta-analysis of 263 studies released in 2016 showed the following.[35]

• Organic meat and milk contained about 50% more beneficial omega-3 fats than conventional animal food.

• Organic meat had slightly lower levels of unhealthy saturated fat.

• Organic milk had 40% more conjugated linoleic acid (CLA) shown to reduce cancer risks, and slightly higher levels of Vitamin E, beta-carotene, and iron.

• Organic meat also had a lower Omega-6 to Omega-3 ratio.

• Organic milk had a 74% lower level of iodine, which could be good or bad, depending on the level people receive from other sources.

In the case of ruminants, some of the nutritional differences stemmed from a grass-fed diet.

The Gold Standard? Or Brass?

For all the good things one can say about the wholesomeness and environmental benefits of organic food, there are several weaknesses.

Premium Price for a Premium Product: The most apparent one is cost – organic carries a premium over conventional food. How much this premium is depends on the type of food and the store where it is sold. A national survey from 2015 pegged the increase at 47%, while a more recent survey using different methodology gauged it at only 7.5%.[36] In general terms, the premium for produce has been less than the increased cost of animal food products.

This premium has gone down marketedly since the 1990s, due in some part to economies of scale as more organic food has been produced. However, cost is still a deterrent, especially to people with low- and moderate-incomes. And the premium may never completely go away. It usually takes more labor to produce organic food, and there is an added cost for certification.

Counterfeit: A second downside is that the organic premium has enticed unscrupulous farmers, input suppliers, and food brokers into a new type of crime: counterfeit organic food. Compounding the predictable motive of greed is that the organic market in the U.S. has expanded so much that the regulatory system that monitors the standards has lacked enough staff to do its job well.

Between the beginning of 2011 and mid-April of 2020,

the U.S. Department of Agriculture logged 136 fraudulent organic certificates used to make false claims that food was inspected.[37] These may have been created without knowledge of the operator or certifying agent.

Though it is a rarity and not the norm, some organic standard violators face prison time.

• In 2015, a New Jersey man was sentenced to 40 months for falsely labeling supplements as organic.[38]

• In late 2018, 3 Nebraska farmers pleaded guilty to selling at least $2.5 million each in counterfeit organic corn and soybeans between 2010 and 2017 through an accomplice grain dealer.[39]

• In 2019, a Missouri farmer was convicted for selling $2.2 million in counterfeit grain to the same brokerage. The broker himself was convicted after admitting to at least $142.43 million in largely fraudulent grain sales.[40]

Counterfeit organics not only swindle consumers, but also hurt organic farmers, who cannot compete to produce real organic food against a fake product that is less expensive to grow.

Defenders of organic standards would point to these incidents as examples of how the enforcement system is working. However, it also shows its vulnerabilities.

Imported Fraud: Not all justice is fair. Just as in conventional food, imports of organic food are more suspect of violations than domestic.

Of the 136 fraudulent organic certificates logged by the U.S. Department of Agriculture, almost 90% of these were of foreign origin. In the U.S., if someone knowingly sells counterfeit organic, not only can they lose their reputation, they can also be fined as much as $18,000 per incident.[41] In rare instances, they are even jailed. However, such sanctions occurring in a foreign country asked to enforce American food laws are not going to be likely or frequent, particularly if the foreign country will not even enforce its own laws.

As example, in 2016-17, 3 shipments of conventional corn and soybeans exported from Turkey were "grain washed" to portray them as organic, yielding millions of extra dollars in profit above the profit they would have already made.[42] When alerted, the U.S. Department of Agriculture, responsible for enforcing domestic organic standards, began an investigation. The agency ultimately revoked the organic designation of 2 import companies, but no foreign people or companies were known to be fined or jailed.

In 2017, a U.S. Department of Agriculture Inspector General audit placed a magnifying glass over the problem.[43] It proved that organic standards were not being verified, and hence enforced, because of the lack of inspection staff. It further found that if the imported crop has evidence of diseases or pests at U.S. ports of entry, it was often treated with chemical pesticides prohibited for use in organics.

Standard Gamesmanship: Another criticism of organic food is that some organic standards themselves are not well defined, leading to uneven enforcement. As studies have shown, organic programs have been successful in reducing pesticides in food and increasing its nutrition levels. However, there are people who helped start the organic movement who are dissatisfied with its direction. They feel that as organic sales have grown, larger producers have made it more difficult for family farmers (one time the backbone of the movement) to compete. They also feel some of the environmental safeguards are being compromised.

An example of this is the organic milk production mandate that cows be grazed at least a third of the year. Grass, as opposed to grain, is the natural diet of bovines. Cows raised on grass are generally healthier. When pastured, they get more exercise, more sunlight and fresh air, and are less exposed to accumulated manure that causes disease, odors, and ammonia emissions in Concentrated Animal Feeding Operations.

The dairy products produced from grass-fed animals are also healthier, higher in beneficial fatty acids, and possibly lower in high cholesterol fatty acids. However, circumstantial evidence shows that not all dairy cows are being grazed according to standards.[44] This decreases the nutritional and environmental value that organic consumers have come to expect. It also makes it more difficult for conscientious dairy farmers that do not take economic shortcuts to compete. It takes more land per cow to properly graze them, and grazed cows produce less milk than animals that are primarily grain fed.

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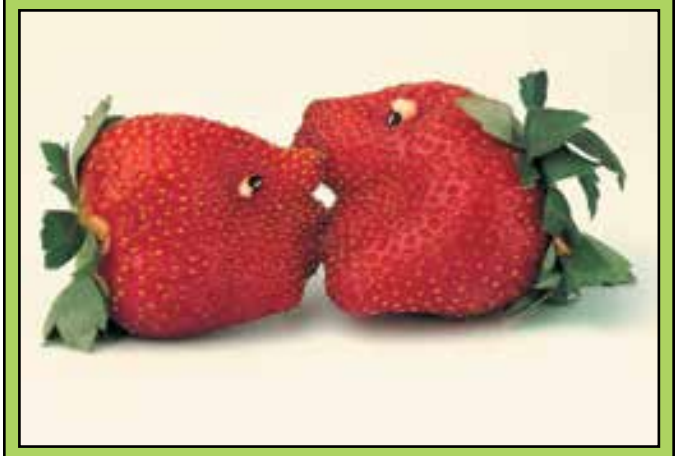
Environmental Food Rating Information

Plant Food



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Cornucopia Institute Organic Scorecards
(Cereals, Soyfoods, Snack Bars, Hexane-Free Foods)
cornucopia.org
Ratings of commercial products based on environmental and social standards, as well as transparency.

Environmental Working Group Food Scores
ewg.org/foodscores
Database of over 80,000 food products rated on a scale of 1 to 10 for nutrition, additives and contaminants such as pesticides, preservatives, antibiotics, and processing. Products include animal, plant, and baby food.

Environmental Working Group Guide to Pesticides in Produce™
ewg.org/foodnews/
Ratings of best and worst fruits and vegetables based on average measured pesticide residues. Annual update / revisions come out every spring. This list can be used for consumers on a tight budget to selectively buy organic food, avoiding produce with the worst residues.

At stores, look for the organic seal on the product or packaging. When buying produce, there is usually a sign next to the price that states if the item is organic. Also, if the item has a "9" at the start of a 5-digit PLU code decal, it designates organic. (A 4-digit code means the produce is conventional.)

Another example is egg production. A henhouse with 100,000 chickens with a tiny screened porch is not the same as pasture-raised chickens given access to fresh air and exercise by foraging on open ground.[45] And again, the large operation's resemblance to Concentrated Animal Feeding Operations makes it difficult for small farmers who pasture-raise hens to compete.

Of Foxes and Hen Houses

Federal organic standard enforcement is compromised for two main reasons. First, there have not been enough staff to enforce standards in the growing market.

Second, federal staff do not directly inspect organic operations. Instead, farmers are required to hire third-party inspectors, who usually announce their inspections in advance. Testing for pesticides is not common. While many of these third-party inspectors have a high level of integrity, some are more permissive than others. A farmer that thinks an inspector is too strict on standards can simply shop around and find another.

Theoretically, the federal program can inspect the inspectors to make sure they are not being too lenient, but again, there has not been enough staff to accomplish much in this direction.

The federal budget that passed in late 2018 has increased the funding and tools necessary for more enforcement of organic standards, including organic imports.[46] Several watchdog organizations that have been repeatedly critical of the U.S. organic inspections seem encouraged by this turn.[47]

Another key strategy to confront quality challenges to the U.S. organic system is to create other certification systems that go beyond what the federal inspection program ensures. The strategy will allow non-profit organizations to press for solutions and reforms that the federal organic program will either not undertake, or is only pursuing at a slow pace.

Some of these alternative rating programs already exist. There are at least 5 organizations that certify animal food for qualities beyond what federal organic standards call for. These include the diet of animals (e.g., grass-fed cattle, organic feed), access to the outdoors and proper exercise, and humane treatment. (See page 39 for more information.)

The Rodale Institute, one of the founders of modern organic agriculture, began to pilot its "Regenerative Organic Certification" in 2018, which deals not only with improving the standard for animal raising, but for organic plant food as well. Though the Rodale program uses federal organic standards as a prerequisite, it goes much deeper. It sets intensive requirements for:

- Environment (e.g., optimal soil carbon capture, tilling only once every 3 years, no deforestation);
- Animal welfare (e.g., prohibition of Concentrated Animal Feeding Operations, prohibition of mutilation such as debeaking, use of humane slaughter practices); and
- Economic fairness to farmers, ranchers, and workers (e.g., living wages and collective bargaining for workers).

Similar to the federal program, the Rodale program requires annual inspections, and it can take several years to complete the process.

Baby Food

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Almost 4 million babies were born in the U.S. each year between 2014 and 2018, and they had quite an appetite. In 2018, America spent about $7 billion on infant formulas and baby food.

Infants are much more sensitive to toxins in their food and environment than adults. To quote the environmental group Pesticide Action Network: *The…enzyme that renders organophosphate pesticides less harmful is not produced at adult levels until the age of 7. Gastrointestinal absorption is greater before the age of 2 because less gastric acid is created, making young children more vulnerable to alkaline pesticides. The blood-brain barrier that provides the nervous system more protection from toxins is not fully developed. The liver and kidneys are not fully developed, so small children are less capable of excreting poisons.*

Despite this, parents often unknowingly purchase baby food tainted with toxins. This gives the word "adulterant" a whole new meaning. Here's an overview of unlabeled contaminants that you should be aware of.

Pesticides: Similar to conventional produce, traces of agricultural pesticides appear in processed baby food. This is made worse when considering that many hazardous ingredients in pesticides (often labeled "inert") are not measured. It also does not consider multiple residues acting together. In pears processed into baby food, for example, 94% of samples were positive for at least one pesticide, but as many as 10 pesticides were measured in some samples.[1]

Ironically, while organic baby food has been shown to have reduced or negligible measurements of pesticides and is not produced with antibiotics or genetically engineered seeds or food, many organic products still have measurable levels of heavy metals. Depending on the product, they may also contain BPA and acrylamide.[2]

BPA: Bisphenol A, discussed previously because it is contained in grocery store receipts, container linings, and some cookware, is an endocrine disruptor, developmental toxin, and reproductive toxin. It is sometimes used in baby food storage containers, and is as likely to leach into baby food as any other food it comes in contact with.

In 2013, the U.S. Food & Drug Administration required that BPA be removed from baby bottles and sippy cups. This was done at the suggestion of the American Chemistry Council in response to a potential public outcry.

However, in a 2018 study that tested 15 polycarbonate baby bottles marked BPA free, safe, or clear, all of them measured residual or migrating BPA.[3] Though none of the samples exceeded the safety limit, BPA in the various samples would supply between 1 and 24% of the limit. Of concern was that combined with other BPA sources, the chemical could exceed the safety threshold and cause harm.

Alternatives to clear polycarbonate plastic bottles are on the market. They include opaque polyethylene and polypropylene plastic, glass, stainless steel, and even (expensive) aluminum. The worry about dropping glass containers is more bearable with silicone sleeves to buffer impacts.

Heavy Metals: In 2018, *Consumer Reports* tested 50 different brands of baby food. The survey found 68% of them tested positive for at least one heavy metal, and that 30% of them found the levels so potent that there would be potential risk to a child who regularly ate one serving or less per day.[4] Interestingly, organic baby foods were just as likely as conventional ones to contain these toxins.

Heavy metals include arsenic, cadmium, lead, and mercury, each with its own hazards. All of them are Persistent Bioaccumulative Toxins that can build up in the body over time. All are carcinogenic, developmental and reproductive toxins, endocrine disruptors, and in sufficient doses, organ toxicants. Arsenic and lead are neurotoxic, and arsenic, cadmium, and lead cause gene mutations.

There are several possible reasons for heavy metal contamination. One is that heavy metals were used in pesticides employed in food production, including lead arsenate and copper arsenate, as early as the middle of the 19th century. U.S. use of lead arsenate peaked in 1944 at 86.4 million pounds.[5] Though it waned to less than 5% of this by 1973, it was not actually banned by law until 1988.[6] Since heavy metals do not biodegrade, it is plausible that these legacy pesticide residues still haunt older farmland today.

Another possible source is poultry litter used as a fertilizer. Arsenic was used in raising chickens for over 70 years until it was banned in the U.S. in 2013.[7] Other sources of

these metals include industrial and mining pollution, and land exposed to leaded gasoline before it was banned. Heavy metals also occur naturally in the earth. Though these often occur at low levels, certain foods are more sensitive than others. For instance, arsenic is more likely to be absorbed in rice compared to other grains.

Acrylamide: Baby products can also be laced with acrylamide, a toxic chemical used in industry, but also created by heating starchy foods at temperatures typical in cooking. It is a carcinogen that causes gene mutation, as well as a developmental and reproductive toxin. French fries and potato chips, grain-foods (breakfast cereals, cookies, and toast), and coffee typically have high levels of this chemical. Since many baby foods are heated during processing, they also contain acrylamide.

Infant Formula Additives: Breastfeeding is positively associated with the reduction in numerous diseases and conditions such as leukemia, gastroenteritis, asthma, and obesity. Despite overwhelming evidence of its medical benefits, a notable percentage of mothers still feed formula to their babies as a main course or as a supplement.

In 2015, 17% of babies in the U.S. were never fed breast milk. And even though the U.S. Centers for Disease Control recommends exclusive breastfeeding until infants are 6 months old, by this age, about 34% of babies had received formula as some percentage of their diet.[8] About 3/4 of the $7-billion baby food market in 2018 was spent on infant formula.[9] So toxins and adulterants in infant formula are highly relevant to a significant percentage of newborns.

Formulas and baby food are often contaminated with heavy metals, as well as BPA from plastic lining in containers. They also often have the controversial additives docosahexaenoic acid (DHA) and arachidonic acid (ARA).

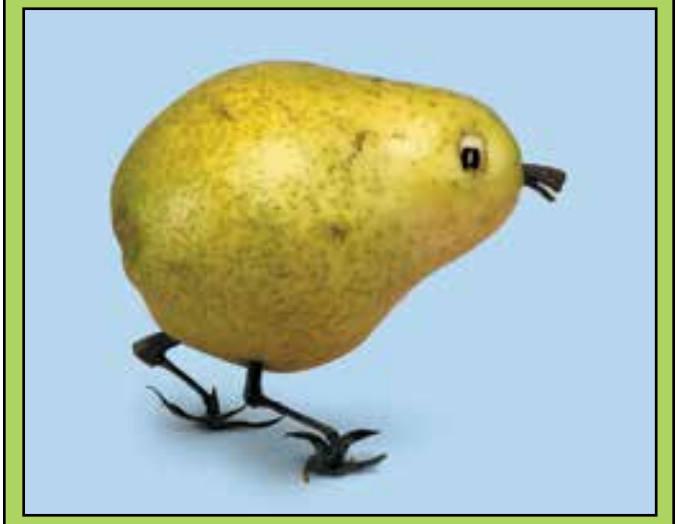
These fatty acids are important to the human brain and eye, and present in human breast milk. Since 2002, DHA and ARA have been synthesized from algae and fungi as additives to infant formula. In addition, dairy companies in general claim that DHA/ARA enhance nutritional qualities. There are at least three good reasons for concern.[10]

• First, while the nutrients themselves are essential, it is not at all clear that the artificial additives are effective at enabling better eyesight and cognitive development. There have been various academic studies on how these additives affect children, and they have conflicting results. Conversely, there have been numerous anecdotal reports of infants with digestive problems presumably caused by formula with these additives.

• Second, the supplements are manufactured with the neurotoxic (and in sufficient concentrations, explosive) solvent hexane, a byproduct of gasoline refining. Hexane residues have been measured at 0.2% in the final DHA/ARA supplement.[11] No consumer regulations limit hexane-derived and -processed additives in food in the U.S.

Environmental Food Rating Information

Baby Food



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Clean Label Project
cleanlabelproject.org
This organization tested over 500 specific baby food and baby formula products for 130 potential toxins including acrylamides, antibiotics, BPA (commonly found in packaging), heavy metals, melamine, and pesticides. The organization tests other products as well, including protein powder, nut butters, and sun screen.

Environmental Working Group Food Scores
ewg.org/foodscores
Database of over 80,000 food products rated on a scale of 1 to 10 for nutrition, additives and contaminants such as pesticides, preservatives, antibiotics, and processing. Products include animal, plant, and baby food.

While this author does not know of any studies that have assessed possible dangers of hexane in food, the chemical is regulated for exposure to industrial workers. Thus exposing children with small body weights and more sensitive metabolism is more than a casual consideration.

• Third, DHA/ARA additives are part of a marketing push by the formula industry to show it has similar qualities to breast milk. To the extent that this marketing discourages or reduces breastfeeding when it is still possible, infant formula (of any kind) provides inferior nutrition.

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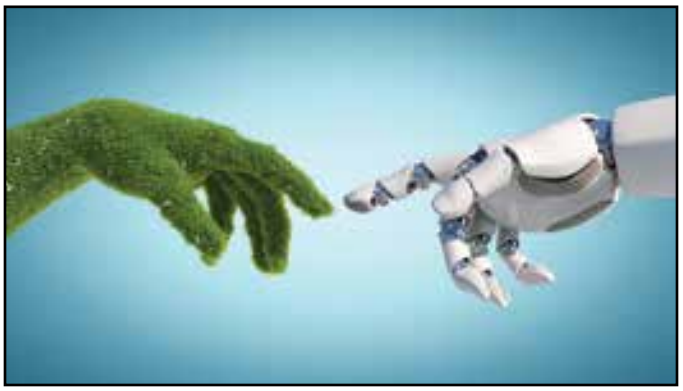

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In 2017, 60% of the estimated 470,000 square miles of food, fiber, or fuel (ethanol) producing cropland in the U.S. was planted with genetically engineered (GE) seeds.[1] The vast majority of this was in major "commodity" crops (canola, corn, cotton, and soy), though GE crops are beginning to make small inroads into produce sales, and even fish. For almost all Americans, they are impossible to avoid: you are eating them, or wearing them, or driving them – usually all three.

GE crops were considered science fiction, or at least novel, in the early 1990s. GE critics of that era now seem prescient for their warnings about the human health and environmental consequences of these new technologies.

State of the Gene Report

GE seed products began commercial sales in the U.S. in the 1990s. By 2019, many of the United States' large commodity crops had one or more GE traits: 92% of corn acres; 94% of soybean acres; 98% of upland cotton acres; and 100% of canola acres.[2] Since corn and soybean derivatives are ubiquitous in processed food, the majority of the U.S. population is ingesting GE crops, at least in small quantities.

By 2017, 100% of sugar beets were also GE.[3] (In 2018, beets provided half of all the domestic sugar supply in the U.S. Domestic sugar products, including cane, accounted for 73% of total American consumption.)[4]

Due to loose laws, and regulatory agencies that critics consider held captive by special interests, the absence of mandatory labeling, and the large share of commodity crops grown for the world market, the U.S. leads the way in GE acreage. In 2017, 40% of all GE crop acreage in the world was in the U.S.[5] Contrasting this is Europe, where the percentage of GE crops grown is negligible due to public suspicion.

GE products have also made small incursions into the U.S. produce market.[6]

• About 6/10ths of 1% of potatoes were GE in 2017. Brands include the INNATE® Russet Burbank, Ranger Russet, Atlantic, and Snowden lines.

• About 4/10ths of 1% of U.S. apples were expected to be GE by 2019. The original brand was Arctic Golden Apples, though this was expected to expand to Fuji and Granny Smith apples as well.

(Both GE apples and potatoes are engineered to eliminate browning when the produce is cut or bruised.)

• About 77% of Hawaiian papaya was GE in 2017. However, the vast majority of papaya consumed in the U.S. was imported, so only about 2% of papayas consumed overall in the U.S. in that year were GE.[7]

• About 6.5% of U.S. yellow crooked neck squash was GE in 2017.

(Both GE papaya and squash are engineered to be resistant to specific viruses.)

The majority of the commodity crops are engineered for two traits. The first is to be herbicide-tolerant (HT), with the most common herbicide being glyphosate (contained in the well-known product Roundup®). The second is to be resistant to certain insects because they contain proteins of bacillus thuringiensis (Bt), a natural pesticide derived from soil bacteria used by organic farmers because it is less toxic than conventional products. Most seeds on the market have both traits. The HT varieties were sold to farmers as a convenient way to save money when eliminating weeds. The Bt varieties were sold as a cheap and safe way to eliminate pests.

The health and environmental effects of these have become increasingly apparent.

• Health advocates stated that GE foods might alter the contents of food, with possible adverse reactions.

• Opponents of HT strains warned that weeds themselves would become resistant or immune to the herbicides that crops were designed to withstand, creating the need to use greater volumes of herbicides or different herbicides.

• Opponents also warned that insects would develop resistance to Bt.

• GE critics worried that the new technologies could disrupt ecosystems.

All predictions have been borne out.

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Medical Problems

Health problems have been linked to GE food. Causes may include the increased use of herbicides (and the residues left on food) in addition to the GE crops themselves.

• A French study conducted in 2009 showed that rats fed with 3 different varieties of GE corn (one that was glyphosate resistant, and two that included Bt pesticide) had a marked effect on liver and kidney health compared to controls after only 90 days on this diet.[8]

• Another French study released (which included two of the same scientists) in 2014 showed rats that ingested various levels of HT corn had pronounced levels of kidney and liver disease and tumor incidence compared to control rats that ate none.[9] In male rats, kidney disease increased 67-133% depending on the percentage of GE corn in their diet. Liver disease increased 150-480%. Breast tumors in female mice increased 25-88%, in large part because the herbicide raised estrogen levels.

The most revealing finding from this study was that it largely used the same methodology Monsanto, the company that created the products, had used to gain regulatory approval. However, instead of observing the rats for only 90 days as was done in the Monsanto study, the French study ran for 2 years.

• A 2008 study by the Austrian health ministry also showed harmful effects to reproduction.[10] Mice fed GE corn had fewer litters, (consequently) fewer total offspring, and more females with no offspring compared to mice fed conventional corn.

• Another long-term 2-year study of mice by an Italian team of scientists in 2008 revealed that female mice fed a diet of 14% GE soy had significant liver deterioration compared to control mice.[11] This followed a study conducted by some of these same scientists a few years before showing that this same GE soy percentage could influence pancreatic metabolism in mice.

• Another Italian team of scientists found that very young and very old mice (which have weaker immune systems than mature adult mice) fed GE corn with Bt insecticide had weakened immune response.[12]

• The Bt toxin spliced into GE crops to make them resistant to insects has been shown to provoke potent immunological reactions when fed to mice.[13]

• At least 2 studies showed that mice fed with GE potatoes had increased incidence of digestive tract irritation.[14]

• Herbicide tolerant crops have been shown to be deficient in key mineral "micronutrients" that are essential for proper nutrition, including calcium, copper, iron, magnesium, manganese, nickel, and zinc.[15] The uptake of nitrogen is also altered.

Another health problem some of these crops are likely to cause is the loss of an important indicator of food spoilage. As stated previously, GE apples and potatoes are now engineered to resist browning when cut or bruised. This common indicator is now masked by "counterfeit freshness." However enhanced the food looks cosmetically, browning has been a time-tested way people have used to avoid food that might be spoiled or contaminated.

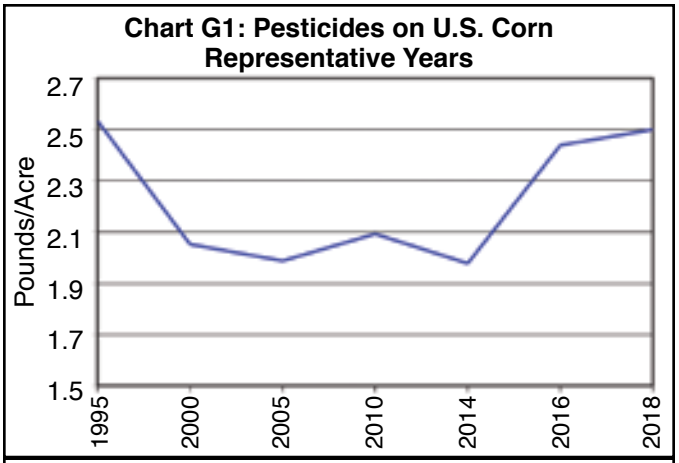
Environmental Problems

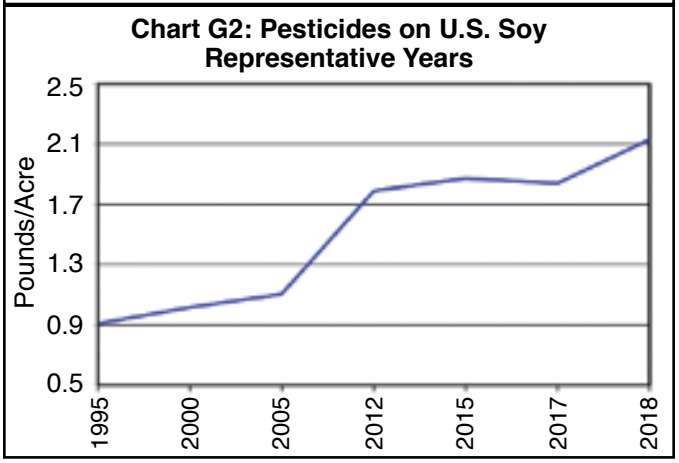
Superweeds: Many GE strains were specifically bred to withstand the herbicide glyphosate (again, the main ingredient in Roundup®). It was convenient for farmers because they could easily use the herbicide on weeds without damaging their crops. Critics warned even before these seeds were sold commercially that the products would become obsolete. They feared some of the unwanted weeds would survive the herbicide treatments and pass the survival trait on to their descendants. They would become, in effect, "superweeds."

This has happened with a seeming vengeance. In 1996, when GE soybeans resistant to herbicides were first introduced commercially, only a small percentage of soybean acreage harbored weeds resistant to the herbicide. By 2012, nearly all soybean acreage had resistant weeds.[16] These weeds can grow so tall that they leave crops in their shadows, and they compete with crops for soil nutrients and water as well as sunlight. Depending on the species and location, superweeds can decrease corn yields 15 to 91% and soybean yields by 44 to 80%.[17]

In 2000, there were 2 species of weeds that were glyphosate resistant. By 2012, there were 13 resistant species.[18] By then, 40% of Illinois farmers had encountered glyphosate-resistant weeds; in Georgia, it was 92%.[19]

Charts G1 and G2 show the increase in pesticide use per acre in U.S. corn and soy crops between 1995 (the year before GE commercial seeds were sold) and 2018.[20] Corn pesticide use did decrease, but has soared back due to weed resistance. Soy pesticide use has more than doubled.





Industrial agriculture's quicksand solutions include using even more glyphosate to compensate for resistance, and using other herbicides while breeding new varieties of crops that will tolerate them. These other herbicides include dicamba, 2,4-D, and mixtures of these with glyphosate.

Superpests: Unlike herbicide use in GE plants, which has increased since they were introduced, conventional insecticide use in corn and cotton has generally fallen by huge percentages per acre since Bt varieties were created.

On closer inspection, it is easy to see why. As example in one GE corn species, the amount of Bt toxin contained is 19 times the amount of conventional topical pesticide needed to target the same pests.[21]

It is also easy to see how insects have developed immunity. First-generation GE Bt cotton varieties only had one Bt toxin laced in their genes. Due to insect resistance, 2nd, and 3rd generation Bt varieties are being planted that have two or 3 different types of Bt toxins in them.[22] Because of these "pyramided" traits, newer GE corn varieties can have 2 to 4 times more Bt toxins embedded in the plant than original varieties developed in the 1990s.[23]

Pesticide danger is magnified when you consider that the U.S. Department of Agriculture data reflected in the charts above does not measure the neonicotinoid insecticide that coats the GE seeds. This is a systemic toxin that permeates the plants' tissue.

GE as Invasive Species: (When Seeds are Weeds) – GE crops have become so common in the U.S. that they have insinuated themselves into the greater environment. In some respect, GE crops and plants have taken on the role of invasive species that crowd out existing ones.

GE crops planted in specific areas do not remain rooted to their original location. They can spread to food supplies or the general environment in at least 4 ways.

1. *Contaminated Seeds* – Due to accidents and improper handling, GE seeds can become comingled with non-GE seeds and organic seeds.

2. *Contaminated Food* – Due to accidents and improper handling, GE crops and processed food such as corn flour can also become mixed with non-GE and organic products.

3. *Contaminated Pollination* – GE plants cross-pollinate with non-GE plants, passing on their genetic traits to the detriment of hapless farmers and consumers, as well as the general environment.

4. *Unrestrained Migration of Plants* – Seed cross-contamination, cross-pollination, and asexual development allow GE plants to escape from farms and test plots to other farms and into the natural landscape.

GE food is not only difficult to avoid in the average American diet, but it has affected the food supplies even for those intentionally trying to avoid them. A study as far back as 2004 showed that 50% of non-GE corn and 83% of non-GE canola had small rates of GE contamination.[24] A 2014 survey of organic farmers revealed that a third of respondents had experienced economic losses from GE contamination.[25]

Documented incidents of contamination in the U.S., with accompanying economic losses to farmers and contamination of the environment, have piled up since at least the year 2000 for alfalfa, canola, corn, flax, papayas, rice, and wheat, as well as turf grass.

• Alfalfa – A strain of this forage crop has been bred to resist glyphosate. In 2013, an export shipment was

Anastasia Rudensky / Shutterstock.

canceled after it was determined to be this GE variety.[26] A 2015 study showed that 27% of roadside stands of wild alfalfa in California, Oregon, and Washington contained transgenic plants.[27]

• Canola – Escaped GE-canola resistant to herbicides is growing rampant along the roadsides of North Dakota. Since it is the state's procedure to spray roadsides with herbicide, the canola survives where other plants cannot. A study found 46% of highway sites had wild canola growing, and 86% of the plants had GE herbicide-resistant traits.[28]

Canola is particularly problematic since it is in the same species (and can cross pollinate with) some vegetable crops, including broccoli rabe, Chinese cabbage and Chinese Mustard, rutabaga, Siberian kale, and turnips, among others.

• Conventional Corn – In 2000, 300 food products were contaminated with a GE variety meant for animal feed and not human consumption because it might cause food allergies. Exports to Japan fell 44% and farmers suffered huge losses.[29] In 2002, experimental corn bred to produce pharmaceutical drugs contaminated 500,000 bushels of soybeans that had to be destroyed.[30] Between 2001 and 2004, a GE variety unapproved for U.S. cultivation was mistakenly distributed to farmers, resulting in the rejection of exports to Japan and the EU.[31] In 2014, between $1 and $3 billion in export losses occurred when China refused to accept GE-contaminated corn.[32]

• Ethanol Corn – The most frightening example of contamination from a GE crop comes from a plant engineered to make fuel. In 2018, 38% of U.S. corn production was used to manufacture ethanol. A new GE-corn variety, *Enogen*, has been created with enhanced enzyme content to assist the breakdown of corn starch to sugar, the base feedstock for the fuel. In 2018, the new seeds were planted on as much as 200,000 acres, roughly 1% of all U.S. land where corn was planted for ethanol production.[33]

However, this new crop is a bane to corn products edible to humans. The enzymes break down the starch, leading to crumbling corn chips, soggy cereals, messy masa, and tamales that do not bind. Stunningly low contamination levels, as low as 0.01% (1 grain in 10,000), can ruin cornflakes, and 0.25% can ruin chips. At least two incidents of this contamination (one of them documented) are believed to have occurred.[34]

• Flax – In 2001, Canada briefly approved GE-flax for cultivation. However, this approval was ultimately rescinded because the country was concerned about loss of the European export market, which banned or discouraged GE varieties. Even though the GE seeds were supposedly destroyed, there were enough of them left to cause crop contamination. This ultimately ruined the export market when they were discovered in 2009.[35] Since 60% of the country's exports went to the EU, the loss to farmers was considerable.

How to Avoid GE Food

Late in 2018, the U.S. Food & Drug Administration created a GE labeling standard. After almost 3 decades of controversy, the agency partially succumbed to consumer pressure to allow buyers clear notice of foods they might wish to avoid for ethical or nutritional reasons. However, the standards have been heavily criticized by consumer advocates.

1. Though nothing precludes immediate participation by food manufacturers, producers, and marketers, labeling is not required until 2022.

2. Most processed foods have derivatives of GE crops in their ingredients (e.g., corn, soy, or canola oil; soy protein; corn starch and sugar), but these ingredients will not have to be identified as GE because the original GE DNA is supposedly destroyed when manufacturing the derivatives.

3. Even when labeling is (finally) required, it may not even have to be in the form of a label. While the "Bioengineered" label is an option, it is not a mandate. An alternative will allow food manufacturers, producers, and marketers to use the QR code on the product. Consumers with smart phones can access information electronically. However, this option can lead to frustration if there is poor or no wireless service, or if the customer does not have a phone with a QR reader application.

4. The new labeling standards may exempt newer seed and food creation techniques that are similar but not identical to the strict definition of GE, such as synthetic biology.

Customers who want to avoid GE products have other options available.

• *Look for the U.S. Department of Agriculture (USDA) Certified Organic and/or the "NON GMO VERIFIED" labels. Neither certification standard allows GE products.*

• *If you are looking at produce, look for the 5-digit PLU code decal. If the code has a "9" at the start, it designates organic. But if it has an "8," it means it is GE. (A 4-digit code means the produce is conventional.)*

• *Avoid products that boast their GE origins, including Arctic apples, INATE® potatoes, and Hawaiian papayas that are not organic. Also, fish eaters should avoid AquaBounty salmon when it comes to market.* *(See more on page 41.)*

• Papaya – Most papayas from Hawaii are intentionally GE. However, pollen from GE varieties has contaminated conventional and organic varieties, and even fruit in people's gardens.[36]

• Rice – In 2006, it was found that GE-rice (long-grain) had contaminated the U.S. supply. It is possible that contamination had been occurring for 5 years before it was discovered. Exports were closed in Japan and many EU countries. About 11,000 affected farmers won a $750 million settlement against the seed producer, Bayer CropScience, for financial losses.[37]

• Wheat – Unlike other commodity crops, GE-wheat has never been approved for commercial U.S. sales. But there have been experimental varieties, with at least 2 instances where they escaped off of test plots. One of these instances, which took place in 2013, hurt the export market to other countries that prohibited GE-wheat, motivating farmers to sue to recoup damages.[38]

• Escaped Turf Grass – Possibly the worst example of a GE product going rogue is the release of a modified species of bentgrass. This was engineered for landscapes such as golf courses to be glyphosate tolerant. It was originally planted in an irrigated area in isolated desert terrain in Oregon to test its growth in a way that would protect the greater environment from incursion. However, wind storms dispersed its tiny seeds off the designated site, and blew its pollen as far as 13 miles away, where it bred with conventional bentgrass and possibly other grass species as well.[39]

The plant was so hardy that it quickly jumped to irrigation ditches, riverbanks, and the Crooked River National Grassland in Oregon, where it crowded out native grasses to the detriment of wildlife that depended on them. By 2016, it invaded noticeable parts of 3 counties in Eastern Oregon, and it had also made incursions in Idaho. In 2017, the U.S. Department of Agriculture excused the developer of the grass, Scotts Miracle-Gro, from further liability if they did not retail the product. However, the grass can never be recalled from nature, and is considered an expensive pest by area farmers – one likely to spread.

GE-bentgrass can be partially controlled by the less-toxic herbicide glufosinate, though, in twisted irony, it is likely that the grass will eventually develop resistance to this herbicide as well.

GE Water Pollution: Run-off from topically applied pesticides in water supplies is unfortunately a common consequence of industrial agriculture. Similar effects can be expected from pesticides embedded in plant tissue. Bt toxins in these GE crops have been detected 7 months after harvest, negatively affecting nearby waterways and the aquatic life in them.[40]

Collateral Damage to Beneficial Insects: The chemicals associated with GE crops cause real harm to pollinators.

Environmental Food Rating Information
Genetically Modified Organisms (GMO)

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Living Non-GMO
livingnongmo.org/find/products
Organization that offers certification for non-GMO products. A list of certified products and retailers is on Web site.

Non-GMO Shopping Guide
nongmoshoppingguide.com
The Institute for Responsible Technology is an organization dedicated to education on the dangers of genetically engineered food and vitamins. Its Web site lists food brands it believes to be free of Genetically Modified Organisms (GMOs). Not all of these foods are organic, and it is possible that some brands of GMO-free food contain additives health-conscious consumers may wish to avoid.

The most well known example is the devastation of the monarch butterfly population, which has decreased 80-90% since the 1990s.[41] A big reason is the near elimination of milkweed in GE crop fields by glyphosate and other herbicides used in GE crops. It is the only plant that monarch caterpillars feed on. Besides the creature's incredible beauty, monarch butterflies assist farmers by pollinating crops.

A U.S. Geological Survey report estimated the chances of the monarch population in the Eastern U.S. going extinct by 2036 at between 11–57%.[42] Another study estimated the likelihood of the monarch population in the Western U.S. going extinct at 63% by 2037.[43]

Honey bee populations are also harmed. Since 2006, they have experienced average winter colony declines of 29% compared to 17-20% loss typical in the 1990s.[44] One possible reason is that bees are directly exposed to glyphosate herbicides, which systemically concentrate in the flowers of various crops that they pollinate.[45]

Bees are also exposed to neonicotinoid pesticides, another systemic toxin, that coat GE-corn seeds. Bees have extremely adverse reactions to this class of pesticide. Corn seed dust that occurs in the planting process has been observed with 700,000 times the level lethal to pollinator bees.[46]

Animal Food
You Are What They Eat

Foto_123/stock.adobe.com

In 2013, the U.S. consumed 10% of the world's animal protein, and only 1% of the world's population consumed more animal food per capita than America.[1] In 2018, America consumed 93 billion eggs, 34 million head of cattle, 110 million pigs, and 7.7 *billion* chickens.[2] There were 9.4 million milk cows in the U.S. that year, producing about 26 billion gallons of milk, enough to fill Lake Austin 4 times![3]

Given our diet and culture, particular care must be taken to avoid the toxins and dangers inherent in the production of meat, fish, and dairy products.

Persistent Bioaccumulative Toxins

Since the end of W.W.II, the production of synthetic chemicals and their use has overwhelmed the environment. Over 86,000 commercial chemicals are manufactured or processed by U.S. industries. However, even hazardous chemicals that are no longer produced can linger in the environment for generations.

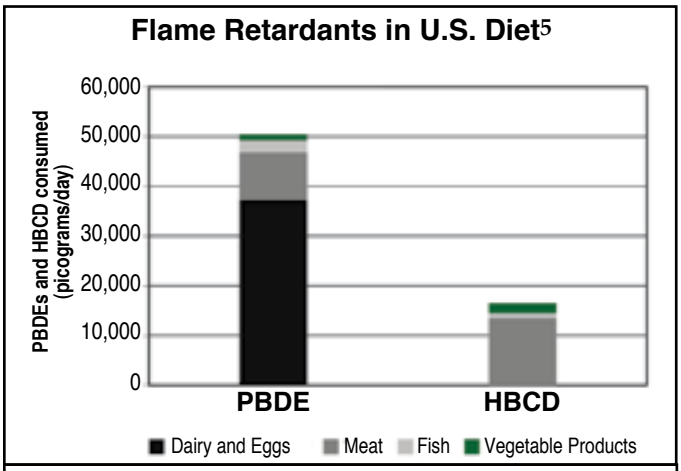
Some of the most dangerous chemicals, both on the market and banned, are labeled Persistent Bioaccumulative Toxins (PBTs) or Persistent Organic Pollutants (POPs). They can take decades or centuries to fully biodegrade, and often bioaccumulate in the environment, including the food and water that people ingest. These toxins tend to build up in body fat of animals. Humans and other carnivores at the top of the food chain that eat animal food accumulate these toxins since they eat food contaminated with them.

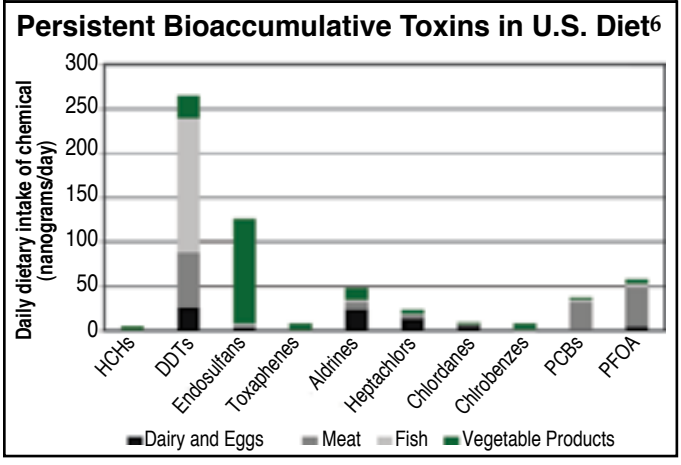
Organochlorine pesticides such as DDT and aldrin, Teflon™-like perfluorocarbons (PFCs), brominated fire retardants (such as PBDE), dioxins from combustion and chlorine production, and banned polychlorobiphenyls (PCBs) often sequester themselves in animal food. Most of this would not have occurred before the 1940s, but is a sad fact of life today. These chemicals are so pervasive in the environment that their presence can be detected in virtually every mammal on the earth, no matter how remote the location.

The graphs in this story detail PBTs from two studies found in various types of food. The first is for flame retardants. The second is for other PBTs: organochlorine pesticides, PFCs, and PCBs. These graphs attempt to estimate the annual toxins consumed in the average U.S. diet. These different chemicals can cause different levels of harm. The majority of dietary exposure from most of these chemicals comes from animal food. (Since the 2010 study reflected in the second chart, endosulfans were banned in the U.S.)

While none of these chemicals exceed a threshold of harm for an individual chemical, they can interact with each other to cause health problems for which they are not tested. In addition to bioaccumulating in the body, they can cause harm by interacting with other chemical exposures unrelated to food (e.g., toxins in air, building materials).

It is concerning that while DDT and aldrin were banned in the U.S. decades ago, their residues continue to appear in food, either in imported products from countries still using these pesticides, or from domestic pesticide applications from long ago that still have not completely degraded. Still, environmental regulation does improve such exposures dramatically. A Swedish study of human breast milk showed a decline of 98% in the organochlorine pesticide DDT since it was banned in that region in the 1970s.[4]





iStock.com / pornsakampa

Some toxins from industrial chemicals take decades or centuries to fully biodegrade. They tend to build up in body fat of animals, with the highest rates in humans and other carnivores at the top of the food chain that eat animal food contaminated with them.

Other toxics and adulterants in animal food can be avoided or limited by buying products where the animals are raised in a natural environment. However, it may be difficult for people to limit PBTs from eating meat and dairy without avoiding their consumption.

Antibiotics Resistance (AR)

About 2 million Americans a year develop Hospital-Acquired Infections, resulting in about 99,000 deaths. The vast majority of these were linked to antibiotic-resistant (AR) bacteria.[7] About 35,000 of these infections result in fatalities, with many more deaths from complications resulting from antibiotic resistance.[8]

Most animals raised for meat or milk in the U.S. are located in "Concentrated Animal Feeding Operations" (CAFOs). The purpose of these quasi-industrial facilities is to harvest as much meat or dairy product per animal as possible, even if this means keeping them in cruel conditions.

CAFOs allow almost no natural light and insufficient amounts of fresh air to promote health in densely packed conditions. Sewage treatment is difficult and usually primitive. Since these conditions promote disease, antibiotics are often mixed with the feed to control illness. In some animals such as cattle, these drugs also promote faster weight gain.

About 66% of the 20.3 million pounds of antibiotics used in the U.S. in 2018 were used in livestock, and 95% of animal drugs were consumed in feed and water, implying that most of this was for non-therapeutic use.[9] Because of this drug abuse, dangerous bacteria that cause disease are becoming resistant to antibiotics that cure animal and human disease. Mutated bacteria that survive low dosages pass this trait on to their progeny. This has reached the point where "superbug" bacteria (that are resistant to some or all antibiotics that are available today) are pervasive.

• Antibiotic resistant bacteria are present on many meat products sold to customers, who can be exposed before cooking or by improper cooking.

• If the AR germs infect a person, they can then spread to a non-infected person.

• The AR resistant traits do not confine themselves to the original pathogen. Different species of bacteria can trade AR genes between each other, making antibiotics less effective in treating other diseases.

• AR bacteria can be spread to workers at CAFOs.

• AR bacteria are also in sewage. Since CAFOs handle their manure by spreading it on land as fertilizer, people can be exposed to the pathogens through the food grown with it. The AR genes from the original bacteria can also spread to bacteria in the soil, as well as bacteria in water bodies through run-off and groundwater seepage.

About 60% of all the antibiotics used in the U.S. in 2017 were used in livestock. This drug abuse is causing dangerous bacteria to resist antibiotics that cure animal and human disease.

Public professionals have been expressing alarm for decades that at some point, all existing antibiotics, at one time considered miracle drugs, may be rendered ineffective due to pathogenic resistance. If public health is dealt this major setback, millions more people around the world will die annually from formerly curable diseases.

To give some tangible outline of this concern, the Environmental Working Group has analyzed antibiotic resistant bacteria in meat samples gathered by the U.S. Food & Drug Administration for several years. From a review of 2015 data, the organization determined that 79% of ground turkey, 71% of pork chops, 62% of ground beef, and 35% of chicken parts were resistant to at least one antibiotic.[10] It further found that 1 in 5 strains of salmonella were AR for amoxicillin, the most commonly used children's antibiotic.

Another alarming study from Pennsylvania showed that AR MRSA (associated with "flesh-eating bacteria" symptoms) was elevated near farm fields that were spreading manure from swine CAFOs.[11] Still other studies showed that MRSA had been found in wind aerosols 150 meters from their areas of origin, and in soil as far away as 300 meters.[12]

Non-Antibiotic Growth Promoters

Weight-Gain Hormones – Slow-releasing hormone-pellets are implanted in the ears of cattle to encourage more growth during the fattening process. These include natural hormones estradiol-17, progesterone, and testosterone, and the synthetic hormones melengestrol acetate, trenbolone acetate, and zeranol.

A SWOLLEN APPETITE
ANIMAL FACTORIES & POLLUTION

Environmental Law & Policy Center of the Midwest

Manure Lagoons from Large Animal Factory

The U.S. is the largest consumer of animal food in the world. It is also the largest producer. The sheer amount of land needed annually to raise feed, forage, and hay for American livestock is equal to the state of California.[1] The amount of land used for grassland grazing is equal to an additional third of the continental U.S.[2] Conventional pork in the U.S. requires 6 times its weight in grain and processed protein to yield a pound of food.[3] For beef, the ratio ranges from 5 to 25; for poultry, it is 3; for eggs, it is 2.

The collective waste (stored onsite in lagoons and pits or in confinement buildings) amounts to 1.2 to 1.4 billion tons of untreated sewage per year. This compares to between 3 and 20 times the amount of *treated* sewage created by the U.S. human population.[4] This manure contains: antibiotics; untreated bacteria and viruses; chemicals for cleaning equipment; heavy metals; pesticides; hormones and growth promoters; and sulfur.

In 2017, there were at least 19,961 large Concentrated Animal Feeding Operations (CAFOs) scattered throughout the U.S.[5] An estimate of small and medium operations, some not included in the previous figure, is 63,000.[6] This amounts to tens of thousands of large and small animal "factories" polluting their neighbors in a manner similar to industrial facilities, but without most of the pollution regulations that refineries and manufacturing plants must follow.

If you are unfortunate to live in proximity of a large CAFO, you will likely be subjected to the pungent odors of ammonia, the rotten-egg smell of hydrogen sulfide, methane and other volatile organic compounds, as well as nuisance dust from dry manure, feed, feathers, and disturbed dirt on feedlots. Though conditions can vary due to the type of livestock, number of livestock, feed additives, and climate, it is typical for nuisance odor and adverse physical and psychological reactions to occur 3 miles from a CAFO.[7] On a bad day, with strong winds and in certain climates, the odors can travel as far as 6 miles.

In 2014, livestock was responsible for 61% of human-made ammonia pollution in the U.S., amounting to 2.1 million tons; this is 90 times more than ammonia released by the domestic chemical manufacturing industry.[8] Livestock was also responsible for 21% of hydrogen sulfide pollution, amounting to 3,150 tons; some larger CAFOs literally emit as much of this chemical as oil refineries.[9] Agitated manure lagoons can expose CAFO workers to hydrogen sulfide vapors 10 times higher than the lethal dose.[10] Yet unlike these rival polluting industries, CAFOs are exempt from reporting emissions, and unless their emissions are extreme, and they get caught (in a state that happens to even *have* regulations), they are not required to mitigate the pollution.

About 70% of CAFO workers suffer from lung ailments caused by these chemicals; in some cases, they have literally died from acute overexposure to them.[11] Neighbors of large CAFOs suffer respiratory and sinus problems, headaches, diarrhea, and increased risk of heart disease, as well as the psychological problems of anxiety, depression, fatigue, memory loss, and sleep disorder.[12] In U.S. counties with CAFOs, an increased infant mortality rate of 7.4% was observed per doubling of animal production.[13]

Studies of CAFO neighbors have also documented decreased property values, increased crime, and a high percentage of people of color living in proximity.[14]

Animal factories contribute to acid rain and ozone, which damage property, crops, forests, and wildlife habitat.[15] CAFOs also damage streams, and eventually even rivers and oceans, by adding nitrogen (from ammonia). This causes acidification, intensifying "dead zones" already caused by agricultural fertilizers, where no aquatic life can survive because the water is depleted of oxygen. Water is also contaminated directly from CAFO run-off and groundwater seepage, which can spread nitrogen, pathogens, and undesirable chemicals in the manure.

The air and water pollution spreads way beyond the immediate radius of harm to neighbors. Acid rain, ozone, particulate pollution, and aerosols (fine, lung-damaging particles created from a combination of CAFO dust and chemicals) are often broadcast over a wide region, adding to damage already created from other pollution sources.[16]

And since the ultimate destination for the stored manure is land application as fertilizer, air and water pollution can potentially occur at whatever site this fertilization occurs, causing many of the same problems as the CAFOs themselves, albeit on a smaller scale.

Livestock digestion was also directly responsible for 4% of U.S. greenhouse gas emissions in 2017.[17] There are even more emissions if one considers energy and fertilizer used to grow feed crops, and used to power the animal factories and slaughterhouses. Emissions are also accelerated by grazing land, which would store more carbon if the biomass was not regularly consumed as cattle forage.

The first hormone added to U.S. beef was diethylstilbestrol (DES) in 1954.[13] Other hormone additives were approved beginning two years later. DES had previously been used for human medical purposes in pregnant women, prescribed as a drug to reduce the incidence of miscarriage. It was banned for human use in the U.S. in 1971 because of the carcinogenic effect it had on the daughters of women who used it. However, DES continued to be used as a growth promoter in livestock until 1979. Still, the practice of hormone treatment remains widespread using the 6 other approved drugs. It is estimated that at least 2/3 of U.S. beef is raised with hormones.[14] Concurrent use of more than one hormone at a time is allowed by federal regulators.

Scientifically, there is no dispute between proponents and opponents of adding these substances to cattle that they add to the level ingested in beef. The argument centers around the dose. Proponents will defend the practice by saying that hormone implants will only add a minute quantity. One advocate estimated beef hormones at 14 parts per trillion for 1.1 pounds of meat, while human hormones such as estrogen can be in adults at 136,000 parts per trillion in men and 513,000 parts per trillion in women per day.[15]

This theory, however, has been challenged. At least two scientific studies have linked harm to male fertility from increased beef consumption.

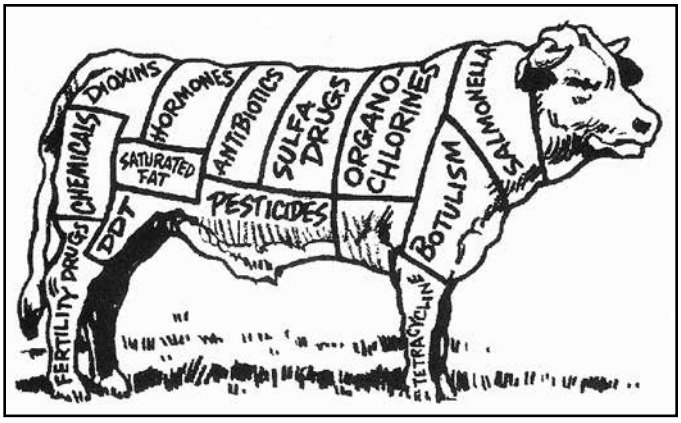
The European Union has banned U.S. meat raised with hormones since 1989. In addition to cancer, the EU is also concerned about endocrinal, developmental, immunological, genetic, and neurotoxic harm, particularly to children.

One of these studies, conducted in 2007, showed an association between high meat consumption in mothers and infertility in their adult sons.[16] The men whose mothers ate beef 7 times or more per week had sperm concentrations 24% lower than than men whose mothers ate less beef, and the rate of subfertility was 3 times higher than than men whose mothers ate less beef (18% vs. 6%). The authors concluded the possible cause was associated with added hormones.

In 2014, another study showed increased consumption of processed meat was associated with decreased sperm count, again possibly linked to growth hormones.[17]

Still other studies show effects to the environment as well as consumers.[18] Fish downstream of run-off of cattle manure (near animal raising facilities and on farms where manure is used as fertilizer) have been affected by hormones. Male fish are demasculated, while females are defeminized.

The European Union has banned U.S. meat raised with these additives since 1989. In its own research, it has called out estrogen as a proven carcinogen, and inferred that the other 5 hormones used in the U.S. could also cause cancer. The EU is also concerned about endocrinal, developmental, immunological, genetic, and neurotoxic harm caused by



Artwork by John Dolley

these substances, particularly to children.[19] Among the concerns of the researchers was that hormone implants could be inserted in the wrong part of the animal. This would result in the drugs being processed into ground meat and exposing them to people at very high doses.

Bovine Growth Hormone – Unlike hormones administered to cattle to promote weight and meat gain, bovine growth hormone (BGH) is a genetically engineered substance injected into cows to induce more milk production. It can increase the yield per cow, but at a cost to both animal and human health.

BGH can cause harm to people that consume cow's milk. It increases the chance of mastitis (inflamed udders), lameness, infertility, and digestive disorders in cows.[20] Increased use of antibiotics to treat mastitis and other infections increases the possibility of antibiotic resistance that can affect humans.[21]

BGH is also associated with an increase in the hormone Insulin Growth Factor 1 (IGF-1). Though evidence is not conclusive, some studies have associated increases in IGF-1 with increased incidence of breast, colon, gastrointestinal, ovarian, and prostate cancer.[22]

Australia, Canada, the EU, Japan, and New Zealand all prohibit the use of BGH.

Unlike most other genetically engineered foods in the U.S., the public has generally rejected milk from BGH-treated cows. Campaigns by environmental and organic-food advocates, as well as labeling by BGH-free dairy producers, have created a toxic marketplace (no pun intended) for dairy produced with this hormone. In 2002, 22% of cows in the U.S. were treated with BGH. By 2014, it had fallen to 15%.[23]

Other Growth Promoters – U.S. pork producers do not use antibiotics as growth promoters. However, they rely on other drugs such as *ractopamine*. During the last few weeks of the "finishing" process, where hogs (as well as other livestock) are fattened before slaughter, hog feed is laced with the drug. It causes them to gain more muscle (and saleable meat) instead of fat.

But it can also contribute to heart problems, hyperactivity, broken limbs, injury, lameness, and increased death in pigs. People ingesting excessive amounts of it through animal food can experience asthma-like symptoms, heart palpitations, and anxiety. By 2010, China had claimed there were 1,700 illnesses attributed to ractopramine between 1998 and 2010 from pork imported from the U.S.[24] The U.S. Department of Agriculture (USDA) was forced to create a certification program proving that pork exported to China and Russia was free of ractopamine because of their governments' health concerns.[25] More than 160 countries have banned its use in livestock, but it is perfectly legal to use in pork sold in the U.S.[26]

Top: Vedaant Sethia/Shutterstock.com Bottom: al7/Shutterstock.com

Zilmax, another chemical used to place weight on cattle late in finishing, has been shown to cause greatly increased feedlot death rates and lameness in the animals. Hoofs have been observed literally falling apart. While the drug fell out of favor with some beef producers due to these health effects, it is still marketed.

Other Chemicals in Animal Food Production

In addition to PBTs, conventional antibiotics that can cause antibiotic-resistant bacteria, and growth promoters, are a host of lesser known toxins and drugs that are used in animal raising. A 2018 *Consumer Reports* analysis of USDA data from meat samples identified: traces of the hallucinogen *ketamine*; the anti-inflammatory drug *phenylbutazone* (so powerful it is banned for human consumption but used on horses); the antibiotic *chloramphenicol* (that can cause life-threatening aplastic anemia); and *nitroimidazoles* (an antifungal medication that is a probable carcinogen).[27]

A 2012 study authored by researchers at Arizona State University and Johns Hopkins University detected 32 drugs or ingredients found in personal care products in the feather meal of chickens, which is used both as a crop fertilizer and as feed for animals (including chickens).[28] While many of these were antibiotics and would be (to some extent) expected, there were also signs of chemicals that would surprise the average reader.

• *Caffeine* is intentionally given to chickens by feeding them coffee pulp and tea powder. It is used as stimulant to keep chickens up at night so that they will eat and gain more weight.

• *Acetaminophen*, the main ingredient in the pain medication Tylenol, is given to young chickens to quell fevers from reactions to vaccinations that are administered to combat the diseased environment in CAFOs. It is also used later in their growth to alleviate pain in their legs brought on by genetics and lack of vitamin D (because CAFOs have no sunlight) that can make it difficult for the birds to walk. Stanching the pain keeps the birds walking and eating.

• *Diphenhydramine*, the active antihistamine ingredient in Benadryl, is used to combat respiratory problems brought on by noxious air in CAFOs.

• *Fluoxetine* (a.k.a. Prozac), an antidepressant, is used in China to keep chickens calm in a CAFO-stressed environment. Less stress produces more tender meat.

• Parasiticides are commonly used in CAFOs to fight infestations often caused by the unsanitary conditions. However, due to the dose, length and time of exposure, and metabolism, not all of these show up in the animal's body at the time of slaughter. The study also discovered *thiabendazole* (used on nematode worms), which is a reproductive and developmental toxin, as well as an organ toxicant in sufficient quantities.

• The study also identified *norgestimate*, a synthetic hormone found in birth control pills, and *dehydronifedipine* and *digoxin*, both used as heart disease medications.

Unhealthy Fat Content

Conventional livestock raised in CAFOs are almost always fed grain to increase slaughter weight, and often to enhance the flavor. But consuming large percentages of grain is not part of these animals' evolution.

This has a particularly large impact on cows. Large percentages of grain in cows' diets not only damages their health, but increases fat content that adversely impacts human consumers. A human diet with too much fat contributes to ailments such as obesity, heart disease, and diabetes.

Grain-fed animals also often contain the wrong *kind* of fat. Certain types (such as Omega-3 and Omega-6 polyunsaturated, low-cholesterol fats) are actually beneficial to people.

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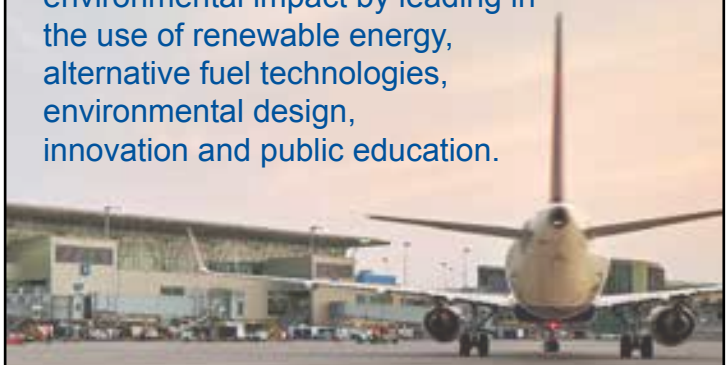

For more information, please visit:
www.austintexas.gov/airport

Austin-Bergstrom International Airport

Omega-3 fats have been proven to lower heart disease; in some studies, they have also been effective in improving fetal brain development and reducing dementia.[29]

Another important consideration is that grain-fed animals have a higher ratio of Omega-6 fats to Omega-3 fats. A ratio of 1 to 1 is considered optimum for health, but the American diet today can be as high as 10 to 1. Higher ratios have been associated with increased heart disease.[30]

Beef and Dairy: Grass-fed beef and dairy cows prove to be low in fat. But interestingly, both organic beef and dairy products also contain higher levels of beneficial Omega-3 and Omega-6 fats.[31] These foods also contain lower ratios of Omega-6 to Omega-3.[32] Omega-3 in grass-fed beef has been shown to be 160% higher than in conventional beef.[33] Some studies also show grass-fed cows produce lower levels of unhealthy high-cholesterol (saturated) fat.[34]

Grass-fed beef is higher in conjugated linoleic acid (CLA), a nutrient shown to reduce cancer risk.[35] Grass-fed meat has also shown higher levels of beta-carotene, Vitamin E, B-vitamins riboflavin and thiamine, and higher levels of calcium, magnesium, and potassium.[36]

Health-conscious consumers of beef should be careful to distinguish between labels. Grass-fed is usually designated by the terms "Select," "Lean," and "Very Lean."

As of this time, there is no U.S. government approved definition or certification program to determine such things as whether grass-fed cattle have been raised on open pasture, what percentage of their food is grass (and what percentage of non-grass food is genetically engineered or organic), or whether they have been given antibiotics and hormones. Conversely, cows certified organic are not required to be grazed more than 120 days a year, and grain can be supplemented even on these days.

The best way to obtain beef and cow's milk that is both organic and grass-fed is to shop for food with labels that certify both qualities. (See table on page 39.)

Pigs and Chickens: There is a conscious effort among a relatively small number of pig and poultry farmers to raise animals on open pasture. "Pasture-raised" livestock are different than "free-range" animals. Free-range livestock are often raised in CAFOs, with the only difference that they have access to the outdoors. Ensuring that they actually *go* outdoors is not required.

Pastured animals are actually raised on open pasture, with permanent or portable shelters often located near them to provide safety from the elements when necessary. Unlike cattle, which have 4 stomachs in their digestive tract to consume grass, pigs and poultry are not predominantly grass eaters. While pigs and chickens can and will eat grass when allowed to forage, *in almost all cases in which they are pasture-raised, grass is not their main source of food.*

Environmental Food Rating Information

Animal Food

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American Grassfed Association
americangrassfed.org
Certification organization that ensures cattle (meat and dairy), bison, goats, pigs, and sheep are humanely raised on pasture instead of feedlots. In stores, look for the organization's seal on products. The Web site also lists ranchers by state for those who want to buy directly from them.

American Pastured Poultry Producers Association
https://apppa.org/directory
Organization that promotes pastured (as opposed to organic or "free-range") poultry. Lists farms that supply this throughout the U.S.

Campaign for Real Milk
realmilk.com/real-milk-finder
Organization that promotes raw milk. Lists farms and dairies that supply this throughout the U.S.

Central Texas Native Nutrition Listserv
E-mail: WAPFAustin@gmail.com
The group encourages and supports CenTex farmers and food producers who take the time, effort, and expense to learn environmentally and nutritionally sustainable methods for raising crops and livestock.

Certified Humane
certifiedhumane.org/whos-certified-2/
Certification organization that ensures cattle (meat and dairy), goats, pigs, poultry, (including laying hens), and sheep are raised humanely, which often overlaps with environmental qualities. Its Web site lists animal raisers who are certified.

Cornucopia Organic Scorecards
(Dairy, Yogurt, Eggs)
cornucopia.org
Ratings of commercial products based on environmental and social standards, as well as transparency.

Eat Wild
eatwild.com
Organization promoting natural food. Lists farms and dairies that supply natural meat and dairy throughout the U.S. Some are certified as American Grassfed.

Environmental Working Group Food Scores
ewg.org/foodscores
Database of over 80,000 food products rated on a scale of 1 to 10 for nutrition, additives and contaminants such as pesticides, preservatives, antibiotics, and processing. Products include animal, plant, and baby food.

A Greener World
agreenerworld.org
Certification organization that ensures cattle (meat and dairy), goats, pigs, poultry (including laying hens), and sheep are raised humanely, which often overlaps with environmental qualities. Its Web site lists animal raisers who are certified, as well as retailers in local areas that sell certified products.

Global Animal Partnership
globalanimalpartnership.org/partners/products-brands/
Certification organization that ensures cattle (meat and dairy), goats, pigs, poultry (including laying hens), and sheep are raised humanely, which often overlaps with environmental qualities. The rating system has 6 tiers, with the top 3 ensuring higher standards. Dairy cow standards were being established in 2019. Its Web site lists animal raisers who are certified.

Sometimes forage crops (e.g., oats, clover, kale) are intentionally raised for grazing. Cow's milk, fish oil and meal, and amino acids might intentionally be fed as protein supplements. Often grain and soy are main staples for pasture-raised pigs and chickens, with forage of grass, seeds, bugs, and worms supplementing this. There is no prescribed pasture-raised diet, and a pasture-raised diet can vary by farm, climate, and season.

Pasture-raised pigs and poultry are not necessarily certified as organic. As with beef and cow's milk, the best way to obtain meat and eggs that are both organic and pasture-raised is to shop for food with labels that certify both qualities. However, as with grass-fed beef, a better quality diet, exercise, and access to the outdoors generally yields a more nutritious product.

With chicken raised for meat, pasture-raised and organic animals have a higher rate of Omega-3 fats, a lower ratio of Omega-6 to Omega-3 fats, and increased iron, Vitamin E, and beta-carotene than conventionally raised animals.[37]

With chicken eggs, pasture-raised and organic animals also have a higher rate of Omega-3 fats and a lower ratio of Omega-6 to Omega-3 fats, as well as increased levels of Vitamin D and E, beta-carotene, and the antioxidants lutein and zeanthin compared to conventionally raised animals.[38]

Large percentages of grain in cows' diets not only damage their health, but increase fat content that adversely impacts humans. It contributes to obesity, heart disease, and diabetes.

Pasture-raised and organic pork also has a higher rate of Omega-3 fats and a lower ratio of Omega-6 to Omega-3 fats, as well as increased levels of iron, Vitamin E and polyphenol antioxidants compared to conventionally raised animals.[39]

Grazed and Confused Eating Safer Up the Food Chain

Consumers who want to buy safer animal food products are confronted with a number of confusing labels, claims, and advertisements that must be sifted through to find safer products. Food safety analysts at the Environmental Working Group recommend that you look for meat (excluding fish) and dairy products endorsed by at least one of half-a-dozen ratings and organizations. These higher standards include: eliminating or limiting feedlots; a better diet of grass or purer grain; prohibition of hormones, other growth promoters, and antibiotics; and more humane treatment. The table below compares these various standards.

In reading this, consumers should be a bit cautious about the U.S. Department of Agriculture organic standards for beef and pork. The laws and rules have changed. These food products were once governed by "Country of Origin Labeling" laws that required disclosure of where they were produced. But due to law changes resulting from international trade disputes, the U.S. now allows foreign beef and pork, including reputedly organic animal food, to be labeled as produced in the U.S. as long as they are *processed* in the U.S., even if they are not raised here.

Since inspections are done in another country, it is difficult to be as confident of the "organic" claim unless the product also carries another reliable certification in this chart.

Livestock Certification Organizations and Their Requirements

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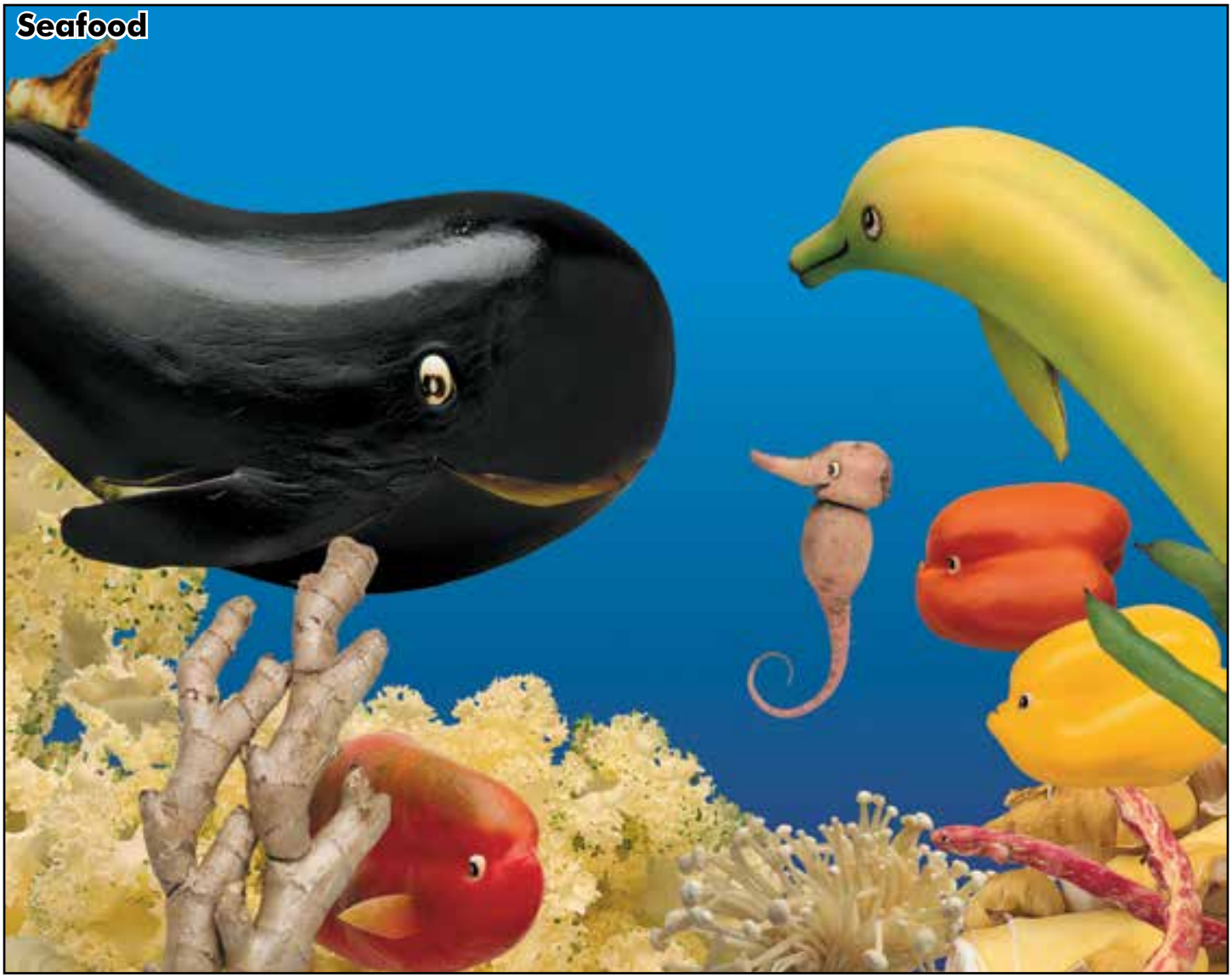
		Raised Primarily on Pasture	No Feedlots Allowed	Prohibits Overcrowding Indoors	Pasture Management to Protect Environment	Primarily Fed Grass and Forage	No Grain Feeding	No Genetically Engineered Feed Allowed	If Grainfed, Organic Feed Required	No Antibiotics to Healthy Animals	No Growth Hormones	Standards to Minimize Painful Mutilation	Assurance of Humane Slaughter
American Grassfed Association	americangrassfed.org	√	√	NA	√	√	√	NA	NA	√	√	X	X
Certified Humane	certifiedhumane.org	√[1]	√	√	X	√	X	X	X	√	√	√[2]	√
Animal Welfare Approved	agreenerworld.org	√	√	NA	X	X	X	X	X	√	√	√	√
USDA Organic	usda.gov/topics/organic	√	X	X	√	√	X	√	√	√	√	X	X
Food Alliance Certified Grassfed	foodalliance.org	√	√	NA	X	√	√[3]	NA	NA	√	√	X	X
Global Animal Partnership	globalanimalpartnership.org	√[4]	X[5]	√	X	√[4]	X	NA	X	√	√	√	X

√[1]=Beef but not dairy cows
√[2]=Prohibits most but not all practices
√[3]=Special grass-fed rating for cows/ruminants; other animals can eat grains
√[4]=In this 6-tiered rating program, steps 4, 5, and 5+ require pasture
X[5]=In this 6-tiered rating program, lower steps allow feedlots



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Between 1970 and 2012, there has been an approximate 52% global decline in marine vertebrate fish, mammals, birds, reptiles, and amphibians.[1] While a major cause is overexploitation of fish and other eatable wildlife, other causes include: 1) loss of critical habitat such as seagrass, wetlands, mangrove wetlands, and coral reefs; 2) overdevelopment of coastlines; 3) climate change (causing acidification of oceans and warmer water temperatures); and 4) pollution from vast quantities of chemicals and plastics.

This last cause in particular not only affects the quantity of eatable fish available to people, but the safe consumption of it. Heavy metals like mercury, as well as Persistent Organic Pollutants (POPs) such as organochlorine pesticides, PCBs and other dioxins, PBDE flame retardants, and PFC Teflon™-like coating chemicals, are sequestered in the flesh and body fat of the fish humans consume.

Due to declines in wild-caught fish availability, the world has adopted aquaculture to fill the demand.

A considerable percentage of fish and sea creatures captured for human food are not wild. In 2017, about half (46%) of the world's fish protein came from "farms" where fish are intentionally raised in pens, tanks, ponds, or other methods of capture.[2] This growing technique is particularly focused on certain types of fish. Worldwide, seafood from aquaculture in 2016 produced: 78% of salmon; 94% of carp; 88% of catfish; 99.7% of sturgeons; 61% of shrimp; 91% of clams, and 97% of oysters.[3]

Environmental effects from farmed fish are considerably more complicated than wild-caught fish. As well as their effect on sustainability of the catch, there is considerably more potential to contaminate food.

• **Fish Feed That is Unsustainable or Environmentally Questionable** – Some species raised on farms are predator species that eat other fish. They are fed with fishmeal or fish oil derived from other fish that are not sustainably harvested. Farmed fish are also often fed grain crops, some of which can be genetically engineered. And they can be fed too much, so that the amount of feed compared to the amount of eatable fish food is quite high.

• **Chemicals** – Many farmed fish are raised in a manner similar to Confined Animal Feeding Operations on land, with many of the attendant problems. Fish and other sea creatures are crowded in netted pens near the shoreline or in enclosed ponds or tanks. Adequate flushing or treatment of animal waste and uneaten food is often lacking, leading to treatment with antibiotics, antimicrobials, and pesticides. Growth hormones are also employed.

And like wild-caught fish, farmed fish can also sequester Persistent Organic Compounds (POPs) and mercury in their bodies due to their consumption of fish-based food, exposure to water contaminants, and in some cases, dwelling deep in the water body near contaminated sediments.

However, in farmed fish, the potential for contamination is much higher, as they generally sequester many more toxins in their bodies. A study comparing dioxin concentrations in different kinds of salmon revealed that the most contaminated farmed salmon (raised in Europe) was at least 16 times more toxic than Pacific wild salmon. A similar analysis showed farmed salmon contained 16 times the level of the dioxin PCB found in wild salmon, 4 times the level found in beef, and 3.4 times the level found in other seafood.[4]

• **Sewage** – Just like land-based livestock operations, fish farms can collect a huge amount of manure. A farm of 200,000 fish can produce as much sewage as a city of 60,000 people. If this waste is not properly flushed, it can cause disease to the fish, and indirectly affect the health of the people that eat them by requiring chemical treatment that consumers will be exposed to. Further, if the waste is not properly treated or disposed of, it can harm the greater environment.

• **Harm to Habitat from Farm Site** – If the farm is located near wetlands and mangroves, it can cause loss of environmentally sensitive habitat.

• **Escape of Farmed Fish** – Escape of a certain number of farmed fish from their pens and ponds into open waters is a tolerated business loss, but often with adverse environmental side effects. Some of these fish are literally native to other continents from where they are raised, and when they escape, they can sometimes become invasive species to their new environment. They can displace native species, cause habitat disruption, spread disease, and upset breeding cycles.

In the case of farmed salmon, for example, Atlantic salmon are often raised on the Pacific coast. If they escape, they might challenge the habitat of native salmon. And if local salmon breed with them, their offspring will be sterile.

Along with escaped farmed fish are the escaped diseases and parasites that these escaped fish carry, possibly wreaking havoc when introduced to a new ecosystem that has not adapted to them.

• **Genetically Engineered (GE) Feed and Fish** – Aquaculture is using GE feed grains, which have been shown to increase cancer, as well as kidney and liver disease, in test animals. Many GE grains are bred for their resistance to certain herbicides, which not only increases chemicals used in agriculture, but eventually encourages "super weeds" that develop resistance to these herbicides.

However, an even larger concern is GE fish. In March 2019, the U.S. Food and Drug Administration approved the first commercial GE fish for domestic production and human consumption. Christened "AquaBounty," this new breed of salmon employs genes from other fish that allow these salmon to grow to full commercial weight in 16 to 18 months, while typical farmed salmon take 32 to 36 months. The new salmon not only saves time, but consumes 25 to 33% less feed. It is probable that this new fish will be marketed in small quantities by 2021.

Environmentalists fear the fish will escape into the wild, where they can displace natural salmon. The creators of this fish have argued that the animals will be raised in virtually escape-proof conditions, and will be sterile females that cannot breed if they do somehow breach captivity. However, the sterility is not foolproof, as salmon have actually been observed to change sex under certain conditions. And many foreign countries where these salmon might be raised in the future have a history of lax enforcement, or no enforcement, of environmental regulations.

• **Source of Breeding Fish** – If wild-caught fish eggs or hatchlings are used as the source of new farmed fish populations, this will deplete the wild-caught population.

• **Protection of Local Wildlife** – Birds, mammals, and other fish may consider farmed fish as part of their diet and attempt to eat them. Fish farmers will sometimes resort to other measures besides exclusion to protect their animals, including execution of local predators.

The quality control system for food safety in the U.S. is far from perfect. However, it is worth noting that 90% of fish consumed by U.S. consumers are imported. Many foreign countries have aquaculture operations that are far more questionable than domestic fish-farm practices.

Rating Fish for Safety and Sustainability

Consumers who want to screen for safety and sustainability have several guides and certification ratings to assist them.

Marine Stewardship Council (MSC) – MSC awards its label to wild-caught fish certified with multifaceted standards for: sustainable harvest of the marine life; fewer ecosystem impacts; and effective management of fisheries. Though the label does not judge food contaminants, wild-caught fish are free of antibiotics,

antimicrobials, hormones, pesticides, and GMO feed. Key to its certification is MSC's ability to trace the seafood from the point-of-catch to the point-of-sale ("bait to plate").

Environmental Working Group – Unfortunately, there is no way for MSC to prevent contamination of wild-caught fish with mercury or POPs. The best thing that seafood eaters can do is to limit mercury intake (depending on the amount of mercury a particular sea creature is likely to absorb). This kind of "seafood quota" would allow most common seafoods to be eaten at least 3 times a week by healthy adults. However, tuna and flatfish (e.g., flounder) generally contain more mercury and would have to be more limited for children and teenagers. Orange roughy, shark, and swordfish are so contaminated with mercury that people of all ages are advised to avoid them.

An online calculator for mercury quotas is discussed in the Sidebar on Food Rating Information.

Seafood Watch – The Monterey (CA) Aquarium Seafood Watch has a comprehensive evaluation of all major types of eatable fish. They are rated green, yellow, or red, depending on a number of factors, including: 1) The species of fish; 2) farmed or wild-caught; 3) if farmed, the type of enclosure; 4) if wild-caught, the capture method; 5) the country or region or origin; and 6) the environmental record of specific countries.

Though there are exceptions for these general ratings, the list below is provided here as a benefit to the readers.

Farmed Fish Ratings – There are at least 3 certification organizations that rate specific fish farms based on the criteria previously described for safety and sustainability. Their logos identify various certified products at retail locations.

Which one is best? Seafood Watch conducted model evaluations for several kinds of fish based on the different criteria previously described.

The chart on the next page shows the composite score of 10 indicators, and the Chemical criteria score alone, since it is the one most important for human consumption.[5] This was averaged for 4 farmed fish species that could be compared: catfish, mussels, shrimp, and tilapia.

MONTEREY SEAFOOD WATCH GENERIC FISH RATINGS

BEST CHOICES
Arctic Char (farmed)
Barramundi (US & Vietnam farmed)
Bass (US hooks and lines, farmed)
Catfish (US)
Clams, Cockles, Mussels
Cod: Pacific (AK)
Crab: King, Snow & Tanner (AK)
Crab: Stone (US)
Crawfish (US farmed)
Lionfish (US)
Mahi Mahi (US handlines)
Mullet: Striped (US)
Oysters (farmed & Canada)
Pompano (US)
Rockfish (AK, CA, OR & WA)
Salmon (New Zealand)
Shrimp (US farmed)
Snapper: Mutton (US diving, handlines)
Sturgeon (US farmed)
Tilapia (Canada, Ecuador, Peru & US)
Tuna: Albacore (trolls, pole and lines)
Tuna: Skipjack (Pacific trolls, pole and lines)
Wahoo (US Atlantic)
Wreckfish

GOOD ALTERNATIVES
Branzino (Mediterranean farmed)
Conch (Belize, Nicaragua & US)
Crawfish (LA wild)
Grouper: Red (US)
Lobster: Spiny (Bahamas & US)
Mahi Mahi (Ecuador & US longlines)
Monkfish (US)
Octopus (Canada, Portugal & Spain pots and traps, HI)
Oysters (US wild)
Salmon (Canada Pacific & US)
Shrimp (Canada & US wild, Ecuador & Honduras farmed)
Snapper (US)
Squid (Chile, Mexico, Peru & US)
Swordfish (US)
Tilapia (China, Colombia, Honduras, Indonesia, Mexico & Taiwan)
Trout: Rainbow/Steelhead (Chile farmed)
Tuna: Albacore (US longlines)
Tuna: Skipjack (free school, imported trolls, pole and lines, US longlines)
Tuna: Yellowfin (free school, trolls, pole and lines, US longlines)

AVOID
Conch (imported)
Crab (Argentina, Asia & Russia)
Crawfish (China)
Lobster: Spiny (Belize, Brazil, Honduras & Nicaragua)
Mahi Mahi (imported)
Octopus (other imported sources)
Orange Roughy
Pompano (imported)
Salmon (Canada Atlantic, Chile, Norway & Scotland)
Sardines: Atlantic (Mediterranean)
Sharks
Shrimp (other imported sources)
Squid (Argentina, China, India & Thailand)
Swordfish (imported longlines)
Tuna: Albacore (imported except trolls, pole and lines)
Tuna: Bluefin
Tuna: Skipjack (imported purse seines)
Tuna: Yellowfin (longlines except US)

Naturland ratings were the best for the overall composite and chemical score, where 1 is the worst score and 10 is the best. Note that every species and fish farm will be different, and hopefully ratings will improve over time.

Average of 4 Farmed Fish Ratings (Catfish, Mussels, Shrimp, Tilapia)			
Organization	Web Site	Overall Score	Chemical Score
Naturland	bapcertification.org	6.6	9.5
Aquaculture Stewardship Council	asc-aqua.org	5.8	6.3
Global Aquaculture Alliance	friendofthesea.org	5.1	3.0

Environmental Food Rating Information

Seafood

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Environmental Working Group's Seafood Calculator
ewg.org/research/ewgs-good-seafood-guide
General guide to the best fish to eat based on a person's individual body weight, age, and sex. It estimates how many weekly servings a person can eat based on average mercury content, and also rates on species sustainability, and nutritional content of beneficial Omega-3 fatty acids.

Monterey Seafood Watch Seafood Search
seafoodwatch.org/seafood-recommendations
Generic ratings for seafood based on sustainability and quality. While this resource goes into great detail over each kind of seafood, a concise shopping list can be downloaded at this Web site.

Food Documentation

Grocery Store Receipts

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15 op. cit., *Humane Society of the United States*, "Major Air Emissions from CAFOs," beginning at Exhibit 1, p. 17.
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