Is Organic Food Worth the Extra Cost?

Modified from the National Institute of Environmental Health Sciences

Introduction

Pesticides are any substance intended to prevent, destroy, repel or mitigate pests. Pests can be insects, mice, weeds, fungi, bacteria or viruses. Pesticides are used during the production and distribution of food products to reduce pest damage. Unfortunately, some pesticides can get left behind on food products. To protect the food supply, the U.S. Environmental Protection Agency sets safe levels of pesticide residues in foods called “tolerances.” Tolerances are based on a risk assessment process that estimates the possible harm pesticides might cause to those who are exposed.

The tolerances are typically based on “oral reference doses,” an estimate of daily oral exposure to the human population that will not result in any harmful effects. One limitation of these risk estimates is that they only consider the potential effect of an individual pesticide and not the combined effects of exposure to multiple pesticides.

The U.S. Food and Drug Administration routinely tests foods for residues for over 60 types of pesticide to ensure that pesticide residue levels are below the tolerances. Some foods have been shown to contain residues of more than one type of pesticide. The FDA also uses food consumption data generated by the U.S. Department of Agriculture to look at how much food is eaten that may contain pesticides.

Tables One on the next page shows foods that a teenager may eat during a typical day and the food testing results for these foods from the FDA pesticide sampling tests in 2001 for two common pesticides: malathion and chlorpyrifos. These pesticides belong to a class called “organophosphates” because they interfere with the body’s ability to transmit electrical signals and control muscle movement.

“Malathion can enter the body if it gets on someone’s skin, inhales it, or if food or drinks are ingested that have been treated by malathion. If exposed to malathion a person can cause nausea, vomiting, weakness, headache, abdominal pain, or diarrhea. Malathion travels to the liver and kidneys and affects the nervous system. The human body generally can break down and remove it quickly. Studies in rats showed that most malathion was gone from their bodies within a day of exposure” (NPIC, Web).

“Chlorpyrifos moves to all parts of the body after exposure. Chlorpyrifos itself is not toxic, but when the body tries to break it down, it creates a toxic form. This toxic form, called chlorpyrifos oxon, binds permanently to enzymes which control the messages that travel between nerve cells. When chlorpyrifos binds to too many of the enzymes, nerves and muscles do not function correctly. The body then must make more enzymes so that normal nerve function can resume. The body can break down and excrete most of the unbound chlorpyrifos in feces and urine within a few days. Chlorpyrifos that finds its way into the nervous system may stay there much longer” (NPIC, Web).

“Chlorpyrifos is very toxic to many bird species such as grackles and pigeons, and it is moderately toxic to others such as mallard ducks. Mallard ducks fed chlorpyrifos laid fewer eggs and raised fewer ducklings. The eggshells were thinner than normal, and many of the young ducklings died. Chlorpyrifos is also very toxic to fish and aquatic invertebrates. It may build up in the tissues of fish and other animals that eat smaller animals. This is known as bioaccumulation. Chlorpyrifos is very toxic to bees. It can poison non-target insects for up to 24 hours after it is sprayed. Chlorpyrifos can be toxic to earthworms for up to 2 weeks after it is applied to soil” (NPIC, Web).

Activity 1:

JIGSAW in a group of 4. Each member of the group reads a different website and shares their information with everyone else in the group. Use these sentence stems as you share with your groups:

1. One cool thing I learned (a fun fact).
2. One interesting thing I would like to know more about.
3. One question I would ask the author.

Websites for JIGSAW:

A. Malathion
B. Chlorpyrifos
C. Organic Products
D. Organic Practices

Activity 2:

Using the table below, you will see that the total dosage in nanograms of malathion and chlorpyrifos is calculated for what you would receive from eating one serving of each of these foods in a day. Here’s a calculation hint:

170 grams of pizza X 1.0 nanograms/gram = 170 nanograms of malathion

170 grams of pizza X 0.08 nanograms/gram = 13.6 nanograms of chlorpyrifos

Food	Serving Size (grams)	Malathion present (nanograms/gram)	Chlorpyrifos present (nanograms/gram)	Malathion from 1 serving in nanograms	Chlorpyrifos from 1 serving in nanograms
Cheese pizza	170	1.0	0.08	170	13.6
White bread	40	27.5	0.1	1100	4
Chicken Pot Pie	200	5.2	0.4	1040	80
Choc chip cookie	15	15.5	0.22	232.5	3.3
Bagel	100	4.8	0.1	480	10

Apple	200	2.0	6.0	400	1200
Peanut Butter	32	8.0	0.95	256	30.4
TOTALS	n/a	n/a	n/a	3678.5	1341.3

1. The oral reference dose (safe level of ingestion) is 0.02 milligrams/kilogram/day for malathion and 0.003 mg/kg/day for chlorpyrifos. An average adult male weighs 70 kg, so a safe level of exposure per day for this person would be:

0.02 mg/kg/day X 70 kg = 1.4 mg/day for malathion

0.003 mg/kg/day X 70 kg = 0.21 mg/day for chlorpyrifos

A. Determine your weight in kilograms using 1 pound = 0.45 kg.

B. Calculate your safe level of exposure per day in mg/day for malathion and chlorpyrifos using your own weight in kg.

C. What is the difference between the safe level of exposure you found in part B and the total amount you receive in a day from your foods (found in the TOTALS tab in the table)? Is it safe for you to eat these foods? Don't forget to convert! 1 nanogram = 1.0 X 10 ^ - 6 milligrams.

2. Assuming your body does not flush out the malathion and chlorpyrifos, how many days would it take for your body to bioaccumulate toxins until you reach the safe level of exposure?

3. Poll others around you of different weights. Determine the effect of body size on the safe level of pesticide exposure, and write a short paragraph about your discovery.

Activity 3:

JIGSAW in groups of 4: Distribute the following four articles to your squad & read for understanding. Discuss the findings with each other.

Together, determine whether or not organic foods are worth a premium price. Remember to refer to the websites and information from the introductory activity, too. Should we ban pesticide use? Limit it? Should consumers have the right to know if a food product has been genetically modified in any way? Should we ban genetically modified foods? Limit them? What might this have to do with global food insecurity and sustainability in the future?

Justify your decision with a solid but short paragraph, and be ready to share it out loud. You may choose to agree or disagree with your squad, but you must write your own justification in your own words.

Article A: Transgenic Travesty *By Fred Schwarz*

Genetically modified crops should be a green activist's dream. They can increase productivity per acre, reduce the need for pesticides and herbicides, improve plants' ability to survive unfavorable conditions, and deliver key nutrients to prevent disease in those who eat them. Nowadays, with food in short supply, GM crops can be especially helpful, as they alleviate shortages where the shortages exist, literally at ground level, with no need to rely on charity from abroad.

Instead, greens hate GM crops. Here's a typical assessment from the Huffington Post: "There have been few experiments as reckless, overhyped and with as little potential upside as the rapid rollout of genetically modified crops." In support of these claims, opponents trot out a constantly shifting set of scientific findings that purport to demonstrate how GM crops harm the environment.

The first to be widely cited was a 1999 paper supposedly showing that pollen from GM corn was toxic to monarch butterfly caterpillars. This laboratory study was swiftly and conclusively dismantled by other scientists, who demonstrated that it bore no relation to actual conditions in the wild. As John Foster, an entomologist at the University of Nebraska, has pointed out, "traditional pesticides are actually a much bigger threat than biotech corn ever will be. A lot more monarchs die on the grills of 18-wheelers than they do from farmers who plant biotech crops."

Another experiment, which suggested detrimental effects on honeybees, also turned out to be deeply flawed. Neither study has been duplicated (though greens still cite them), and no new evidence of significant harm to non-target insects has been found.

Another common charge against GM foods is that they could cause problems with allergies. The evidence: In the mid-1990s a soy plant with a Brazil-nut gene added was found to be potentially allergenic in humans. This happened long before the plant reached the market, and even though it was intended as animal feed, it never went on sale. As this incident shows, allergenic proteins are fairly easy to recognize and test for; that's why no GM food has ever caused allergies in consumers. In fact, genetic engineering is currently being used to remove allergens from foods, raising the possibility of allergy-free peanuts and even seafood.

Do GM crops reduce biodiversity--for example, by displacing other plants or eliminating parts of the food chain? Evidence for this is weak at best. A 2001 article published in Nature purported to show such a decrease caused by GM corn in Mexico, but the study was so problematic that the journal's editors retracted it the following year. Unsurprisingly, GM opponents continue to tout this paper and

portray its authors as martyrs (unlike those who dissent from scientific orthodoxy on global warming, who are mocked as "deniers").

Overall, there is at least as much evidence that GM crops increase biodiversity (by reducing use of pesticides and herbicides, among other things). Here, as with the other charges against GM crops, the purported effects are tiny if not illusory, and no different from what occurs with many common practices in non-GM agriculture, while the benefits are large and quantifiable.

The closest thing to a legitimate objection has to do with the risk of promoting resistance to pesticides and herbicides. One type of GM crop produces a substance that is lethal to certain pest species but safe for humans. The most common such substance is Bt, an insect-killing protein produced in nature by the bacterium Bacillus thuringiensis. As a natural product, it is widely used by organic farmers, who worry about the possibility of Bt-resistant pests.

GM plants can also be made resistant to a given herbicide. Monsanto sells a number of "Roundup Ready" crops that are immune to the company's Roundup herbicide. This greatly simplifies weed control for farmers, reducing the need for tillage and, in many cases, the amount of herbicide applied. Opponents say that herbicide-resistant traits could migrate from Roundup Ready crops to the wild through wind-borne pollen, creating "superweeds" that would be hard to kill.

There's a grain of truth in these criticisms, because anytime you use herbicides and pesticides, some organisms will develop immunity. That's a fact of life in farming, and there are ways to deal with it, such as rotating crops or using a different herbicide or pesticide. But the problem of pests' developing resistance through natural selection is no greater with GM crops than it is with non-GM ones. As for "superweeds," such hybrids are very rare and far from super. In one widely publicized study, researchers collected 95,000 seeds from wild plants and found exactly two that showed GM-induced herbicide resistance. When the researchers returned to the same field the following year, they found none. As agricultural scientists have long known, random cross-breeding almost never yields offspring that can reproduce, let alone flourish.

For an example of how anti-GM activists grasp at straws, consider the case of MON 863, a corn variety modified by Monsanto to make it resistant to rootworms. It has been approved for use as animal fodder by the regulatory bodies of ten nations and even the foot-dragging European Union. A group of anti-GM scientists examined one safety study using rats and found (in the words of a sympathetic article) "a highly significant and sustained 3.3 percent decrease in body weight in males, and a 3.7 percent increase in females." A male rat weighs roughly a pound, and a female perhaps two-thirds of that, so we're talking about half an ounce; and even so, other studies found contradictory

results. Yet Greenpeace still has on its website a document called "MON 863: A Chronicle of Systematic Deception."

Despite such determined opposition, GM crops are widely cultivated in industrial and developing nations. Roughly half the world's GM farming takes place in the United States, where some 140 million acres are planted. This includes around 90 percent of America's soybeans, more than 80 percent of its cotton, and more than 60 percent of its corn. Other American GM crops include canola, squash, and alfalfa. Argentina and Brazil are the next-biggest GM planters, mostly in soybeans and cotton, with Canada following and India and China coming up fast. About 20 other countries grow GM crops--including Iran, which recently became the first nation to introduce GM rice.

Yet in the places where food shortages have hit the hardest, and where increased production could do the most good, GM crops are shunned. The only African country to permit GM crops is South Africa. Elsewhere, scare tactics by greens and fears about access to foreign markets (such as the EU, which has grudgingly dropped its prohibition on GM foods but still imposes high regulatory barriers) have led to bans, even in countries where almost all crops are consumed locally. Most Southeast Asian nations also shun GM crops, as do those in the Caribbean and the Middle East. Why do the poorest nations resist such a beneficial technology?

Simply put, it's because poor countries are the easiest for environmental activists to push around. A recent paper by Carl Pray of Rutgers, Robert Paarlberg of Wellesley, and Laurian Unnevehr of the University of Illinois examined the reception given to GM crops in different nations. In one case they studied, a GM papaya resistant to ringspot virus was eagerly accepted in Hawaii, reviving that state's papaya industry after the virus had nearly eliminated it. By reducing the virus's prevalence, the GM variety made possible the renewed cultivation of non-GM and even organic papayas as well.

In Thailand, by contrast, when a similar virus-resistant papaya was developed by Thai scientists to suit local conditions, "Greenpeace partially destroyed GM papaya trials in Khon Kaen and launched a media campaign claiming genetic pollution." Since there was no powerful interest to argue the pro-GM side, Thailand's small farmers were not able to overcome Greenpeace's campaign of intimidation and misinformation. Something similar happened when genetically modified potatoes were tried in Mexico. Green activists prevailed on McDonald's and Frito-Lay--anxious about their public image, like any big corporation--to swear off GM potatoes, They then spread a phony biodiversity controversy, and the government program promoting GM potatoes among Mexico's small farmers was abandoned.

To be sure, sometimes there are economic reasons for farmers to avoid GM crops. Travis Kavulla, formerly of NATIONAL REVIEW and now a Gates Scholar studying African history at Cambridge, says that "many Africans' main sticking point with GM seeds is that they are frequently annuals, with further seeds needing to be bought year-to-year on the returns of the crop." The first GM cotton plant introduced in India was not appropriate for the climate, and many failures resulted. (In addition to the plant's textile uses, cotton seeds are used for cooking oil and animal fodder.) But now GM cotton is spreading rapidly in India. In fact, before GM seeds became widely available, they sold for inflated prices on the black market, just as Brazilian farmers smuggled in GM soy seeds before their government legalized them.

The GM industry is everything that greens hate: big, corporate, technological, and American. That's why two of its biggest opponents in the developing world are Hugo Chavez of Venezuela and Robert Mugabe of Zimbabwe. Yet GM crops yield great benefits, which is why they have been so widely adopted wherever farmers have enough power to stand up for their interests. As Kavulla points out, "Western rhetoric on GM is something of a ruse, especially when many African governments would eagerly sell GM crops (and at higher prices) if only they had a market to do so." In this way, small farmers and consumers in Africa and Asia suffer at the hands of fastidious greens in the prosperous West.

Article B: “Yes: It's Common Sense to Try to Avoid Pesticide Exposure” ***By Chensheng (Alex) Lu***

Is there definitive scientific proof that an organic diet is healthier? Not yet. Robust scientific studies comparing food grown organically and food grown conventionally don't exist, thanks to a lack of funding for this kind of research in humans.

The lack of definitive evidence--combined with the higher price of organic food--has given skeptics a golden opportunity to argue that organic isn't worth the cost and effort.

But let's be clear: Some convincing scientific does exist to suggest that an organic diet has its benefits. What's more, it only makes sense that food free of pesticides and chemicals is safer and better for us than food containing those substances, even at trace levels.

While studies in recent years have delivered a decidedly mixed message about the healthfulness of organic food, those on both sides of the debate generally agree that organic produce typically contains fewer pesticides than conventional produce, and that people may be able to reduce or eliminate agricultural chemicals from their bodies by adopting an organic diet

This was illustrated in a study published in the journal Environmental Health Perspectives in 2006. That study, which I led, showed that within five days of substituting mostly organic produce for conventional produce in children's diets, pesticides disappeared from the children's urine.

Many say the pesticides found in our food are nothing to fear because the levels fall well below federal safety guidelines and thus aren't dangerous. Similarly, they say the bovine growth hormone used to increase cows' milk yield is perfectly safe.

But federal guidelines don't take into account what effect repeated exposure to low levels of chemicals might have on humans over time. And many pesticides were eventually banned or restricted by the federal government after years of use when they were discovered to be harmful to the environment or human health.

Pesticides, in particular, are made to kill organisms, and the President's Cancer Panel in 2010 made clear that it sees them as a threat, advising Americans to "reduce their cancer risks by choosing, to the extent possible, food grown without pesticides or chemical fertilizers."

Organic skeptics like to cite a meta-analysis study published in the Annals of Internal Medicine last year that suggested organic foods are neither healthier nor more nutritious than their conventional counterparts.

Left out of that analysis, however, were recent field studies showing that organic produce, such as strawberries, leafy vegetables and wheat, not only tastes better but contains much higher levels of phenolic acids than conventional produce. Phenolic acids are secondary plant metabolites that can be absorbed easily through the walls of intestinal tract, and can act as potent antioxidants that prevent cellular damage, and therefore offer some protection against oxidative stress, inflammation and cancer.

Yes, organic food typically costs more and can be harder to find than traditional food, but one could argue that the price of conventional food is artificially low because of all the subsidies that organic farmers don't get and that the government could do more to help organic farmers lower their costs. Nevertheless, when bought in-season, organic produce is often comparable in price to conventional produce.

A good strategy for consumers on limited budgets is to buy the organic versions of foods on the Environmental Working Group's "Dirty Dozen" list, as they typically contain the most pesticides. Or, consumers could focus on buying the organic versions of the foods they eat most.

As for suggestions that organic food is just as susceptible to bacterial contamination as regular food, that is off point. That type of contamination can happen after harvesting and often has nothing to do with how food is grown.

Knowing that we could reduce our exposure to pesticides and increase our exposure to antioxidants by eating organic food, it makes great common sense to consume more of it.

Article 3: “No: There Is Little Evidence Organic Food Is Worth the Cost” *By Janet H. Silverstein*

There is no definitive evidence that organic food is more nutritious or healthier than conventional food, but there is proof that eating more fruits and vegetables and less processed food is.

Therefore, our focus as a society should be to eat as much fresh food and whole grains as possible--regardless of whether it is organically grown or not.

Organic food is more expensive than conventional offerings--up to 40% more, according to some estimates--which could make it cost-prohibitive for families on limited food budgets. Given the lack of data showing that organic food leads to better health, it would be counterproductive to encourage people to adopt an organic diet if they end up buying less produce as a result.

If families can afford to buy organic and still put a good amount of healthy food on the table, then the decision about whether to spend the extra money on organic produce, milk and meat should be based on a solid understanding of what we do and don't know about the benefits.

It is difficult to compare the nutritional value of organic versus conventional food because the soil, climate, timing of harvest, and storage conditions all affect the composition of produce. Still, published studies have found no significant differences in nutritional quality between organic and nonorganic produce or milk.

Similarly, there is no evidence that giving bovine growth hormone (BGH) to cows changes the composition of milk or affects human health. BGH is inactive in humans and degrades in the acidic environment of the stomach.

As for pesticide exposure, the U.S. in 1996 established maximum permissible levels for pesticide residues in food to ensure food safety. Many studies have shown that pesticides levels in conventional produce fall well below those guidelines.

While it's true that organic fruits and vegetables in general contain fewer traces of these chemicals, we can't draw conclusions about what that means for health as there haven't been any long-term studies comparing the relationship between exposure to pesticides from organic versus nonorganic foods and adverse health outcomes. It may seem like "common sense" to reduce exposure to these chemicals, but there are currently no good evidence-based studies to answer the question.

While awaiting definitive studies, families on limited budgets who are concerned about pesticide exposure can refer to the Environmental Working Group's list of the "Dirty Dozen," those foods with the highest pesticide residues, and the "Clean 15", the foods with the lowest pesticide concentrations.

A good strategy would be to focus on buying organic versions of the foods on the "Dirty Dozen" listing.

We would like to think that organic food is grown locally, put in a wheelbarrow and brought directly to our homes. However, much of it comes from countries where regulations might not be as tightly enforced as in the U.S., and labeling of the foods might be misleading.

And just because food is labeled organic doesn't mean it is completely free of pesticides. Contamination can occur from soil and ground water containing previously used chemicals, or during transport, processing and storage. Organochlorine insecticides, for example, were recently found in organically grown root crops and tomatoes even though these pesticides haven't been used for 20 years.

A recent epidemic of salmonella deaths from both organic and nonorganic peanuts, meanwhile, suggests that organic meat and produce are just as susceptible to infection by bacteria and fungi as other foods.

Given what we know, the best diet advice we can give families is to eat a wide variety of produce and whole grains. Whether they want to buy organic is up to them.

Article 4. Can organic food feed the world? New study sheds light on debate over organic vs. conventional agriculture

Can organic agriculture feed the world? Although organic techniques may not be able to do the job alone, they do have an important role to play in feeding a growing global population while minimizing environmental damage, according to researchers. A new study concludes that crop yields from organic farming are generally lower than from conventional agriculture. That is particularly true for cereals, which are staples of the human diet -- yet the yield gap is much less significant for certain crops, and under certain growing conditions, according to the researchers.

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The study, which represents a comprehensive analysis of the current scientific literature on organic-to-conventional yield comparisons, aims to shed light on the often heated debate over organic versus conventional farming. Some people point to conventional agriculture as a big environmental threat that undercuts biodiversity and water resources, while releasing greenhouse gases. Others argue that large-scale organic farming would take up more land and make food unaffordable for most of the world's poor and hungry.

"To achieve sustainable food security we will likely need many different techniques -- including organic, conventional, and possible 'hybrid' systems -- to produce more food at affordable prices, ensure livelihoods to farmers, and reduce the environmental costs of agriculture," the researchers conclude.

Overall, organic yields are 25% lower than conventional, the study finds. The difference varies widely across crop types and species, however. Yields of legumes and perennials (such as soybeans and fruits), for example, are much closer to those of conventional crops, according to the study, conducted by doctoral student Verena Seufert and Geography professor Navin Ramankutty of McGill and Prof. Jonathan Foley of the University of Minnesota's Institute on the Environment.

What's more, when best management practices are used for organic crops, overall yields are just 13% lower than conventional levels. "These results suggest that today's organic systems may nearly rival conventional yields in some cases -- with particular crop types, growing conditions and

management practices -- but often they do not," the researchers write. Improvements in organic management techniques, or adoption of organic agriculture under environmental conditions where it performs best, may help close the yield gap, they indicate.

"Our study indicates that organically fertilized systems might require higher nitrogen inputs to achieve high yields as organic nitrogen is less readily available to crops. In some cases, organic farmers may therefore benefit by making limited use of chemical fertilizers instead of relying only on manure to supply nitrogen to their crops," Seufert says. "At the same time, conventional agriculture can learn from successful organic systems and implement practices that have shown environmental benefits, such as increased crop diversity and use of crop residues."

Yields are only part of a set of economic, social and environmental factors that should be considered when gauging the benefits of different farming systems, the researchers note. "Maybe people are asking the wrong question," Prof Ramankutty says. "Instead of asking if food is organically grown, maybe we should be asking if it's sustainably grown."

The results point to a need to get beyond the black-and-white, ideological debates that often pit advocates of organic and local foods against proponents of conventional agriculture, Prof. Foley adds. "By combining organic and conventional practices in a way that maximizes food production and social good while minimizing adverse environmental impact, we can create a truly sustainable food system."

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