The Organic Center www.organic-center.org

State of Science Review: The Organic Option

Simplifying the Pesticide Risk Equation: The Organic Option

by Charles Benbrook

March 2008

Foreword

You hold in your hands a state-of-the-art discussion of how and where Americans are exposed to pesticides in our diet, of the seasonal variations in pesticide risks, and of how these dietary risks can be nearly eliminated by food choices that are within your own control.

You will learn that the average American is exposed to 10 to 13 pesticide residues each day from food, beverages, and drinking water. The levels and risks are very low in most instances. But this is not always the case. Some of these exposures pose clear risks, particularly when they occur during pregnancy, the first years of life, during other vulnerable periods

This is important news as it comes at a time when there is a growing recognition in the scientific and medical communities that pesticide exposure is a major risk factor in the development of neurological conditions from ADHD to Alzheimer's disease.

As a pediatrician, I am often asked by mothers how they might help protect their children from high profile neurodevelopmental disorders like ADHD and autism. Almost every day I come face to face with the children behind the grim statistics on these learning disabilities. When I look in the eyes of these children, or their mothers, I cannot help but feel a sense of urgency in getting the word out about how families can avoid risk factors contributing to these conditions.

Reducing pesticide exposures will help in other ways. It will contribute to a wide range of efforts aimed at lowering the number of premature deliveries and their many associated consequences, and it will help prevent harm to a child's developing immune and reproductive systems.

It's time for action. With strategic organic food choices you have the power to dramatically reduce pesticide exposures to you and your family starting with your very next meal.

Alan Greene, MD
Board Chair
The Organic Center
March 2008

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Executive Summary

Since the release of our 2004 report comparing the frequency and levels of pesticide residues in conventional and organic food, three questions repeatedly come up:

- Which organic foods should a consumer seek out to avoid possibly dangerous pesticide exposures?
- To what degree might organic food reduce pesticide dietary exposures and risk?
- And the "so-what" question — How will my health, and the health of my family change if we eliminate most pesticide exposure via the diet by consuming organic food?

Because a significant number of new studies have come out since 2004, along with four more years of data on pesticide residues in organic and conventional foods, we are now able to provide direct answers to the first two questions, and a general response to the third.

The answers presented in this report are as detailed and accurate as possible, given the availability of pesticide residue data in organic and conventional food, the state of pesticide risk assessment science, and the capacity of a small nonprofit organization to compile, integrate, and analyze enormous government datasets.

High-Risk Pesticide Food Combinations

Fruits and vegetables account for the majority of pesticide residues and risk in the diet, especially the diets of infants and children, which is why the USDA's Pesticide Data Program (PDP) focuses on these foods. Throughout this report we use PDP information on residues in organic and conventional foods, and in domestically grown and imported foods, to assess levels of dietary risk.

There are clear, and in some cases, dramatic upward spikes in pesticide residue levels and risks during the winter months when imports account for a large share of perishable fresh fruits and vegetables in the market place. For this reason, the list of foods accounting for the greatest pesticide risks per serving differs in the summer, when mostly U.S.-grown produce is consumed, in contrast to winter months, when imports account for a large percent of sales, especially for perishable fruits and vegetables that do not store well for long periods (like grapes, berries, peaches, tomatoes, and spinach).

Accordingly, we provide one list of relatively high-risk foods based on residues found by PDP in domestically grown produce, and a second list reflecting residues in imported foods. The first list should be used during the spring-summer-fall months when domestically grown fresh produce accounts for the majority of sales. The second list, based on residues in imported fruits and vegetables, is most useful during the winter months. Each list is ranked according to a dietary risk index (DRI) score – the bigger the number, the greater the risk.

A Key Point—

Don't let the fear of pesticides reduce your consumption of health-promoting fruits and vegetables. Consumers can minimize pesticide exposures when shopping for organic produce by referring to these two tables —

Conventional Fruits and Vegetables with the Highest Pesticide Dietary Risk Index Scores: Domestically Grown Produce

Fruits	Dietary Risk Index	Vegetables	Dietary Risk Index
Cranberries	178	Green beans	330
Nectarines	97	Sweet bell peppers	132
Peaches	54	Celery	104
Strawberries	56	Cucumbers	93
Pears	48	Potatoes	74
Apples	44	Tomatoes	68
Cherries	32	Peas	66
		Lettuce	54

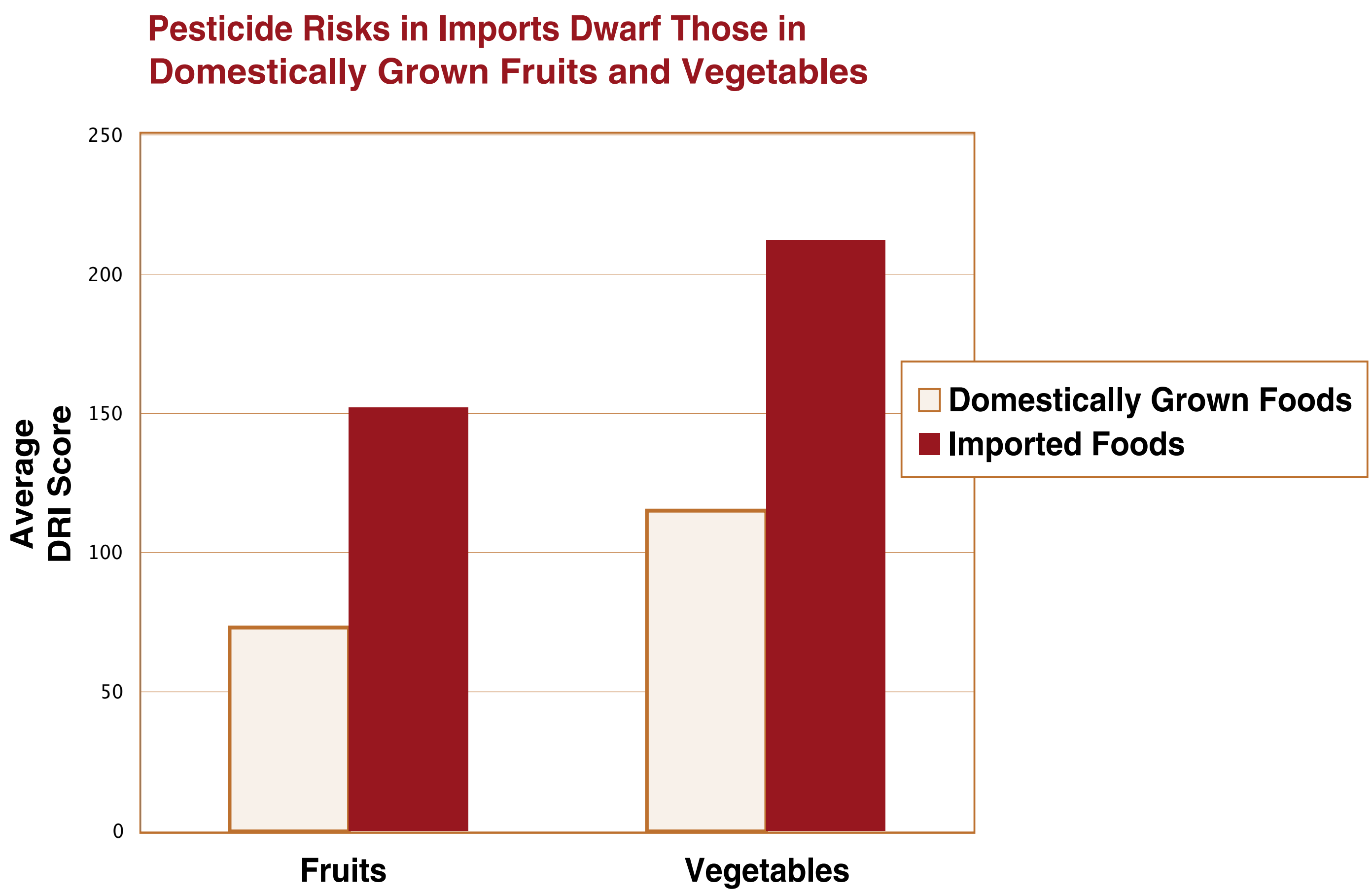
Imported Fruits and Vegetables with the Highest Pesticide Dietary Risk Index Scores

Fruits	Dietary Risk Index	Vegetables	Dietary Risk Index
Grapes	282	Sweet bell peppers	720
Nectarines	281	Lettuce	326
Peaches	266	Cucumbers	317
Pears	221	Celery	170
Strawberries	78	Tomatoes	142
Cherries	31	Green beans	93
Cantaloupe	31	Broccoli	62
Apples	30	Peas*	48
		Carrots	30

* Ratio of DRI value in fresh to processed peas, domestic production (6), multiplied by imported value for processed peas (8). PDP has not tested fresh imported peas.

DRI scores in the above tables come from a 2006 report by the Environmental Protection Agency's (EPA) Office of Inspector General (OIG). The DRI draws on EPA risk assessment methods and data. It integrates the level of residues in food with a pesticide's toxicity, to produce a relative risk index. DRIs can be calculated for single food-pesticide combinations (e.g., acephate in pears), or all the pesticide residues found in a particular food.

Figure 1.



Note the large difference between some domestically grown fruit and vegetable DRI scores and those for the same imported produce. Imported conventional sweet bell peppers have a DRI score of 720, more than twice the also high domestic pepper score of 330. The imported cucumber score is more than three-times higher than the DRI for domestic cucumbers.

The average DRI score for the seven conventional, domestically grown fruits in the first list is 73, while the eight imported fruits average 152, just over twice as high. For the vegetables, the average domestic DRI value is 115, compared to 212 for imports, as shown in Figure 1.

People also want to know which foods contain relatively few residues and pose only modest pesticide risks. Hundreds of thousands of samples of food show consistently that several foods contain far fewer and generally less risky pesticide residues than the fresh fruits and vegetables on our lists:

- Citrus fruits (the grapefruit DRI for 2006 is around 2),
- Bananas and pineapples, with DRI scores less than one,
- Onions, DRI far less than one,
- Beef, pork, lamb, and poultry meats,
- Grains and grain-based products, except for relatively low levels of insecticides used during storage, and
- Most processed foods and several dried fruits (e.g., raisin DRI in 2006 was less than 5, and tomato paste was 15-times lower than tomatoes).

A 97% Solution

DRI scores can be used to estimate the probable reduction in pesticide dietary risk from consumption of organic food, in contrast to conventionally grown food. Most of the pesticide risk in the diet stems from residues on fresh fruit and vegetables. Today, organic fresh produce sales account for close to 9% of retail sales, and are substantially reducing pesticide exposures for millions of Americans.

More progress is bound to occur since several major fruit and vegetable producers in the Western U.S. are moving ahead with ambitious plans to convert a significant share, and in some cases all or most of their acreage to organic

production. In tree-fruits, Stemilt Growers, a major Washington-State based grower-packer is leading the way and has committed to the conversion of 100% of the acres of some fruits to organic production within the next few years, and expects that half or more of its apples will be grown organically within a decade.

In fact, the only thing holding back the conversion of most fruit and vegetable production west of the Mississippi River to certified organic is consumer demand, coupled of course with a pay price for growers that includes a meaningful premium (i.e., at least 20%). The growing systems and technology are available and generally are as reliable as conventional systems, and the infrastructure available to help transitioning and already-organic producers is rapidly catching up to that supporting conventional farmers.

The transition of fruit and vegetable acreage to organic systems east of the Mississippi River poses more difficult challenges because farmers face much more intense insect and plant disease pressure. Still, some innovative farmers have found ways to profitably grow organic crops in the humid regions in the eastern U.S., and ongoing research will hopefully provide new strategies and tools for dealing with problem pests.

Fruits and vegetables are grown on less than 8 million acres in the U.S., less than 3% of the nation's cropland. If just this critical 3% were converted to organic production, what would the impact be on today's levels of pesticide dietary risks?

For domestically grown fruits and vegetables consumed regularly by infants and children, and tested by the PDP in the last four years, we project that risks would drop by at least 97%.

Imported fruits and vegetables, unless grown organically, will remain a major pesticide dietary risk concern, especially in the winter and for perishable fruits and vegetables.

Section IV describes the analysis leading to this encouraging conclusion. In short, we calculated DRI scores for all organic food-year combinations in which USDA tested one or more samples in the last four years of PDP testing, taking into account all residues found in those samples. DRI scores were calculated in the same way for the conventional samples of these same foods, again taking into account all the pesticide residues found in the samples. We added together the total DRI scores across all food-year combinations for both the organic and conventional samples, and then estimated the total reduction across all organic food.

Achieving such a dramatic reduction in pesticide dietary risks will require that the vast majority of domestically grown and imported fruits and vegetables become certified organic. Recent strong growth in organic fruit and vegetable production will surely continue, rising from today's approximate 9% market share to between 30% and 50% of total sales, but growth beyond that threshold will require new investments and technology, and both strong and steady consumer demand.

Would a 97% Reduction in Pesticide Dietary Risk Improve Public Health?

For healthy adult individuals and couples that are not pregnant, or trying to become pregnant, it is not possible to say with certainty whether, and to what degree a 97% reduction in pesticide risk, as currently understood and measured, would improve public health.

Recent science suggests probable links between adult exposures to pesticides and diabetes, cancer, and several neurological diseases of aging. But the links are not strong enough to project the consequences of a significant drop in pesticide dietary exposures. Almost certainly there will be benefits for healthy adults, we just cannot predict or quantify them, given the present state of knowledge.

But for the four million pregnant women, the four million fathers-to-be, and the nearly 40 million children age 12 and under, there will almost certainly be significant health benefits following a substantial reduction in pesticide residues in food.

There will be more full-term births and fewer underweight babies. The rate of several birth defects should go down, in some cases perhaps by one-quarter or more.

But above all else, there will likely be a significant decline in the often subtle, but still adverse impacts of pesticides on the developing baby, as a result of the mother's exposures to pesticides. Any substantial decline in dietary pesticide risks will dramatically reduce pesticide impacts on a child's developing immune, reproductive, and nervous systems.

Benefits from avoiding pesticide exposures begin approximately six months before conception and run through young adulthood, and indeed for some health problems, throughout life. This is because many of the developmental deficits triggered by prenatal and early pesticide exposures increase the risks of chronic diseases, and metabolic and neurological problems that erode well-being much later in life.

A November 2007 scientific consensus statement issued by the Collaborative on Health and the Environment reports that 5% to 15% of all children under the age of 18 are impacted by learning and developmental disabilities. Mental retardation impacts about 1.4 million children, and ADHD (attention deficit hyperactivity disorder) inflicts 8.7% of 8- to 15-year-old children.

A substantial reduction in pesticide exposure will remove, or markedly lessen, an important risk factor for these sorts of developmental problems. The positive impact for millions of children could well be significant, and surely will be well worth the effort.

I. Pesticide Residues in Conventional and Organic Food

The Center's May 2004 State of Science Review entitled "Minimizing Pesticide Dietary Exposure Through the Consumption of Organic Food" analyzed pesticide residues in conventional and organic food through 2002 – the year the National Organic Program (NOP) rule came into full effect. Five years later, it is time to take stock of the impact of the rule, drawing on four more years of U.S. Department of Agriculture (USDA) data on residues in conventional and organic food.

This report relies heavily on the USDA's "Pesticide Data Program" (PDP), as did our 2004 report. The PDP was started by Congress in 1991 in response to public concerns over the apple pesticide Alar (daminozide), and the government's lack of good data on actual residues in food, information essential in carrying out meaningful pesticide dietary risk assessments.

Congress directed the USDA to focus PDP testing on the foods most commonly consumed by infants and children. The nation's focus on pesticide risks in children's food intensified after the release of the 1993 National Academy of Sciences report *Pesticides in the Diets of Infants and Children*, and passage in 1996 of the "Food Quality Protection Act." Any analysis based on residues found by the PDP is therefore heavily weighted toward the most important pesticide risks facing pregnant women, infants, and children.

The Department tests about 12,000 to 15,000 samples annually, encompassing 10-12 fresh foods and 4-6 processed foods. Samples are prepared for testing to reflect residues in food "as eaten." Basic results reported by the PDP in their annual summary reports include: number of samples for each crop/food, percent positive for each pesticide, minimum and maximum residue level, number of residues found per sample, violative residues, and limits of detection. (For more on the PDP, see Appendix 1).

PDP usually tests between 600 and 750 samples of a given food each year. In the case of a common food like apples, the 743 samples tested during 2004 were a tiny fraction of the apples consumed that year. As shown in Table 1, each apple tested by PDP in 2004 represents some 3.6 million apples. So, how does this information help place PDP results into perspective?

Consider an example. By far the riskiest pesticide commonly found in conventional apples in 2005 was azinphos-methyl (AZM). This organophosphate (OP) insecticide was present in 31.5% of PDP samples; there were about 44 billion servings of apples consumed in 2005. Accordingly, there were likely about 13.8 billion servings of apples consumed in the U.S. in 2004 with AZM residues, and a typical child would be exposed to AZM through apples around 50 times a year, depending of course on how often he or she eats apples. By analyzing the raw PDP data files, it is possible to study the frequency and levels of

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Table 1.

Consumption of Apples in the U.S. in 2005	
20,865	Grams of apples consumed per person
151.2	Apple servings per person (138 grams per serving)
43,846,739,130	Apple servings per year
46	Apple pounds consumed per person
290,000,000	U.S. Popualtion
13,340,000,000	Pounds apples consumed
743	Apple samples tested by PDP (5 pounds per sample)
3715	Pounds apples tested by PDP
3,590,850	Each PDP apple sample tested represents 3.6 million apples

Source: Apple per capita consumption from USDA Economic Research Service, *Fruit and Nuts Situation and Outlook Yearbook/FTS-2006*, October 2006.

residues in different types of food – conventional and organic – and food grown domestically in contrast to imported food. This new report focuses on PDP data from 2003 through 2006, the most recent year available. The raw data has been moved into an Access database, allowing us to carry out a range of analyses spanning the frequency of residues by type of food and geographic source, as well as residue levels and risks.

As in the Center's 2004 report, most of the tables and discussion that follow focus on residues of recently used pesticides, and exclude the long-banned organochlorine (OC) insecticides like DDT, aldrin, and heptachlor. Residues of these insecticides, and their metabolites, are still found in many animal products and some foods, and are present in the body fat of virtually all Americans. The presence of OC residues is addressed in several sections of this report – but unless otherwise indicated, tables and figure exclude OC residues.

A. Frequency of Residues

From 1993 to 2006, the PDP tested over 86,000 samples of fruits and vegetables that were not recorded as organic: 39,130 fruit and 47,180 vegetable samples. We call these samples "nonorganic" or "conventional" throughout this report. The vast majority of these samples are listed with no market claim by the PDP, although a few dozen each year are recorded as "Ingegrated Pest Management (IPM-Grown,)" or "No Detectable Residues (NDR)" or "pesticide free".

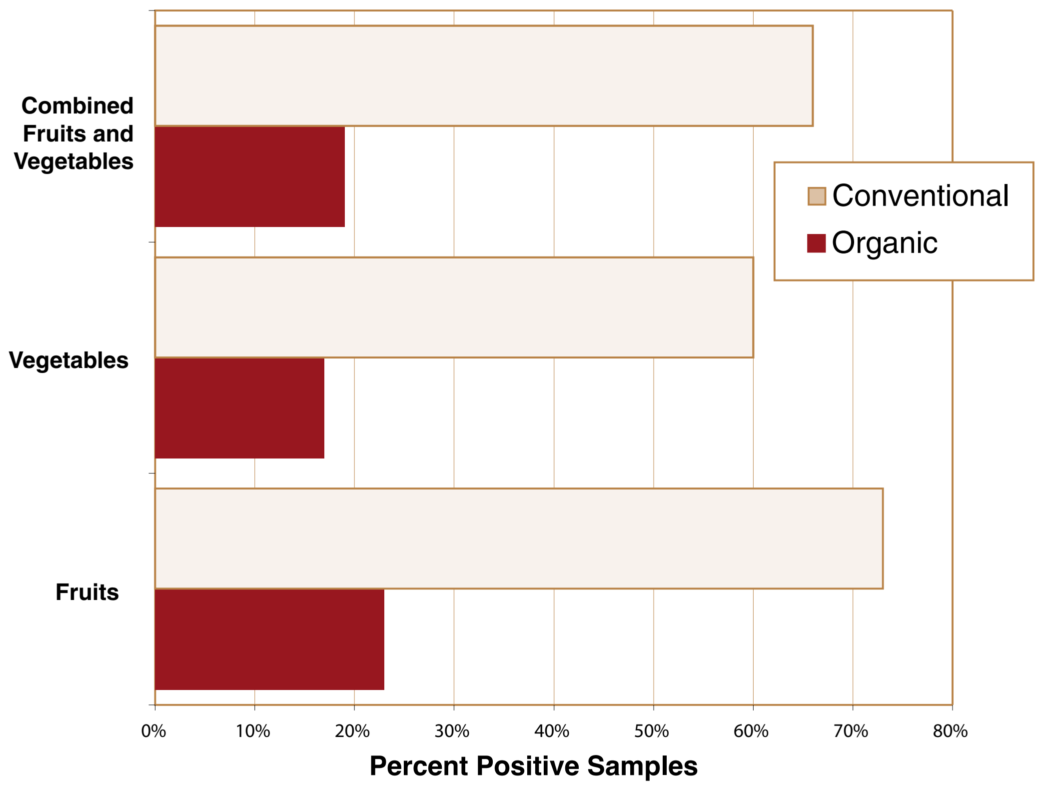
In our 2004 report, we showed that the residue patterns of "IPM-Grown", "NDR", and "pesticide free" samples are similar to conventional samples, and so this year we group them into the "nonorganic" category.

About three-quarters of 39,000 nonorganic fruit samples contained residues, while 60% of nonorganic vegetables were found to contain one or more residues, as shown in Figure 1 and Table 2. Appendix 2, Table 1 contains the detailed results for fruits and vegetables during the 1993 to 2006 period.

USDA tested 720 samples of organic fruit and vegetables in this same period. Just under one-quarter of 258 organic fruit samples contained a pesticide residue and 17% of the 462 organic

Figure 2.

Frequency of Residues in Organic and Conventional Fruits and Vegetables, 1993-2006 PDP



vegetables tested positive for one or more residues. Accordingly, over this 14-year period –

- Nonorganic, or conventional fruit is about 3.2-times more likely than organic fruit to contain a residue,
- Conventional vegetables are 3.5-times as likely,
- Conventional fruits and vegetables were 3.47 times more likely to have residues compared to organic produce across all fruits and vegetables.

Some progress has been made in reducing the frequency of residues in organic fruits and vegetables. On average from 1993 through 1999, 26% of the samples of organic fruit tested contained a residue. The percent had dropped by 35% to 17% in the 2006 PDP.

Among vegetables, 23% tested positive over 1993-1999, and 16% in 2006, a drop of 30%. The percent of conventional fruit and vegetable samples testing positive have remained relatively steady during this period. The percent of conventional fruit with residues was 65% in 2006, but over 80% in 2000, 2004, and 2005. The percent of conventional vegetables testing positive has been more stable, falling between 50% and 69% in most years (average of 65% from 1993 to 1999, and 67% in 2006).

These data on changes over time in the frequency of residues understate the progress made in both conventional and organic food because the limits of detection (LOD) in PDP testing have fallen in recent years compared to the 1990s. The LOD reduction has been modest for most of pesticides, but for some the reductions have been significant (an order of magnitude or more).

Table 2.

Frequency of Pesticide Residues in Fruits and Vegetables by Market Claim, Excluding the Residues of Banned Organochlorines: PDP 1993-2006

	'Organic' Market Claim			NOT 'Organic' Market Claim		
	Number of Samples	Number of Positives	Percent Positive	Number of Samples	Number of Positives	Percent Positive
Total Fruits	258	59	23%	39,130	28,580	73%
Total Vegetables	462	77	17%	47,180	28,325	60%
TOTAL FRUITS AND VEGETABLES	**720**	**136**	**19%**	**86,310**	**56,905**	**66%**

Organic Sampling Density Still Inadequate

The 720 samples of organic fruits and vegetables tested in this 14-year period represent less than 1% of the total number of samples, and a sampling rate that is far too low given that the PDP is supposed to test organic foods about as frequently as they appear in the food supply.

Almost 2% of the total number of samples of fruits and vegetables were organic in the 2006 PDP. That year total U.S. fruit and vegetable sales were $78.8 billion, while organic fruit and vegetable sales reached $6.7 billion, or 8% of overall fruit and vegetable sales (data from the Organic Trade Association's 2007 Manufacturer Survey). Accordingly, the PDP is still under sampling organic produce by about four-fold. The USDA needs to markedly increase the number of organic samples tested in future years, and continue increasing the sampling density on an annual; basis in step with growth in the sales of organic foods.

B. Previous Analyses

Our current findings are consistent with earlier analyses of the frequency of pesticide residues in conventional and organic food. A detailed overview of pesticide residue patterns in conventional, IPM-grown, and organic food was published in 2002 in the peer-reviewed journal *Food Additives and Contaminants* (Baker et al., 2002). This research report remains the only peer-reviewed assessment of differences in pesticide residues by market claim.

The study encompassed six years of data from the USDA's Pesticide Data Program (1993-1999), ten years of California Department of Pesticide Regulation (DPR) data (1989-1998), and the results of a 1998 Consumers Union (CU) testing project focusing on four crops (apples, peaches, tomatoes, and peppers).

Baker et al., (2002) reported that nearly three-quarters of the fresh fruits and vegetables (F&V) consumed most frequently by children in the U.S. contain residues. In general, soft-skinned fruit and vegetables tend to contain residues more frequently than foods with thicker skins, shells, or peels.

The Food Additives and Contaminants paper presents consistent data from three sources that show that the pattern of residues found in organic foods differs markedly from the pattern in conventional samples. Differences in favor of organic food in each of the three datasets were subjected to rigorous statistical tests, and found to be highly significant in all three cases.

In the case of foods tested by USDA's PDP from 1993-1999, conventional fruits were 3.6 times more likely to contain residues than organic fruit samples. Conventional vegetables were 6.8 times more likely to have one or more detectable residue. Data from California's DPR shows that conventional food was more than five-times more likely to contain residues than organic samples. CU's testing of four foods found residues in conventional foods three-times more often (Baker et al., 2002).

International data point to comparable patterns in pesticide residues in conventional and organic food. Great Britain's pesticide sampling program found residues in conventional food 7.5 times more frequently than in organic samples of the same foods in 2001 testing (Pesticide Residue Committee, 2001), a pattern reflected in more recent UK reports on residues.

C. Why Organic Samples Sometimes Contain Residues

Some pesticide residues in organic food are expected, given that a few dozen pesticides are approved for use on organic food. Examples include spinosad, sulfur, copper fungicides, oils, several botanicals, *Bacillus thuringiensis (Bt)*, soaps, certain microbial pesticides, and pheromones. Of these pesticides, the PDP only tests routinely for spinosad, since the other active ingredients are regarded as safe and are exempt from the requirement that a tolerance be established to cover residues.

By volume, sulfur, horticultural oils, and copper-based fungicides are among the most heavily used pesticides on both organic and conventional produce farms. These pesticides are used in similar ways for comparable reasons on organic and conventional fruit and vegetable farms.

But many conventional pesticides can move across field boundaries by drift or through use of contaminated irrigation water. Soil-bound residues of persistent pesticides used years ago before a farmer switched to organic methods account for a large portion of the residues found in organic and conventional root crops and spinach. Cross-contamination with post-harvest fungicides applied in storage facilities, or later along the food supply chain, is a common cause of low-level fungicide residues in organic fruit and vegetables.

The small percent of samples sold as organic and found to contain levels of conventional pesticide residues comparable to conventional foods reflect laboratory error, inadvertent mixing of product, or mislabeling, and some cases likely represent fraud somewhere in the farm to retail supply chain. Each year, the PDP usually finds a few to a half-dozen organic samples that contain residues very similar to the conventional samples.

Fortunately for those people, organizations, and government agencies working to preserve the trust of consumers in organic food, these high-residue samples rarely represent more than a few percent of the organic samples tested. For many people though, a few percent is a few percent too much, and new efforts are under consideration to more aggressively enforce compliance with the rules governing pesticide use and residues.

II. Residues by Food Group

Some major food groups – most oils, meat, and poultry products – contain few detectable pesticides (other than residues of long-banned OC insecticides like DDT), and contribute modestly to overall pesticide dietary exposures and risk.

Grain products contain few pesticides other than insecticides used during storage. The 2006 PDP tested 687 samples of wheat and found two organophosphate (OP) insecticides used to treat stored grain in 16.7% (chlorpryifos-methyl) and 63% (malathion) of the samples. Eight other pesticides were found in 1% to 5% of the samples, and five more in less than 1%.

In a special survey of wheat flour in 2004, the PDP tested 725 samples and found two post-harvest storage insecticides in a significant share of samples: malathion (49.4%) and chlorpyrifos-methyl (20.8%). Seven other pesticides were found in just one sample each of wheat flour, three were detected in 2-5 samples, and four were detected in 10-21 samples.

A special PDP sampling of rice in 2000 also detected two post-harvest storage OP insecticides in 17 percent to 24 percent of samples. Only a few other samples had residues of different insecticides and herbicides.

A. Animal Products

Contemporary use pesticides are rarely detected in meat and poultry products. The 2006 PDP tested 655 samples of poultry breasts and found no residues in 94%. A special survey tested 480 samples of poultry adipose, liver, and muscle tissues in 2001. Other than low-levels of organochlorine residues (DDE p,p', dieldrin), 11 samples were found to contain one of six pesticides. A 2001 special survey of beef detected only two pesticides (diazinon, endosulfan sulfate) in a handful of samples, other than organochlorine residues, which remain common in animal products.

Dairy Products

Milk was tested for pesticide residues by the PDP in 1996, 1997, and 1998 (see Table 3 below). Very few residues were found. In fact, only about 15 percent of the samples tested in each of those years contained any residues.

About 95 percent of the residues found in 1996-1998 milk testing were DDE, a breakdown product of DDT, which was banned from agricultural use in the early 1970s. DDT is very persistent and remains to this day in many cropland soils; its soil half-life (time required for 50% to dissipate) is generally between 15 and 30 years, depending on soil and climatic properties. For the next several decades, farmers can do little to avoid DDE residues in milk, but fortunately, the levels will incrementally decline and become less of a concern.

Table 3.

Pesticide Residues in Milk - 1998
Tesing of 595 Samples by the USDA's Pesticide Data Program

Pesticide	Number of Positives	Number of Samples	Percent Positive
Chlorpropham	1	594	0.2%
DDE p,p'	82	595	13.8%
Diphenylamine	1	595	0.2%
Lindane	1	594	0.2%
0-phenylphenol	5	218	2.3%
Total Residues Found	90		
Average Residues per Sample	0.17		

Milk returned to the PDP in 2004-2005. In February 2006, the results of the 2004 testing were released, and are shown in Table 4. All 739 milk samples tested contained residues and the average sample had 2.88 residues – a dramatic jump from the late 1990s.

DDE was found in 96 percent of the milk samples and almost certainly came from corn, soybean, and other animal feeds. Diphenylamine (DPA) was found in 98 percent of the samples. Another long-banned OC insecticide, dieldrin, was found in 41 percent of the samples.

A synthetic pyrethroid insecticide was found in 24 percent of the samples and the endocrine disruptor endosulfan was found in 18 percent. A highly-toxic breakdown product of the carbamate insecticide carbofuran was found in 9 percent of the samples. These positive samples in conventional milk reflect billions of servings collectively per year across the U.S. population with high-risk pesticide residues and hundreds of servings per year for most children.

More residues were found in milk in 2004-2005 than in the late 1990s because, in large part, the USDA looked harder. Between 1998 and 2004, the PDP adopted much more sensitive analytical chemistry methods. For example, the methods used to test milk in 2004 were 100-times more sensitive in picking up DPA residues, and 17-times more sensitive in detecting DDE and endosulfan than the methods used in 1996-1998. A table comparing the sensitivity of the analytical methods used to test milk in the 1990s and 2004-2005 is in Appendix 2.

Table 4.

Pesticide Residues in Milk - 2004 Testing of 739 Samples by the USDA's Pesticide Data Program

Pesticide	Number of Positives	Percent Positive	Mean of the Positives (ppm)
3-hydroxycarbofuran	65	8.8%	0.0003
Bifenthrin	3	0.4%	0.0001
Cyfluthrin	11	1.5%	0.0010
Cyhalothrin, Total	128	17.3%	0.0005
Cypermethrin	1	0.1%	0.0010
DDE p,p'	710	96.1%	0.0005
Dieldrin	307	41.5%	0.0002
Dimethoate	6	0.8%	0.0001
Diphenylamine	728	98.5%	0.0002
Endosulfan sulfate	134	18.1%	0.0002
Fluvalinate	3	0.4%	0.0018
Permethrin, Total	33	4.5%	0.0011
Total Residues Found	2,129		
Average Residues per Sample	2.81		

Milk was again tested by PDP in 2005 (see Appendix 2 for results table). DDE and diphenylamine (DPA) were found in 85% and 92% of 746 samples. The synthetic pyrethroids cyhalothrin (21%), permethrin (2.8%), bifenthrin (0.4%), and cyfluthrin (0.8%) were also found, so about 25% of the samples contained a synthetic pyrethroid residue.

Ten out of 739 samples of milk tested by the PDP in 2004 were reported as "organic." Just like virtually all samples, all 10 samples contained DPA and nine had DDE residues.

DPA in Milk?

The discovery of diphenylamine in almost all milk samples in 2004-2005 was a major surprise. DPA is a "high volume" industrial chemical used for many purposes in manufacturing rubber and plastic parts, and in making certain drugs. It is also a pesticide that is used as an apple plant-growth regulator. DPA is applied to apples as they are placed into storage and helps delay ripening and preserves apple fruit quality.

EPA estimates that only about one-third of apples are treated with DPA. Given that only a small percentage of milking dairy cows might be fed apple wastes at any one time, it is unlikely that the pesticide use of DPA is the source of residues in milk samples tested in 2004-2005. Instead, the DPA must be finding its way into milk through some other route, or routes. Possibilities include –

- Animal drug use,
- Rubber and/or plastic products used on dairy farms or in milk processing plants, and/or
- Ingredients used in milk cartons and packaging.

The levels of DDE and DPA found in milk in 2004-2005 were very low – the average level of DPA found in positive milk samples was 0.19 ppb. The highest residue levels found were, at most, about 2,000-fold lower than the levels found in apples, and were no greater than one-quarter of the applicable EPA tolerance (the maximum allowable limit of a pesticide in a given food).

Milk Exposures and Risk Warrant a Closer Look

Milk is a very important food in the diet of infants and children and, for this reason, the presence of any industrial chemical in milk is cause for concern. The fact that over one-quarter of the conventional milk samples tested in 2004 contained endosulfan or a carbofuran metabolite is deeply worrisome, given that these chemicals are among the pesticides found in numerous toxicological studies to pose serious developmental risks during pregnancy and to infants and children as their bodies grow and mature.

The 2005 PDP milk testing shows that 44% of conventional samples had three or more residues, and 13% had four or more. Four samples, representing millions of servings during 2005, had six residues. The potential for synergistic interactions between the multiple pesticides in milk can be and should be addressed by federal research agencies as a matter of priority. Well-accepted toxicological models are available to test the developmental risks of chemical mixtures and should be used to determine whether there is reason for continued concern over pesticide residues in such an important food.

EPA is currently carrying out a cumulative risk assessment of the synthetic pyrethroids to determine whether contemporary uses and residues in conventional food comply with the Food Quality Protection Act's "reasonable certainty of no harm" standard. The results of this assessment may convince the EPA that new restrictions are needed on this family of insecticides to reduce exposures to infants and children through milk and fruit and vegetable products.

B. Multiple Residues

Residues of several pesticides often are found by the PDP in the same sample of fruit and vegetables. The PDP reports residues of a parent chemical, like endosulfan, separately from metabolites, like endosulfan sulfate. So when PDP reports that a given sample had five distinct residues, these might include those of parent chemicals and a metabolite. In such a case, four different pesticides were detected, in addition to one metabolite of one of the four.

A conventionally grown raisin sample in 2006 PDP testing contained 11 residues and one kale sample had 10. One apple sauce sample had nine residues, and 53.6% of the 744 apple sauce samples had three or more residues – a worrisome finding given that apple sauce is a favorite first food for many infants, and remains a frequently consumed food through childhood.

One spinach sample also had nine residues, as did three kale samples.

Conventional peaches, a soft-skinned fruit, tend to have, on average, more residues per sample than any other fruit. In 2006 PDP testing, only 1.1% of the peach samples contained no residues, and 5.6% had one. But almost one-half the samples (46.6%) contained five or more residues. This is why the peach has an endowed chair near the top of the Environmental Working Group's list of most contaminated foods and also appears on our list of relatively high pesticide-risk foods.

Figure 2.

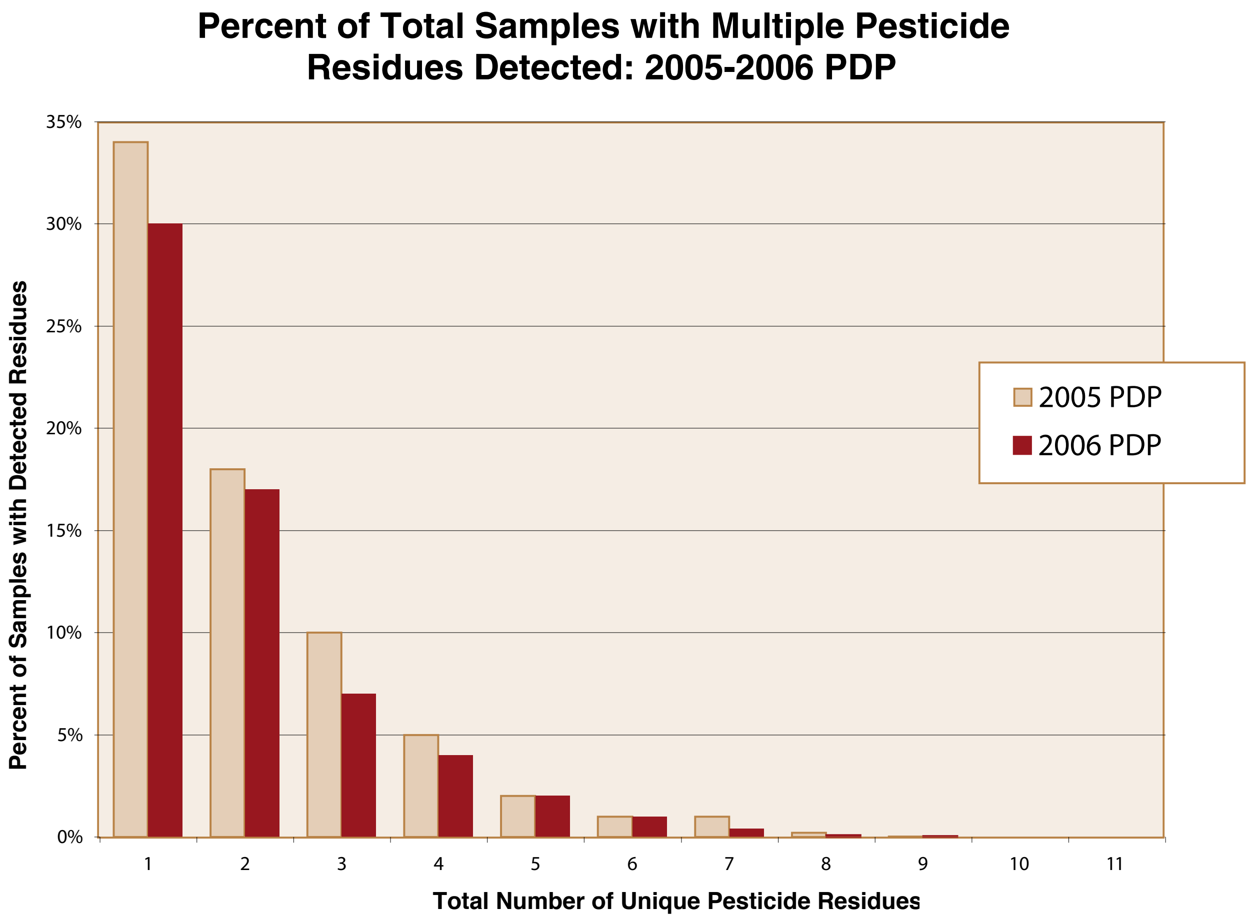


Figure 2 provides an overview of the percent of samples of fruits and vegetables with one, two, or more residues as reported in the 2005 and 2006 PDP annual summaries. Note that this table includes the residues of the banned organochlorine pesticides.

Apples were also tested by the PDP in 2004 and 73% of 743 samples contained three or more residues, and 25% had five or more. Seven samples had eight. Just 2% of the nonorganic apple samples had no residues, while 80% of the organic apple samples had no residues (four out of five tested).

Lettuce was another crop in 2004 plagued by multiple residues – just under 36% had four or more residues, and two lettuce samples toped the "multiple residue chart" with nine residues. The five organic lettuce samples all tested clean. But the all-time record goes to conventional sweet bell peppers, last tested by PDP during 2003. Two pepper samples contained 12 different residues, and three samples had 11. Almost 22% had six or more residues. Only 3.4% had none. Eleven organic sweet bell pepper samples were tested and 91% had no residues (one positive).

Fortunately, multiple residues are rare in other crops and foods. Only 1.7% of dried plums had more than one pesticide on them, as did 3.9% of eggplant.

In 1993-1999, the PDP found that about 45 percent of conventional fruit and vegetable samples contained residues of two or more pesticides, while 7.1 percent of organic samples had multiple residues (Baker et al., 2002). The average conventional apple tested in this period by PDP contained residues of three different pesticides. In Consumers Union testing, 62 percent of conventional samples contained multiple residues, compared to 6 percent of organic samples.

Remarkably, the PDP tested 530 apple samples in 1996 and found that the odds of buying a bag of conventional apples with nine or more pesticide residues was as great as selecting a bag with no residues. In 2003 the odds were about the same of selecting a bag of conventional apples with seven or more residues, compared to a bag with none.

In 2006 PDP testing, 34% of the nonorganic, conventional samples had multiple residues, compared to 4.2% of the organic samples (Figure 3). Accordingly, conventional fruits and vegetables are about eight-times more likely than organic samples to have multiple residues.

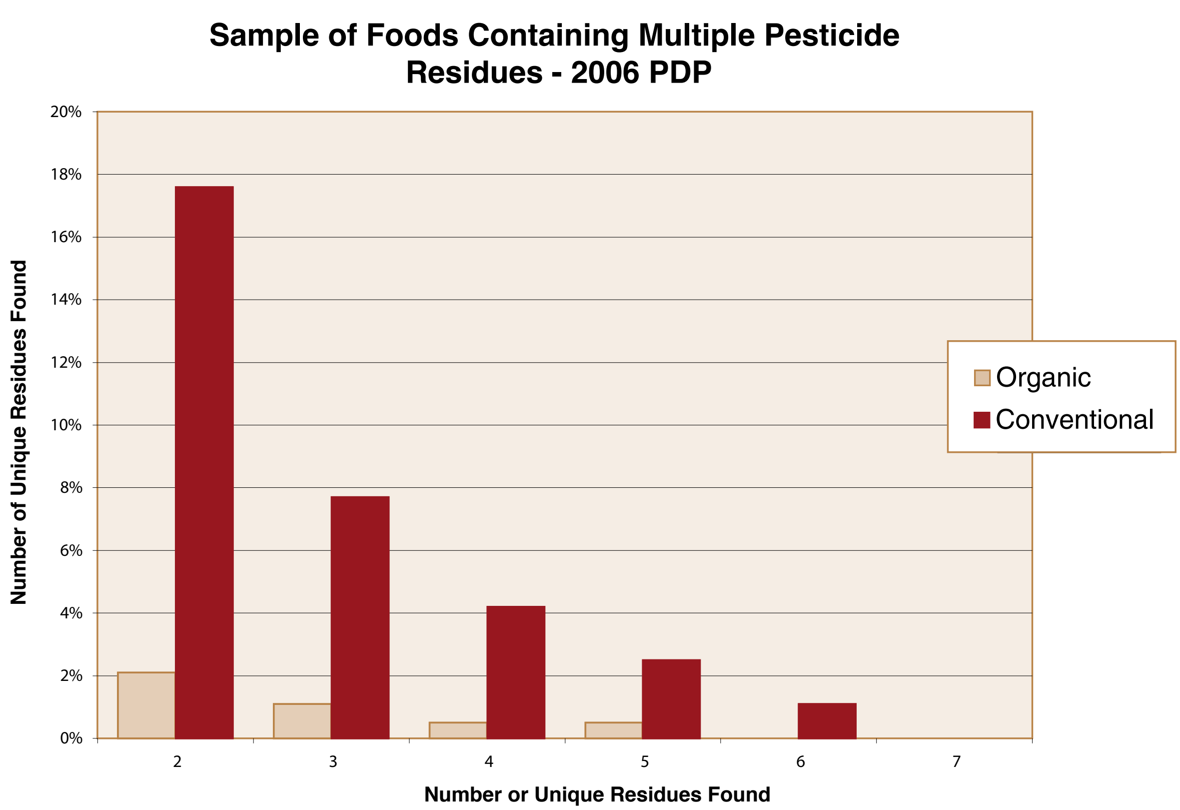
Detailed information on the occurrence of multiple residues in different foods is reported each year in a PDP annual report appendix table entitled "Number of Pesticides Detected per Sample." For example, Appendix K in the 2004 PDP report reports that almost 11 percent of the 12,446 samples tested contained four or more residues, while over 12 percent of the sweet bell peppers tested contained seven or more residues.

Multiple Exposures Occur Daily

With surprising frequency, all Americans, including infants and children, are exposed to pesticides via their diet and drinking water. According to recent USDA food consumption surveys, the average American consumes about 3.6 servings of fresh and processed fruits and vegetables daily, of which about two are fresh fruits and vegetables. Since the average piece of conventional fruit or vegetable contains about two different pesticides and/or pesticide metabolites, most children are consuming three to four residues daily just through fresh fruits and vegetables.

Most of us are exposed to another two to three residues via milk, and on average, another two to three from other foods, juices, and beverages, for a total of seven to ten from food.

Figure 3.



Drinking water is another major source of pesticide exposure, particularly for children living in the Midwest and other farming regions. In recent years the PDP has also tested drinking water as it comes out of the tap. About 54 percent of drinking water samples tested positive for one or more pesticides and pesticide metabolites in 2004 (see PDP annual report Appendix M for detailed findings). Individuals in the U.S. consume about six servings of drinking water per day, about half of which contain pesticides, so water adds about another three exposures per day to an individual's total.

Accordingly, the average American is exposed to 10 to 13 pesticide residues on a daily basis from food and drinking water. Fortunately, the levels are very low in most cases and the residues pose modest, if any, risks.

But this is not always the case. The weight of scientific evidence supports the conclusion that some residues are high enough to pose clear risks, particularly when exposures occur at vulnerable periods of fetal development, during the first years of life, or when a person is coping with an illness. This conclusion is backed up by comparing high-end PDP residues with the maximum levels of pesticides that can be present in a typical serving of food for a child, without that child being exposed over his or her personal safety limit, or "Reference Concentration" (RfC) (Groth et al., 2000).

The PDP finds several hundred residues each year at levels above the applicable RfC. These residues fall in a gray area – they are higher than what EPA regards as safe, yet most are below the levels shown to cause adverse impacts in experimental animals. But a few dozen residues are found each year that exceed RfCs by a 100-fold or more. The typical safety factor applied by regulatory agencies in estimating human Reference Doses from animal experiment "no observable adverse effect levels" is 100.

These few dozen high-risk residues represent many billion servings of conventional food each year, and a significant share of total pesticide dietary risks. This is why the EPA clearly has more work to do in delivering on the promise of the 1996 Food Quality Protection Act—a promise to fully protect infants and children from damaging pesticide exposures.

III. The Use and Toxicity of Pesticides Approved for Organic Agriculture

The U.S. Department of Agriculture's National Organic Program (NOP) rule sets forth the criteria governing the creation of a National List of materials that are approved for use in organic farming and food processing, as well as a process for adding or eliminating materials from the list.

In general on organic farms, synthetic chemical substances, including most synthetic pesticides, are prohibited, while most natural substances including botanical pesticides, copper fungicides, and sulfur, are allowed. A small number of exceptions to this "synthetic versus non-synthetic" rule are included on the National List. In addition, some relatively toxic natural substances are now prohibited or severely restricted (e.g., rotenone, sabadilla, and arsenic).

Sticky pheromone traps help to control insects. Pheremones are natural scents emitted by female insects to attract males for mating.

The Organic Materials Review Institute (OMRI) maintains a database of some 315 brand name pesticide products approved for use in organic production (see Appendix 3, Table 1). Twenty sulfur products are listed – the most for any pesticide in OMRI's database. There are 18 *Bacillus thuringiensis* products, along with several other microbial pesticides. Fifteen botanicals are listed, 11 copper fungicides, a dozen garlic products, almost 20 neem pesticides (containing the active ingredient azadirachtin), two dozen pheromone products (used in traps or to disrupt insect mating), various repellants, soap-based products, and a relatively new biochemical insecticide called spinosad.

Added Limits on Use by Organic Farmers

Of the 315 products on the OMRI list, 88% are classified as "Restricted," and 12% are "Allowed." "Allowed" pesticides can be used without restrictions, as long as an organic farmer includes them in their organic system plan and follows label directions. But "Restricted" status products can be used only under specific circumstances, often including limitations beyond label requirements on when, where, and how a product can be applied.

The distinction is significant. While conventional farmers may use any registered pesticide in a manner consistent with the label, organic farmers must both follow the label and adhere to additional restrictions imposed by organic certifiers. OMRI records the general restrictions imposed on pesticides in its listing of generic products (e.g., soap-based insecticides, or copper fungicides). These restrictions usually address circumstances in which a given pesticide product can and may not be used, added restrictions designed to reduce risks to certain nontarget organisms, and/or steps growers must take to exhaust all non-pesticide alternatives.

In addition, organic farmers must report all pesticides they foresee a need to apply in the upcoming crop season in their organic system plan that is submitted to certifiers. The plan must explain the cultural and biological practices that will be used to prevent pest problems, and specify the pest population thresholds or damage criteria that must be exceeded before an application is made.

Certifiers review and approve these organic system plans before the growing season begins. During annual inspections, pesticide use records are among the most carefully inspected documentation. Any deviation in pesticide use patterns from the approved organic system plan raises a red flag. Certifiers can impose additional restrictions on a particular grower if they feel OMRI-approved pesticides have been relied on too heavily, because of inadequate attention to preventive practices. Conventional growers face no such requirements and oversight.

A. The Toxicity of Pesticides Allowed in Organic Production

All pesticides are "toxic" to at least some organism, at least to the extent that the pesticide somehow kills, weakens, blocks reproduction, strengthens a plant's defenses, or repels a pest away from a crop. Otherwise, a farmer would not pay money to buy a pesticide, nor waste the time and effort required to apply it.

When most people talk about the toxicity of pesticides, they are usually referring to toxicity to people, or mammals. The job of pesticide regulators is complicated by the fact that different types of pesticides are toxic to different classes of organisms. Some products, like the synthetic pyrethroid insecticides, are extremely toxic to small aquatic invertebrates, but are not very acutely toxic to people or birds.

Pesticide manufacturers often market pesticides that are toxic to people in a granular form to reduce human exposure, but this increases bird risks as a result (granular insecticides sometimes appear to be small seeds to birds).

The important and very effective new biochemical insecticide spinosad is approved for both conventional and organic crop uses. It is a cost-effective alternative for conventional farmers to the high-risk organophosphate (OP) and carbamate insecticides that are among the riskiest products used in production agriculture.

For organic farmers, spinosad is the first new, highly effective insecticide approved for use on organic farms that works just as well, or better than many conventional insecticides. Despite its relatively high cost, many organic fruit and vegetable farmers have incorporated spinosad in their organic system plans, and some appear to be using it heavily. The only two samples of cranberries that tested positive in 2006 for spinosad were organic, and one contained residues over the tolerance.

While far less risky to most organisms than the OPs and carbamates, spinosad is among the most toxic pesticides ever applied to bees. All farmers must be disciplined in choosing when and where, and how to apply spinosad, to assure that foraging bees are not in the vicinity. If they are during or soon after an application of spinosad, they are not likely to survive the day.

Still, risks to humans clearly drive most pesticide regulatory decisions. Virtually all the pesticides cancelled, suspended, or driven off the market by EPA have fallen out of favor because of risks to humans. When the EPA identifies a significant risk to some other class of organism, steps are usually imposed through product reformulation or labels to reduce, or mitigate those risks.

Until recently there were a half-dozen relatively toxic (to humans) botanical insecticides approved for use by organic farmers, but now, only one remains in relatively common use – pyrethrins derived from chrysanthemum flowers. Pesticides containing pyrethrins are highly toxic but degrade rapidly (in hours), and hence rarely leave detectable residues in harvested food. Plus, they are applied at extremely low rates, on the order of one to two one-hundredths of a pound per acre. In contrast, OP insecticides are applied at a 50- to 100-times higher rate per acre.

A survey of organic farmers carried out by the Organic Farming Research Foundation (OFRF) found that only 9 percent of 1,045 farmers applied botanicals regularly (mostly pyrethrins and neem), and that 52 percent never use them, 21 percent use them rarely, and 18 percent "on occasion" (Walz, 1999).

On average the microbial, botanical and biochemical pesticides approved for organic production are applied at lower rates than conventional pesticides. Table 5 lists nine examples of pesticides approved for organic farming (seven of them insecticides) – *Bacillus thuriengensis*, *Bacillus subtilis*, spinosad, *Coniothyrium minitrans*, *Beauvaria bassiana*, pheromones, pyrethrum, rotenone, and azadirachtin. For each of the nine, the table includes two or three common conventional pesticides used to control the same pests in the same crops. The table compares the average conventional pesticide active ingredient application rates, to the average rate across the organic alternatives.

On average across these nine cases, the conventional alternatives are applied at 14-times the rate of the organically approved materials.

Organic Materials are Far Less Toxic than Conventional Alternatives

Pesticides approved for organic farming are also much less toxic per pound of active ingredient, when compared to the conventional pesticides used to manage the same pests. Appendix 3, Table 2 covers 15 comparisons, and reports acute and chronic toxicity to mammals, as well as "Environmental Impact Units" (EIUs) linked to a typical acre-treatment. EIUs are pesticide

Table 5.

Pesticides Approved for Organic Farming and Typical Conventional Alternatives: Average Use Rates on Conventional Farms Exceed Average Organic Application Rates by 14-Fold

Organic pesticide / Conventional Alternative	Trade Name	Typical Use Rate (pounds active ingredient per acre)
Bacillus thuringiensis	Xentari, Dipel	0.04
Azinphos-methyl	Guthion	0.58
Endosulfan	Thiodan	0.83
Thiamethoxam	Platinum	0.062
Bacillus subtilis	Serenade, Rhapsody	0.01
Azoxystrobin	Abound	0.16
Zoxamide	Gavel	0.16
Captan	Captan	2.4
Spinosad	Entrust	0.08
Cypermethrin	Ammo, Cymbush	0.08
Methomyl	Lannate	0.52
Coniothyrium minitans		0.1
Thiophanate methyl	Topsin M	0.58
Iprodione	Rovral	0.73
Beauveria bassiana	Mycotrol, Naturalis	0.01
Chlorpyrifos	Lorsban	1.25
Imidacloprid	Admire	0.12
Pheromones	Multiple products	0.001
Pyriproxyfen	Esteem	0.0745
Methoxyfenozide	Intrepid	0.25
Pyrethrum	Pyganic, Safer	0.01
Dimethoate	Dygon	0.55
Carbofuran	Furadan	0.9
Rotenone	Rotenone	0.04
Acephate	Orthene	0.69
Chlorpyrifos	Lorsban	1.25
Azadirachtin (neem)	AZA-direct, Neemix	0.16
Carbaryl	Sevin	1.58
Phosmet	Imidan	1.43
Average Use Rate Nine Organic Products		**0.05**
Average Use Rate 20 Conventional Products		**0.7**

use-pattern specific, and reflect typical use rates and formulations. The Pesticide Environmental Assessment System (PEAS) was developed by Benbrook Consulting Services and is used to estimate EIUs associated with a specific pesticide use. The PEAS encompasses relative risks to workers, dietary exposure, birds, small aquatic invertebrates, and bees. Table 6 summarizes the differences in toxicity across the 14 cases covered in detail in Appendix 2, Table 2.

The first two measures of toxicity in Table 6 are based on laboratory animal experiments – the lower a pesticide's LD50 or cPAD, the more toxic the pesticide. Accordingly, LD50 and cPAD ratio values in these two columns that are under one reflect cases where the organic material is less toxic than the average of the conventional alternatives.

The third measure – Environmental Impact Units– is different. The larger the EIU value, the greater the expected overall environmental and public health impact. EIUs differ in other ways and are a far more realistic measure of potential pesticide risks than simple comparisons of toxicity. EIUs are crop and region specific and reflect relative risks per acre treatment with a given pesticide, taking into account factors that can alter exposure levels.

For example, EIU values reflect rates of application, formulations, when and how a product is applied, as well as steps taken to reduce exposures to particular nontarget organisms. For this reason, EIUs are the most accurate comparative measure of risk potential between organically approved materials and conventional alternatives that are reported in Table 6.

Table 6.

Ratio of Conventional Alternatives to Allowed Organic Pesticides: Acute and Chronic Toxicity, and Environmental Impact Units (EIU) (see notes)

Organic Material	Ratio of LD50 Conventional to Organic	Ratio of cPAD Conventional to Organic	Ratio of EIU Conventional to Organic
	Values > 1 = Organic More Toxic	***Values > 1 = Organic More Toxic***	***Values > 1 = Conventional More Toxic***
Bacillus thuringiensis	0.10	NA	2,528
Bacillus subtilis	1	NA	7.7
Spinosad	0.01	0.03	0.35
Beauveria bassiana	0.059	NA	136
Pheromones	1	NA	1,900
Pyrethrum	0.16	0.04	29.7
Rotenone	0.33	0.15	1,427
Azadirachtin (neem)	0.04	0.13	632
Copper products	5	1.02	0.32
Bicarbonate (K and Na)	0.79	0.08	3.9
Sulfur products	1.67	0.68	0.65
Kaolin clay	0.01	0.14	6.9
Petroleum oils	0.22	0.18	5.2
Soaps	0.06	0.26	22
Average EIU 14 Cases			**479**

Notes: "NA" is "Not Available." The EPA does not require registrants of these organically approved products to do the testing required to establish a chronic "Population Adjusted Dose."

"EIU's" are based on the Pesticide Environmental Assessment System (PEAS) and reflect potential risk per acre treated with an organically approved product, compared to its conventional alternatives. See Appendix Table 3.2 for more on PEAS.

Pesticides approved for use on organic farmers are generally less acutely toxic to mammals (see LD-50 column in Table 6). The conventional alternatives (dimethoate, carbofuran) to the most toxic (to mammals) botanical approved for use by organic farmers – pyrethrum – are over six-times more acutely toxic, and 23-times more chronically toxic. Among organically approved materials, copper fungicides are the most toxic compared to standard conventional alternatives.

Organically approved pesticides are also generally less toxic in terms of chronic risk to humans (as measured by the EPA-set cPAD, or chronic Population Adjusted Dose). Copper fungicides are the only organically approved pesticide that is (barely) more toxic than common conventional alternatives.

In terms of risks to people, birds, small aquatic organisms and bees, as measured by EIUs, conventional alternatives to organically approved pesticides are on average 478-times more damaging than organically approved materials. One reason for the big difference is that organically approved materials rarely appear as residues in food (except for spinosad and sulfur), whereas some of the conventional alternatives pose significant dietary risks that are reflected in their EIU scores.

There are three cases in Table 6—spinosad, copper fungicides, and sulfur—where the organic material has a higher EIU score than the conventional alternatives, and each warrants some discussion.

Spinosad is a relatively new biochemical insecticide derived from soil microorganisms. It is an extremely valuable material for conventional fruit and vegetable growers working to move away from the high-risk OP and carbamate insecticides. There are also organically approved formulations of spinosad on the market, which have been welcomed by many organic farmers.

Spinosad has a highly beneficial toxicological profile – except for its impacts on bees, which leads to its relatively high EIU score. The spinosad label contains explicit instructions on how to minimize bee risks, but some adverse impacts on pollinators have been documented and organic certifiers need to monitor the degree to which organic farmers find ways to apply spinosad that protect pollinators.

Copper fungicides are used widely in organic and conventional farming and pose significant risks to aquatic organisms, and are somewhat more acutely toxic to mammals than their conventional alternatives. Fortunately, given when and how copper fungicides are applied, adverse impacts are rarely significant. Concerns persist, however, over the buildup of copper in the soil, the primary reason these products are heavily restricted by all organic certifying bodies around the world, and since 2004, are no longer allowed for organic farming in at least two countries within the European Community.

Sulfur is the third organically approved material with higher EIUs than conventional alternatives. Sulfur is applied at a very high rate – typically 10 to 15 pounds per acre. Because of these high rates, it does pose some worker and ecological risks. Still, the EIU score for sulfur (2.9) is low compared to high-risk insecticides, which typically have EIU scores well over 100, and sometimes over 200.

B. Pesticide Problems Impacting Organic Foods and Farmers

Despite the relatively small number of organic samples tested each year by the PDP, some persistent pesticide residue problems are now apparent. Post-harvest fungicides are among the most common residues found in organic fruit and vegetables. They account for about one-third of the total number of positive organic samples reported by PDP from 1993 through 2006.

How do they get onto organic produce?

Cross-contamination most likely occurs in a cold storage facility, during trucking, or at the retail store level. If a box of treated conventional apples is placed too close to a box of organic apples, there can be some movement of fungicide from one box to another.

NOP rules governing the separation of conventional and organic produce are designed to prevent this sort of inadvertent cross-contamination and are, for the most part, working reasonable well, given that the majority of fresh organic fruits and vegetables lack post-harvest fungicide residues that are very common on conventional produce.

Not Just Dust in the Wind

Drift of pesticides onto specialty crops like herbs or berries is a growing problem, and can be very costly for organic farmers. An inadvertent pesticide residue found on an organic crop is regarded as acceptable under the NOP rules as long as the level found is below 5% of the applicable EPA tolerance. But what about cases where there is no tolerance for the pesticide on the organic crop impacted by drift?

If there is no tolerance, then the presence of ***any*** detectable level of a pesticide in an organic crop renders the crop adulterated, and unmarketable, even if the residue poses virtually no risk.

This scenario has plagued Jacobs Farm herb production near Half Moon Bay, California the last few years. Various pesticides approved for use on broccoli and other conventional vegetable crops have drifted a short distance onto Jacobs Farm organic herb fields. A buyer (Whole Foods) first detected residues in routine testing. Because there are no herb crop tolerances covering the pesticides that drifted onto the organic herb fields, the grower had no choice other than to report the residues to the California Department of Food and Agriculture and destroy the crop. Millions of dollars have been lost by the farm and high-stakes litigation is underway.

This unfortunate case points to a growing problem and major issue for the farm community – how can organic and conventional high-value specialty crops co-exist in the same areas? Is it the obligation of a conventional farmer to keep pesticides applied on his or her land from drifting

onto a nearby organic farm, or must organic farmers live with, and bear the costs of pesticide pollution from neighboring farms?

A definitive answer to this question is likely to require passage of new state and/or federal legislation, just as the case with the spread of pollen and seeds from genetically engineered crops onto organic farmers, or into the organic seed supply. Policy-makers need to address these questions to prevent costly and protracted disputes that pit organic farmers against conventional growers, and waste the collective resources of the farm community.

C. Dealing with Recurrent Problems and Preventing New Ones

Inadvertent mislabeling of organic products, and fraud, are not common problems, but do occur. One of 11 organic sweet bell peppers tested in the 2004 PDP contained residues – and not just one. This U.S-grown pepper sample contained eight residues. While there were 29 conventional bell pepper samples with nine or more residues, it is inconceivable that an organic sample could contain eight residues. This was a clear-cut case of either human error or fraud.

In fact, this mislabeled organic sample contained 0.22 ppm of chlorpyrifos, a very high level. The mean level of chlorpyrifos in the 95 conventional sweet bell pepper samples that also tested positive for this insecticide was 0.048 ppm – about one-fifth of the level in this exceptionally "hot" organic pepper sample.

According to NOP rules, any pesticide residue found at a level exceeding 5 percent of the published tolerance warrants investigation by the certifier. The organic sweet bell pepper with eight residues in 2004 testing should have triggered an investigation by the certifier, given that two of the residues found were over 5% of the applicable tolerance (chlorpyrifos and bifenthrin).

In cases where the PDP finds an illegal residue (over tolerance, or no tolerance), the "PDP communicates these findings to the FDA," the agency responsible for monitoring compliance with pesticide tolerances (see page xi, 2005 PDP annual summary). For the same reasons, PDP should routinely report to the NOP any residue found in an organic sample above 5 percent of the existing EPA tolerance (and to the FDA, if over-tolerance).

An email to the NOP could provide whatever information the PDP has on the source of the sample – where it was grown, shipper, point of collection, etc. In some cases, this information would allow the NOP to determine the certifier involved with the product. The certifier could then be alerted, so that a follow-up investigation could be carried out, as required by NOP rules.

In 2004 testing, there were six organic samples with residues over 5% of the applicable tolerance. Nine out of 190 organic samples tested in 2006 would have triggered this reporting requirement (see Appendix 2, Table 4 and 6).

The best way to reduce the frequency of such instances in the future is for the NOP, certifiers, buyers, and retailers, working in tandem, to trace the origins of today's instances back to the stage in the supply chain where the problem occurred. Doing so routinely will lead to clear answers in some percentage of the cases, and each answer will help prevent similar instances in the future. In this way, the organic food sector, and consumers as a whole will benefit in a new way from the public investment made each year in the PDP.

IV. Potential to Reduce Pesticide Dietary Risks through Organic Farming

Our 2004 report on pesticide residues in organic and conventional fruits and vegetables reported that -

- Residues are about 3.5 times more common in conventional food, compared to organic,
- Multiple residues occur much more frequently in conventional produce, and
- Residue levels of a given pesticide are generally higher in positive conventional samples, compared to organic samples of the same food found to contain the same residue.

Based on these findings, we concluded that the dietary risks from pesticide residues in food are far lower in the average serving of organic food, say an apple, compared to an average serving of conventional apple.

Since release of the 2004 report, many people have asked – Well, lower by how much? By one-third, or one-half? By 90%?

A second question repeatedly comes up – Can you provide a list of the top-five or top-ten foods to buy organic to most significantly reduce pesticide risks? People concerned about raising kids on a tight budget also often ask for a list of foods where the extra money for organic may only reduce pesticide dietary risks marginally.

We answer both questions in this section as fully as possible, given available data on pesticide residues and toxicity, and the state of pesticide dietary risk assessment science.

A. The Organic Option: A 97% Solution

Consistently over the last decade about 80% of organic samples tested by the USDA's "Pesticide Data Program" (PDP) have contained no residues. No detectable residues equals virtually no exposure or risk.

So for this portion of the organic food supply, the reduction in risk from the levels in conventional food is essentially 100%. But what about the approximate 20% of organic food that is found to contain a residue in most years of PDP testing?
We estimated the reduction in dietary risk in this portion of the organic food supply by analyzing all foods tested by PDP from 2003-2006 which included organic samples. We focused on fruit and vegetable products, because they account for such a large share of total dietary risk, and excluded animal products and organochlorine residues.

We calculated "Dietary Risk Index" (DRI) levels for each of the 63 foods in which both conventional and organic samples were tested by the PDP in the last four years. A DRI was calculated based on all pesticide residues found in the organic samples of each food, and the DRI was calculated for the conventional samples of each food encompassing all the residues found in those samples.

DRI values for a pesticide-food combination were calculated based on a simple formula – the ratio of the mean of the residues found in the food, divided by the chronic Reference Concentration (cRfC) for the pesticide.

Calculating Chronic Reference Concentrations

The cRfC is the maximum concentration of pesticide in a given food that is regarded by EPA as safe to consume in a single day, in light of the pesticide's chronic "Population Adjusted Dose" (cPAD) set by the agency. (A cPAD is the maximum exposure to the pesticide considered acceptable in a day, per kilogram of a person's body). Chronic RfC values change as a function of how large a person is, and how much of a given food they consume in a given day.

We calculated cRfC values for all pesticides detected by PDP based on a 20 kilogram child (about 44 pounds), who consumes 100 grams of a given food. Different serving sizes and weights change the absolute values of cRfCs across pesticides, but not relative values between pesticides.

DRI values were calculated for each residue found in the organic samples of a given food, and were then the added together across all residues detected, to produce a DRI value encompassing all residues found. The same was done with the conventional samples of food tested in the same year, producing a conventional, aggregate DRI value.

The next steps entail adding the DRI values for the organic samples of the 63 foods together; adding the conventional sample DRI scores together across the 63 foods; and, calculating the percentage reduction brought about in the organic foods, based on differences in aggregate DRI values.

Table 7 shows the results – the aggregate DRI value across the organic samples of the 63 foods is 83, and for the conventional food samples, 546. Accordingly, based on the foods tested by PDP from 2003 through 2006, the average serving of organic food reduced dietary risks by 85%.
So, for the 20% portion of the organic food supply with residues, switching from conventional to organic food will, on average, reduce pesticide risk levels by 85%.

For the other 80% of organic foods, dietary risks are reduced essentially 100%. Averaged across all organic samples, the reduction in dietary risks expected from a switch to organic food is just under 97%. (The weighted average equals [0.2 x 85%] + [0.8 x 100%]).

Table 7.

Comparison of the Dietary Risk Index (DRI) Scores for Organic and Conventional Foods Tested in the Same Year by PDP from 2003-2006 (excludes animal products)

Year	Number Foods	DRI Score All Organic Samples	DRI Score All Conventional Samples
2006	19	42.3	280.1
2005	15	0.6	74.4
2004	15	39.3	101
2003	14	1.2	90.6
Totals	63	83	546

Calculating DRI Values

DRI values for a given food-pesticide-year combination are calculated as the ratio of the mean residue level and the pesticide's chronic Reference Concentration (cRfC). A pesticide's cRfC is determined by its toxicity as estimated by the EPA. Three pieces of information are needed to calculate a cRfC: the serving size of a given food (usually in grams), the weight of a child (usually in kilograms), and the chronic toxicity of the pesticides, as determined by the EPA ("acceptable intakes," or cPADs are expressed as milligrams of the pesticide per kilogram of bodyweight per day).

In this analysis, we assume a typical serving size of each food, and a 20-kilogram child. Use of a different serving size, or a heavier or lighter child, will change the absolute DRI value for each food-pesticide-year combination, but not the relative values, nor the differences between conventional and organic samples.

Another Piece of Evidence

A research team at the University of Washington in Seattle led by Dr. Chenseng (Alex) Lu has studied the reduction in exposures to common organophosphate (OP) insecticides among school age children switching from a conventional to predominantly organic diet. The study has been carried out three times utilizing progressively sensitive and sophisticated experimental designs, and the papers reporting the results have all been published in *Environmental Health Perspectives*, a journal of the National Institute of Environmental Health Sciences.

The results have been dramatic and consistent – dietary exposure to this class of pesticides is virtually eliminated after just a few days on a predominantly organic diet "Lu et al., 2007". Following a few days back on the same diet composed of conventional foods, the urinary metabolites measured in the children's urine returned to the pre-intervention level.

Dr. Lu's research provides clear-cut biomonitoring evidence in support of this report's conclusion that the switch to organic food can dramatically reduce pesticide dietary exposures and risk.

B. Identifying Priority Foods to Minimize Pesticide Exposures and Promote Healthy Development and Aging

The Center is often asked to provide a list of the top-five or top-ten foods to buy organic, if a person wants to most significantly reduce pesticide dietary exposures and risks. One simple answer is to look for "certified organic" labels when selecting the fruits and vegetables that you, or your children like to eat most frequently. The exceptions to this rule are fruits and vegetables with thick skins or outer leaves that are not consumed, like bananas, citrus fruit, onions, and pineapples.

Families raising kids on a tight budget also ask for a list of foods that pose very little or no pesticide risks, where the extra money for organic may do little to reduce exposures. Here, the simple answer is again fruits and vegetables with a thick peel or skin that is not consumed, plus processed fruit and vegetable products that tend to pose minimal pesticide risks (see Table 10, page 32 for examples of processed fruit and vegetables that pose far lower dietary risks than fresh produce).

We know from several EPA risk assessments, and past analyses of PDP data, that pesticide residue patterns vary greatly in fresh fruits and vegetables that are domestically grown, compared to those that are imported.

Some fresh fruits and vegetables store well for many months. Examples include apples, pears, potatoes, onions, and squash. But many other fruits and vegetables are highly perishable, including berries, leafy greens, tomatoes, peaches, plums, green beans, and grapes. During winter months in the U.S. market, a substantial portion of most of these perishable items is from imports.

For this reason, we present a list of the fruits and vegetables posing the greatest dietary risks per serving for both the summertime, based on PDP samples of domestically grown produce, and during the wintertime, when the DRI values are all based on residues found just in imported foods.

For foods tested by the PDP through 2003, we used domestic and imported food DRI values reported in an appendix to the investigative report done by the EPA's "Office of Inspector General" on the impacts of the "Food Quality Protection Act" (FQPA) on dietary pesticide risks levels. The August 1, 2006 report is entitled "Measuring the Impact of the FQPA: Challenges and Opportunities, Report No. 2006-P-00028", and is available on the OIG website (http://www.epa.gov/oig/reports/2006/20060801-2006-P-00028.pdf). A supplemental report describing the dietary risk index methodology used by the OIG is posted at http://www.epa.gov/oig/reports/2006/20060801-2006-P-00028A.pdf. Benbrook Consulting Services, under contract to the OIG, calculated the dietary risk index levels incorporated in the OIG report.

The OIG DRI methodology differs from the method described in the above section, because the purpose of the OIG study was to quantify the risk reduction impacts of the FQPA using quantitative methods as close as possible to EPA's science policies and risk assessment methods. Doing so required a more complicated approach in the estimation of DRI values, but the differences have little impact on the relative ranking of risks. For foods in the below lists tested since 2003 by the PDP, we estimated DRI values using the OIG methodology.

Important Caveats

The fresh fruits and vegetables in Tables 8 and 9 have been extensively tested by the PDP, which was designed and is managed to focus on foods that are important in the diets of infants and children. We cannot predict the DRI values associated with fruits and vegetables not tested by the PDP.

These lists only reflect the ***dietary*** risks stemming from pesticide use. Bananas, for example, rarely contain any residues, and will never make a top-ten list based on dietary risks. Does this mean there are no benefits associated with the purchase of organic bananas? Certainly not!

Pesticides applied in banana plantations throughout Central and South America pose significant risks to workers, birds, and aquatic organisms. There are ample reasons to minimize pesticide use on food crops beyond reducing dietary exposures and risk, both in the U.S. and abroad.

Table 8.

Conventional Fruits and Vegetables with the Highest Pesticide Dietary Risk Index Scores: Domestically Grown Produce			
Fruits	Dietary Risk Index	Vegetables	Dietary Risk Index
Cranberries	178	Green beans	330
Nectarines	97	Sweet bell peppers	132
Peaches	54	Celery	104
Strawberries	56	Cucumbers	93
Pears	48	Potatoes	74
Apples	44	Tomatoes	68
Cherries	32	Peas	66
		Lettuce	54

Table 9.

Imported Fruits and Vegetables with the Highest Pesticide Dietary Risk Index Scores			
Fruits	Dietary Risk Index	Vegetables	Dietary Risk Index
Grapes	282	Sweet bell peppers	720
Nectarines	281	Lettuce	326
Peaches	266	Cucumbers	317
Pears	221	Celery	170
Strawberries	78	Tomatoes	142
Cherries	31	Green beans	93
Cantaloupe	31	Broccoli	62
Apples	30	Peas*	48
		Carrots	30

* Ratio of DRI value in fresh to processed peas, domestic production (6), multiplied by imported value for processed peas (8). PDP has not tested fresh imported peas.

Note how much higher the DRI values are in the imported fruits and vegetables. This is caused by the generally higher and more frequent residues in imported fruits and vegetables, compared to the same crop grown in the U.S. In some cases, the differences between imports and domestic produce are dramatic (grapes, lettuce), and in other cases the differences are modest. In a few cases, imported produce has lower aggregate DRI values than domestic produce (apples, potatoes).

C. Processed Foods are a Good Option to Reduce Pesticide Exposure

Most people know that fresh, whole fruits and vegetables usually deliver the most nutrients per serving, compared to canned, frozen, or otherwise processed foods. But during the winter, if only imported conventional fresh produce is available, consumers should consider choosing canned or frozen domestically grown fruits and vegetables. Table 10 shows the usually dramatic impact of processing on the pesticide risk levels in most fruits and vegetables.

Frozen fruits and vegetables typically deliver a significant portion of the nutrients present when the crop was harvested. Processed fruit products that involve little or no cooking tend to retain most of their original nutrients. However, the addition of excessive sugar or salt in canned fruits and vegetables can turn a nutritious food into less of one.

Another factor increases the nutrient content in many processed fruit and vegetable products. Farmers are typically able to delay the harvest of fruit and vegetables bound for processing longer than typically the case with fresh produce. This is because it usually takes only a few hours to get the fruit or vegetables harvested from a field to the processing plant, whereas produce destined for the fresh market has to be picked green enough to hold up during packing, storage, shipping, and often lengthy journeys.

In general, vitamin and antioxidant levels in fresh produce increase as fruit ripens. For most fresh market fruit and vegetables that must be picked days, or even weeks before fully ripe, nutrient levels may be reduced by one-third or more.

The type and degree of processing also has a big impact on both the extent to which pesticide residues are eliminated, and the portion of nutrients in the fresh fruit that are retained. In general, pesticide risks are reduced the most when processing removes peels, skins, or other leaves, and subjects the rest of the fruit or vegetable to thorough washing and/or cooking. For nutrients, freezing produce, and canning without cooking tends to preserve nutrients most effectively, while peeling and/or cooking tends to reduce nutrient density.

Processed tomato products are an interesting exception to the rule about the impact of processing on nutrient density. Several studies have shown that lycopene levels actually go up when raw tomatoes are converted to tomato sauce, and are further concentrated when tomato sauce is processed into tomato paste.

Table 10.

Processed Foods* Pose Far Lower Pesticide Dietary Risks than Fresh Produce (see notes)

Fruits	Dietary Risk Index	Vegetables	Dietary Risk Index
Fresh Apples	44	Green beans	330
Apple Juice	5	Proc. green beans	17
Apple Sauce	2	Imported proc. green beans	29
Grapes	21	Peas	66
Grape Juice	7	Proc. Peas	11
		Imported proc. peas	8
Oranges	28	Spinach	29
Orange juice	4	Proc. Spinach	28
Peaches	837	Tomatoes	103
Proc. Peaches	2	Proc. tomatoes	12
Imported proc. Peaches	1	Imported proc. tomatoes	9
		Tomato paste	7
Pears	48		
Pear juice	32		
Proc. pears	0.1		
Strawberries (2000)	56		
Proc. Strawberries (2000)	69		
Proc. Strawberries (1999)	50		

Notes:
Most recent year processed item tested with close match to a year in which the fresh food form was also tested, domestic samples only 1994-2003.

Includes residues of organochlorine insecticides.

* All foods domestic, unless otherwise noted

APPENDIX 1. The U.S. Department of Agriculture's Pesticide Data Program (PDP)

The U.S. Congress funded the "Pesticide Data Program" (PDP) in order to improve the accuracy of pesticide dietary risk assessments carried out by the U.S. EPA. The program is carried out by the USDA's Agricultural Marketing Service. The PDP focuses on the foods consumed most heavily by children and food is tested, to the extent possible, "as eaten" (Agricultural Market Service 2004). For example, banana and orange samples are tested without the peel; processed foods are tested as they come out of a can, jar or freezer bag.

Since its inception the PDP has tested nearly 250,000 samples of the 20-odd foods consumed most frequently by children: milk, apples, apple juice, pears, peaches, grapes, oranges, bananas, peas, green beans, carrots, tomatoes, and strawberries have been in and out of the program two or three times. Less commonly consumed foods like nectarines and cranberries have also been tested.

In general, the more residues found in one round of PDP testing for a given food, the more likely that food will be added again to the program. About one-quarter of the samples in a given year are processed foods and juices. Appendix A in each annual PDP summary report presents the history of PDP testing by commodity, for both fresh and processed foods.

Some 300 to 800 samples are tested of each fresh or processed food, although as few as 120 samples have been run of some foods. The sample design strives to reflect the composition of the food supply in terms of the geographic origin of food. The number of domestic versus imported samples is roughly proportional to their respective share of annual consumption.

The USDA also records information on any market claims made on a given sample of food. Possible claims include "organic," "IPM-grown," "No Detectable Residues" or "pesticide free." Each market claim is supposed to be sampled roughly in proportion to their occurrence in retail market channels. As a result, PDP results allow comparisons to be made of the frequency and levels of pesticide residues in domestic versus imported foods, across food groups, as well as by market claim.

Appendix 2. Pesticide Residues in Conventional and Organic Food Samples

Appendix 2. Table 1 Detection Limits for Selected Pesticides Found in Milk: PDP Testing in 1996, 1997, 1998 and 2004

	Detection Limits (ppb)				
Pesticide	**1996**	**1997**	**1998**	**2004**	**Difference Between 1996 to 2004**
3-hydroxycarbofuran	4	4	4	0.12	33
Cyfluthrin	20	20	20	0.6	33
Cyhalothrin, Total	NA	NA	NA	0.15	NA
DDE p,p'	1	1	1	0.06	17
Dieldrin	1	1	1	0.12	8
Dimethoate	1	1	1	0.07	14
Diphenylamine	6	6	6	0.06	100
Endosulfan sulfate	1	1	1	0.06	17
Permethrin, Total	2	3	2	0.6	3

Appendix 2. Table 2 Pesticide Residues in Milk - 2005 Testing by the USDA's Pesticide Data Program (PDP)

Pesticide	Number of Positives	Percent Positive	Mean of the Positives (ppb)
3-hydroxycarbofuran	45	6.0%	0.2196
Bifenthrin	3	0.4%	0.1471
Carbaryl	2	0.3%	0.0830
Cyfluthrin	6	0.8%	1.0000
Cyhalothrin, Total	155	20.8%	0.3133
DDE p,p'	637	85.4%	0.4988
Dieldrin	173	23.2%	0.1330
Dimethoate	1	0.1%	0.1000
Diphenylamine	683	91.6%	0.3460
Endosulfan sulfate	115	15.4%	0.1435
Permethrin, Total	21	2.8%	1.2524
Tetrachlorvinphos	2	0.3%	0.2700
Total Residues Found	1,843		
Average Residues per Sample	2.43		

Total samples of milk in 2004 were 746, all domestic samples.

Appendix 2. Table 3 Pesticide Residues Found in 67 Organic Samples Tested in 2003 by the PDP

CROP - PESTICIDE DATA PAIRS (CPDP)		ORIGIN	COUNTRY OR STATE	RESIDUE LEVEL (ppm) - Dairy Products (ppb)	EPA TOLERANCE (ppm) - Dairy Products (ppb)	RATIO of the RESIDUE to EPA TOLERANCE	MEAN RESIDUE LEVEL IN ALL POSITIVE SAMPLES	RATIO OF RESIDUE LEVEL TO MEAN RESIDUE
Butter	DDE p,p'	Domestic	Unknown	2.7	1250	0%	17.11130508	16%
Butter	Endosulfan sulfate	Domestic	Unknown	6.9	500	1%	3.633695652	190%
Pears	Thiabendazole	Domestic	Unknown	0.073	10	0.7%	0.479983607	15%
Spinach	Chlorpyrifos	Domestic	Unknown	0.007	0.1	7.0%	0.012333333	57%
Spinach	DDE p,p'	Domestic	Unknown	0.036	0.5	7.2%	0.018632768	193%
Spinach	DDE p,p'	Domestic	Unknown	0.019	0.5	4%	0.018632768	102%
Spinach	Iprodione	Domestic	Unknown	0.013	NT		0.013	100%
Spinach	DDE p,p'	Domestic	Unknown	0.022	0.5	4%	0.018632768	118%
Sweet Potatoes	Piperonyl butoxide	Domestic	Unknown	0.2	EX		0.07355102	272%

NOTE: NT - No Tolerance; EX - Exempt

Appendix 2. Table 4 Pesticide Residues Found in 73 Organic Samples Tested in 2004 by the PDP

CROP - PESTICIDE DATA PAIRS (CPDP)		ORIGIN	COUNTRY OR STATE	RESIDUE LEVEL (ppm) - Dairy Products (ppb)	EPA TOLERANCE (ppm) - Dairy Products (ppb)	RATIO of the RESIDUE to EPA TOLERANCE
Sweet bell Pepper	Chlorpyrifos	Domestic	Unknown	0.22	1	22%
Sweet bell Pepper	Bifenthrin	Domestic	Unknown	0.096	0.5	19%
Sweet Potatoes	Chlorpyrifos	Import	Brazil	0.007	0.05	14.0%
Sweet Potatoes	Dieldrin	Import	Brazil	0.01	0.1	10.0%
Winter Squash	Dieldrin	Domestic	Unknown	0.01	0.1	10.0%
Milk	Diphenylamine (DPA)	Domestic	Unknown	0.88	10	9%
Sweet Potatoes	Piperonyl butoxide	Domestic	Unknown	0.017	0.3	5.7%
Milk	Diphenylamine (DPA)	Domestic	Unknown	0.52	10	5%
Sweet bell Pepper	Permethrin, trans	Domestic	Unknown	0.026	1	3%
Milk	Diphenylamine (DPA)	Domestic	Unknown	0.23	10	2%
Sweet bell Pepper	Permethrin, cis	Domestic	Unknown	0.023	1	2%
Milk	Diphenylamine (DPA)	Domestic	Unknown	0.21	10	2%
Grapes	Imidacloprid	Domestic	Unknown	0.017	1	2%
Oranges	Chlorpyrifos	Domestic	Unknown	0.007	0.5	1.4%
Sweet bell Pepper	Oxamyl	Domestic	Unknown	0.033	3	1%
Milk	Diphenylamine (DPA)	Domestic	Unknown	0.1	10	1%
Milk	Diphenylamine (DPA)	Domestic	Unknown	0.1	10	1%
Milk	Diphenylamine (DPA)	Domestic	Unknown	0.1	10	1%
Milk	Diphenylamine (DPA)	Domestic	Unknown	0.1	10	1%
Milk	Diphenylamine (DPA)	Domestic	Unknown	0.1	10	1%
Milk	Diphenylamine (DPA)	Domestic	Unknown	0.1	10	1.0%
Oranges	Imazalil	Domestic	Unknown	0.05	10	0.5%
Sweet bell Pepper	Myclobutanil	Domestic	Unknown	0.005	1	1%
Sweet bell Pepper	Methamidophos	Domestic	Unknown	0.002	1	0%
Oranges	O-Phenylphenol	Import	Mexico	0.017	10	0.2%
Milk	DDE p,p'	Domestic	Unknown	2	1250	0%
Sweet bell Pepper	Tetrahydrophthalimide (THPI)	Domestic	Unknown	0.0328	25	0%
Milk	DDE p,p'	Domestic	Unknown	1.5	1250	0%
Sweet Potatoes	O-Phenylphenol	Domestic	Unknown	0.017	15	0.1%
Sweet Potatoes	O-Phenylphenol	Domestic	Unknown	0.017	15	0.1%

Appendix 2. Table 5 Pesticide Residues Found in 127 Organic Samples Tested in 2005 by the PDP								
CROP - PESTICIDE DATA PAIRS (CPDP)		ORIGIN	COUNTRY OR STATE	RESIDUE LEVEL (ppm) - Dairy Products (ppb)	EPA TOLERANCE (ppm) - Dairy Products (ppb)	RATIO of the RESIDUE to EPA TOLERANCE	MEAN RESIDUE LEVEL IN ALL POSITIVE SAMPLES	RATIO OF RESIDUE LEVEL TO MEAN RESIDUE
Milk	Diphenylamine (DPA)	Domestic	Unknown	2.5	10	25%	0.346032211	722%
Heavy Cream	Permethrin Total	Domestic	Unknown	60.1	250	24%	18.72857143	321%
Heavy Cream	Diphenylamine (DPA)	Domestic	Unknown	1	10	10%	1.121311475	89%
Heavy Cream	Diphenylamine (DPA)	Domestic	Unknown	1	10	10%	1.121311475	89%
Heavy Cream	Diphenylamine (DPA)	Domestic	Unknown	1	10	10%	1.121311475	89%
Heavy Cream	Diphenylamine (DPA)	Domestic	Unknown	1	10	10%	1.121311475	89%
Milk	Diphenylamine (DPA)	Domestic	Unknown	0.62	10	6%	0.346032211	179%
Milk	Diphenylamine (DPA)	Domestic	Unknown	0.48	10	5%	0.346032211	139%
Pears	Cyhalothrin, Lambda	Import	Argentina	0.01	0.3	3%	0.01	100%
Milk	Diphenylamine (DPA)	Domestic	Unknown	0.29	10	3%	0.346032211	84%
Milk	Diphenylamine (DPA)	Domestic	Unknown	0.22	10	2%	0.346032211	64%
Milk	Diphenylamine (DPA)	Domestic	Unknown	0.22	10	2%	0.346032211	64%
Milk	Diphenylamine (DPA)	Domestic	Unknown	0.21	10	2%	0.346032211	61%
Milk	Diphenylamine (DPA)	Domestic	Unknown	0.2	10	2%	0.346032211	58%
Watermelon	Thiamethoxam	Import	Mexico	0.0036	0.2	2%	0.002457143	147%
Pears	Thiabendazole	Domestic	Unknown	0.16	10	2%	0.591432432	27%
Plums	Azinphos methyl	Import	Argentina	0.031	2	2%	0.01240625	250%
Apples	Acetamiprid	Domestic	Unknown	0.012	1	1%	0.016628571	72%
Milk	Diphenylamine (DPA)	Domestic	Unknown	0.1	10	1%	0.346032211	29%
Milk	Diphenylamine (DPA)	Domestic	Unknown	0.1	10	1%	0.346032211	29%
Milk	Diphenylamine (DPA)	Domestic	Unknown	0.1	10	1%	0.346032211	29%
Milk	Diphenylamine (DPA)	Domestic	Unknown	0.1	10	1%	0.346032211	29%
Milk	Diphenylamine (DPA)	Domestic	Unknown	0.1	10	1%	0.346032211	29%
Milk	Diphenylamine (DPA)	Domestic	Unknown	0.1	10	1%	0.346032211	29%
Milk	Diphenylamine (DPA)	Domestic	Unknown	0.1	10	1%	0.346032211	29%
Milk	Diphenylamine (DPA)	Domestic	Unknown	0.1	10	1%	0.346032211	29%
Milk	Diphenylamine (DPA)	Domestic	Unknown	0.1	10	1%	0.346032211	29%
Milk	Diphenylamine (DPA)	Domestic	Unknown	0.1	10	1%	0.346032211	29%
Milk	Diphenylamine (DPA)	Domestic	Unknown	0.1	10	1%	0.346032211	29%
Strawberries	Metalaxyl	Domestic	Unknown	0.072	10	1%	0.067770833	106%
Apples	Diphenylamine (DPA)	Domestic	Unknown	0.071	10	1%	0.449195455	16%
Lettuce	DDE p,p'	Domestic	California	0.0032	0.5	1%	0.004385321	73%

Appendix 2. Table 6 Pesticide Residues Found in 190 Organic Samples Tested in 2006 by the PDP

CROP - PESTICIDE DATA PAIRS (CPDP)		ORIGIN	COUNTRY OR STATE	RESIDUE LEVEL (ppm)	EPA TOLERANCE (ppm)	RATIO of the RESIDUE to EPA TOLERANCE	MEAN RESIDUE LEVEL IN ALL POSITIVE SAMPLES	RATIO OF RESIDUE LEVEL TO MEAN RESIDUE
Cranberries	Spinosad	Domestic	Unknown	0.025	0.01	250%	0.019	131.5789474
Cranberries	Spinosad	Domestic	Unknown	0.013	0.01	130%	0.019	68.42105263
Summer Squash	Chlordane cis	Domestic	Unknown	0.016	0.1	16%	0.006575	24.33460076
Summer Squash	Heptachlor epoxide	Domestic	Unknown	0.007	0.05	14%	0.0153	9.150326797
Carrots	Trifluralin	Domestic	Unknown	0.13	1	13%	0.036267447	3.584481668
Summer Squash	DDE p,p'	Domestic	Unknown	0.007	0.1	7%	0.016	4.375
Summer Squash	DDT p,p'	Domestic	Unknown	0.007	0.1	7%	0.007	10
Spinach	Permethrin trans	Domestic	Unknown	1.3	20	7%	0.720822648	0.090174747
Spinach	DDE p,p'	Domestic	Unknown	0.028	0.5	6%	0.016	3.5
Spinach	Permethrin cis	Domestic	Unknown	1	20	5%	0.739671972	0.067597532
Potatoes, Frozen	Chlorpropham	Domestic	Unknown	2.1	50	4.2%	0.68753	0.061088243
Spinach	Acetamiprid	Domestic	Unknown	0.0076	0.2	3.8%	0.0788	0.482233503
Carrots	Tetrahydrophthalimide (THPI)	Domestic	Unknown	0.067	2	3.4%	0.077428571	0.432656827
Spinach	Permethrin cis	Import	Mexico	0.67	20	3.4%	0.739671972	0.045290347
Summer Squash	Chlordane trans	Domestic	Unknown	0.003	0.1	3.0%	0.00463	6.479481641
Watermelon	Imidacloprid	Import	Mexico	0.015	0.5	3.0%	0.018368421	1.633237822
Spinach	Permethrin trans	Import	Mexico	0.45	20	2.3%	0.720822648	0.031214336
Orange Juice	Bromacil	Import	Brazil / US	0.002	0.1	2.0%	0.002	10
Potatoes, Frozen	Chlorpropham	Domestic	Unknown	0.98	50	2.0%	0.68753	0.028507847
Carrots	DDE p,p'	Domestic	Unknown	0.051	3	1.7%	0.016	1.0625
Carrots	DDE p,p'	Domestic	Unknown	0.049	3	1.6%	0.016	1.020833333
Carrots	DDE p,p'	Domestic	Unknown	0.043	3	1.4%	0.016	0.895833333
Spinach	DDT p,p'	Domestic	Unknown	0.007	0.5	1.4%	0.007	2
Carrots	DDE p,p'	Domestic	Unknown	0.039	3	1.3%	0.016	0.8125
Carrots	DDE p,p'	Domestic	Unknown	0.026	3	0.9%	0.016	0.541666667
Spinach	Spinosad	Domestic	Unknown	0.051	8	0.6%	0.077416364	0.082346932
Spinach	Spinosad	Domestic	Unknown	0.05	8	0.6%	0.077416364	0.080732286
Grapefruit	Imazalil	Domestic	CA	0.062	10	0.6%	0.058696246	0.105628561
Grapefruit	Thiabendazole	Domestic	CA	0.05	10	0.5%	0.0007	7.142857143
Carrots	DDE p,p'	Domestic	Unknown	0.013	3	0.4%	0.016	0.270833333
Apple Sauce	Carbaryl	Import	Canada	0.038	10	0.4%	0.009	0.422222222

Appendix 3. Pesticides Approved for Use in Organic Production

Appendix 3. Table 1 Pesticide Brand Name Products Approved for Use by the Organic Materials Review Institute (OMRI), 2007

Category	Product Name	Company	Status
Adjuvants – for pesticide use	Britz Dryspreader	Britz Fertilizers, Inc.	Restricted
Adjuvants – for pesticide use	Green Valley™ Natural Plant Wash	WTB Technology	Restricted
Adjuvants – for pesticide use	Green Valley™ Ultra Guard Plant Wash	WTB Technology	Restricted
Adjuvants – for pesticide use	Phyto-Plus® Plant Stimulator (Buffer)	Baicor, L.C.	Restricted
Adjuvants – for pesticide use	Profilm 60	INVETISA De Mexico, S.A. de C.V.	Restricted
Adjuvants – for pesticide use	ThermX™ 15P	American Extracts	Restricted
Adjuvants – for pesticide use	Tri-Fol®	Wilbur-Ellis Company	Restricted
Bacillus thuringiensis	Able®	Certis USA	Restricted
Bacillus thuringiensis	Agree® WG	Certis USA	Restricted
Bacillus thuringiensis	Bactospeine DF	Valent BioSciences® Corp.	Restricted
Bacillus thuringiensis	Biobit® HP	Valent BioSciences® Corp.	Restricted
Bacillus thuringiensis	Britz Bt Dust	Britz Fertilizers, Inc.	Restricted
Bacillus thuringiensis	Delfin® WG	Certis USA	Restricted
Bacillus thuringiensis	Deliver®	Certis USA	Restricted
Bacillus thuringiensis	DiPel® 2X	Valent BioSciences® Corp.	Restricted
Bacillus thuringiensis	DiPel® DF	Valent BioSciences® Corp.	Restricted
Bacillus thuringiensis	DiPel® PRO DF	Valent BioSciences® Corp.	Restricted
Bacillus thuringiensis	Foray® 48 SI Biological Insecticide Flowable Concentrate	Valent BioSciences® Corp.	Restricted
Bacillus thuringiensis	Gnatrol® DG	Valent BioSciences® Corp.	Restricted
Bacillus thuringiensis	Javelin® WG	Certis USA	Restricted
Bacillus thuringiensis	Safer® Brand Garden Dust	Woodstream Corporation	Allowed
Bacillus thuringiensis	VectoBac® WDG	Valent BioSciences® Corp.	Restricted
Bacillus thuringiensis	XenTari® DF	Valent BioSciences® Corp.	Restricted
Bacillus thuringiensis	XenTari® WDG	Valent BioSciences® Corp.	Restricted
Bacillus thuringiensis	Xtreem DF	Valent BioSciences® Corp.	Restricted
Beauveria spp.	Mycotrol O®	Emerald BioAgriculture	Restricted
Beauveria spp.	Naturalis® H&G	Troy BioSciences, Inc.	Restricted
Beauveria spp.	Naturalis® L	Troy BioSciences, Inc.	Restricted
Biological Controls	AgriPhage™	OmniLytics, Inc.	Allowed
Biological Controls	Bloomtime Biological™	Northwest Agricultural Products™ Inc.	Allowed
Biological Controls	Bloomtime Biological™ FD	Northwest Agricultural Products™ Inc.	Allowed
Biological Controls	Carpovirusine	Arysta LifeScience North America Corporation	Allowed
Biological Controls	DiTera® DF	Valent BioSciences® Corp.	Allowed
Biological Controls	JUQ Trichoderma spp	Gauri Lab-Microorganismos Beneficos	Allowed
Biological Controls	Kodiak® Concentrate Biological Fungicide	Bayer CropScience LP	Allowed
Biological Controls	Semaspore Bait™	Planet Natural	Allowed
Biological Controls	Symbion®	Integrated BioControl Systems, Inc., dba BioControl Systems, Inc.	Allowed
Biological Controls	VectoLex® WDG	Valent BioSciences® Corp.	Allowed
Biological Controls	Yield Shield® Concentrate Biological Fungicide	Bayer CropScience LP	Allowed
Boric Acid	Safer® Brand Roach & Ant Killing Powder	Woodstream Corporation	Restricted
Botanical Pesticides – allowed	Farnam Equisect™ Fly Repellent	Farnam Companies, Inc.	Allowed
Botanical Pesticides – allowed	PyGanic® Crop Protection EC 5.0 II	MGK Co.	Restricted
Botanical Pesticides – allowed	Safer® Brand Ant Killer	Woodstream Corporation	Restricted
Botanical Pesticides – allowed	Victor Poison-Free® Ant & Roach Killer	Woodstream Corporation	Restricted
Botanical Pesticides – restricted	Antipest	DOF, Ltd.	Restricted
Botanical Pesticides – restricted	Bioshampoo Plaguisin	Ankarte	Restricted
Botanical Pesticides – restricted	EcoExempt® IC	EcoSMART Technologies, Inc.	Restricted
Botanical Pesticides – restricted	Heads Up® Plant Protectant	HeadsUp Plant Protectants, Inc.	Restricted
Botanical Pesticides – restricted	Honcobacter	Ankarte	Restricted
Botanical Pesticides – restricted	Nemagard	Natural Organic Products Int'l, Inc.	Restricted
Botanical Pesticides – restricted	Orange Guard® Fire Ant Control	Orange Guard, Inc.	Restricted
Botanical Pesticides – restricted	Organic Nemafert	DOF, Ltd.	Restricted
Botanical Pesticides – restricted	Organocide™ Organic Insecticide • Fungicide	Organic Laboratories, Inc.	Restricted
Botanical Pesticides – restricted	Promax™	Bio HumaNetics™	Restricted
Botanical Pesticides – restricted	Proud 3™	Bio HumaNetics™	Restricted
Botanical Pesticides – restricted	Safer® Brand Houseplant Insect Killer Aerosol	Woodstream Corporation	Restricted
Botanicals – allowed	Garlic Shield®	Grotek, Inc.	Allowed
Calcium Polysulfide	BSP Lime-Sulfur Solution	Ag Formulators, Inc.	Restricted
Calcium Polysulfide	Green Cypress Lime-Sulfur Solution	Monterey AgResources	Restricted
Calcium Polysulfide	Oidiomil	Produmix Ltda.	Restricted
Copper Sulfate	Basic Copper 53	Albaugh, Inc.	Restricted
Copper Sulfate	Copper Sulfate Crystals	Chem One, Ltd.	Restricted
Coppers – fixed	Britz Copper Sulfur 15-25 Dust	Britz Fertilizers, Inc.	Restricted
Coppers – fixed	Champion® Wettable Powder	NuFarm Americas, Inc.	Restricted
Coppers – fixed	COC WP	Albaugh, Inc.	Restricted
Coppers – fixed	Concern® Copper Soap Fungicide	Woodstream Corporation	Restricted
Coppers – fixed	CSC Copper Sulfur Dust Fungicide	Martin Operating Partnership, L.P.	Restricted
Coppers – fixed	Cueva Fungicide Concentrate	W Neudorff GmbH KG	Restricted
Coppers – fixed	Cueva Fungicide Ready-To-Use	W Neudorff GmbH KG	Restricted
Coppers – fixed	DuPont™ Kocide® 2000 Fungicide/Bactericide	E. I. duPont de Nemours and Company	Restricted
Coppers – fixed	DuPont™ Kocide® 3000 Fungicide/Bactericide	E. I. duPont de Nemours and Company	Restricted
Coppers – fixed	Lilly Miller® Cueva™ Copper Soap Fungicide (Ready to Use)	Lilly Miller Brands	Restricted
Coppers – fixed	Nordox® 75 WG	Nordox AS	Restricted
Coppers – fixed	NuCop® 50WP	Albaugh, Inc.	Restricted
Corn Gluten	Bio-Herb	Biofix Holding, Inc.	Restricted
Diatomaceous Earth	Chemfree Insectigone® Ant Killer	Woodstream Corporation	Restricted
Diatomaceous Earth	Chemfree Insectigone® Crawling Insect Killer	Woodstream Corporation	Restricted
Diatomaceous Earth	Concern® Diatomaceous Earth Crawling Insect Killer	Woodstream Corporation	Restricted
Diatomaceous Earth	Insecta-Kill	Biofix Holding, Inc.	Restricted
Diatomaceous Earth	Insecto An Insecticide For Control of Grain Insects and House Insects	Natural Insecto Products	Restricted
Diatomaceous Earth	MotherEarth™ D Pest Control Dust	Whitmire Micro-Gen Research Laboratories, Inc.	Restricted
Diatomaceous Earth	Safer® Brand Ant & Crawling Insect Killer	Woodstream Corporation	Restricted
D-limonene	Orange Guard®	Orange Guard, Inc.	Restricted
Essential Oils	Bare Skin Barrier	Natures Balance Care, LLC	Allowed
Ferric Phosphate	First Choice® Sluggo® Snail and Slug Bait	Western Farm Service, Inc.	Restricted
Ferric Phosphate	Garden Safe® Slug & Snail Bait	Schultz® Company	Restricted
Ferric Phosphate	Scott's® EcoSense Slug and Snail Bait	Scotts Canada Ltd.	Restricted
Ferric Phosphate	Sluggo®	Lawn and Garden Products, Inc.	Restricted
Ferric Phosphate	Sluggo® Slug & Snail Bait	Omex Agriculture, Inc.	Restricted
Ferric Phosphate	Sluggo® Slug & Snail Bait	W Neudorff GmbH KG	Restricted
Ferric Phosphate	Sluggo®-AG	Lawn and Garden Products, Inc.	Restricted
Fungicides – nonsynthetic	Bionatrol - M®	Compactagro	Restricted
Fungicides – nonsynthetic	Contans® WG	Sylvan Bioproducts, Inc.	Restricted
Fungicides – nonsynthetic	Mycostop® Biofungicide	Verdera Oy	Restricted
Fungicides – nonsynthetic	Mycostop® Mix	Verdera Oy	Restricted
Fungicides – nonsynthetic	SoilGard® 12G	Certis USA	Restricted
Fungicides – nonsynthetic	SPORAN® EC	EcoSMART Technologies, Inc.	Restricted
Fungicides – nonsynthetic	SPORATEC™ AG	ClawEl Specialty Products a Division of Brandt Consolidated, Inc.	Restricted
Garlic	Bio Crack® + Plus	Berni Labs. S. de R.L. Microindustrial	Restricted
Garlic	BioRepel™	JH Biotech, Inc.	Restricted

Category	Product Name	Company	Status
Garlic	CropGuard EC™	American Biodynamics	Restricted
Garlic	Garlic Barrier AG+	Garlic Research Labs	Restricted
Garlic	Garlic Shield®	Grotek, Inc.	Restricted
Garlic	Lawn & Turf Fungicide	Garlic GP Ltd. Co.	Restricted
Garlic	Organic BioLink® Buffer & Penetrant	Westbridge	Restricted
Garlic	Organic BioLink® Insect Repellant	Westbridge	Restricted
Garlic	Ornamental Fungicide	Garlic GP Ltd. Co.	Restricted
Garlic	Repeller	Natural Resources Group	Allowed
Garlic	Rose Fungicide	Garlic GP Ltd. Co.	Restricted
Garlic	Tecnocidal Allicin	Aromaticos Quimicos Potosinos, S.A. de C.V. (Grupo Tecnaal)	Restricted
Garlic	Vegetable & Garden Fungicide	Garlic GP Ltd. Co.	Restricted
Gibberellic Acid	GA3 20% Plant Growth Regulator Soluble Powder	LT Biosyn, Inc.	Restricted
Herbicides – nonsynthetic	Blackberry & Brush Block (with batch number that begins with 'OP')	Greenergy, Inc.	Restricted
Herbicides – nonsynthetic	MATRAN® EC	EcoSMART Technologies, Inc.	Restricted
Herbicides – nonsynthetic	MATRATEC™ AG	ClawEl Specialty Products a Division of Brandt Consolidated, Inc.	Restricted
Herbicides – nonsynthetic	Weed Zap™	JH Biotech, Inc.	Restricted
Hydrogen Peroxide	Di-Oxy Solv Organic™ Broad Spectrum Algaecide / Bactericide / Fungicide	Flo-Tec, Inc.	Restricted
Hydrogen Peroxide	OxiDate Broad Spectrum Bactericide / Fungicide	BioSafe Systems	Restricted
Hydrogen Peroxide	StorOX®	BioSafe Systems	Restricted
Iodine	IoGold™ Recharge	IoGold Systems, Inc.	Restricted
Lime sulfur	Rex Lime Sulfur Solution	OR-Cal, Inc.	Restricted
Limonene	Concern® Citrus Home Pest Control™	Woodstream Corporation	Restricted
Limonene	GreenMatch O™ Burndown Herbicide	Cutting Edge Formulations, Inc.	Restricted
Limonene	Nature's Avenger® Organic Herbicide Concentrate	Cutting Edge Formulations, Inc.	Restricted
Limonene	Nature's Avenger® Ready To Use (RTU) Organic Herbicide	Cutting Edge Formulations, Inc.	Restricted
Limonene	Orange Guard® Ornamental Plants	Orange Guard, Inc.	Restricted
Limonene	Safer® Brand Fire Ant Killer	Woodstream Corporation	Restricted
Microbial Products – allowed	Actinovate® AG	Natural Industries, Inc.	Restricted
Microbial Products – allowed	Actinovate® SP	Natural Industries, Inc.	Restricted
Microbial Products – allowed	Ballad® Plus Biofungicide	AgraQuest, Inc.	Restricted
Microbial Products – allowed	Rhapsody®	AgraQuest, Inc.	Restricted
Microbial Products – allowed	Serenade® A Wettable Powder Biofungicide	AgraQuest, Inc.	Restricted
Microbial Products – allowed	Serenade® ASO	AgraQuest, Inc.	Restricted
Microbial Products – allowed	Serenade® Garden Disease Control Concentrate	AgraQuest, Inc.	Restricted
Microbial Products – allowed	Serenade® Garden Disease Control Ready to Use	AgraQuest, Inc.	Restricted
Microbial Products – allowed	Serenade® Garden Lawn Disease Control	AgraQuest, Inc.	Restricted
Microbial Products – allowed	Serenade® MAX™	AgraQuest, Inc.	Restricted
Microbial Products – allowed	Sonata®	AgraQuest, Inc.	Restricted
Mined Minerals – unprocessed	C-M PowderGard®	ACM-Texas, LLC	Allowed
Mined Minerals – unprocessed	Garden-Ville Organic Insecticide	ACM-Texas, LLC	Restricted
Mined Minerals – unprocessed	Surround® WP Crop Protectant	Engelhard Corp.	Restricted
Mulch – synthetic	Brite'Nup	Pacific Coating Technologies, Inc.	Restricted
Neem Extract and Derivatives	Agroneem Plus®	Agro Logistic Systems, Inc.	Restricted
Neem Extract and Derivatives	Agroneem®	Agro Logistic Systems, Inc.	Restricted
Neem Extract and Derivatives	AZA-Direct™	Gowan Co.	Restricted
Neem Extract and Derivatives	Azatrol®	PBI/Gordon Corp.	Restricted
Neem Extract and Derivatives	Concern® Garden Defense Multi-Purpose Spray Concentrate	Woodstream Corporation	Restricted
Neem Extract and Derivatives	Concern® Insect Killing Soap, Derived from Neem, Concentrate	Woodstream Corporation	Restricted
Neem Extract and Derivatives	Concern® Insect Killing Soap, Derived from Neem, Ready to Use	Woodstream Corporation	Restricted
Neem Extract and Derivatives	Garden Safe® Fungicide 3-in-1	Schultz® Company	Restricted
Neem Extract and Derivatives	Garden Safe® Fungicide 3-in-1 Concentrate	Schultz® Company	Restricted
Neem Extract and Derivatives	Green Light® Neem Concentrate	Green Light Company	Restricted
Neem Extract and Derivatives	Green Light® Rose Defense® Concentrate	Green Light Company	Restricted
Neem Extract and Derivatives	Green Light® Rose Defense® Ready-to-Use	Green Light Company	Restricted
Neem Extract and Derivatives	Meen Insect Growth Regulator	Certis USA	Restricted
Neem Extract and Derivatives	Monterey 70% Neem Oil	Lawn and Garden Products, Inc.	Restricted
Neem Extract and Derivatives	Neem Oil RTU	Certis USA	Restricted
Neem Extract and Derivatives	NeemGard®	Certis USA	Restricted
Neem Extract and Derivatives	Neemix® 4.5	Certis USA	Restricted
Neem Extract and Derivatives	Organica® K+ Neem® Insecticidal - Fungicide Ready To Use	Organica BioTech, Inc.	Restricted
Neem Extract and Derivatives	Organica® K+ Neem® Insecticide - Fungicide	Organica BioTech, Inc.	Restricted
Neem Extract and Derivatives	Safer® Brand 3 in 1 Garden Spray Concentrate	Woodstream Corporation	Restricted
Neem Extract and Derivatives	Tecnoneem	Aromaticos Quimicos Potosinos, S.A. de C.V. (Grupo Tecnaal)	Restricted
Neem Extract and Derivatives	Triact® 70 EC	Certis USA	Restricted
Neem Extract and Derivatives	Trilogy®	Certis USA	Restricted
Nematicides – nonsynthetic	Dragonfire-CPP™	Poulenger USA, Inc.	Restricted
Nematicides – nonsynthetic	Ontrol™	Poulenger USA, Inc.	Restricted
Oils – nonsynthetic sources	Concern® Pesticidal Spray Oil	Woodstream Corporation	Restricted
Oils – nonsynthetic sources	ECO E-RASE™	IJO Products, LLC	Restricted
Oils – nonsynthetic sources	E-Rase™ Concentrate Powdery Mildew Control	Lawn and Garden Products, Inc.	Restricted
Oils – nonsynthetic sources	GC-3™	JH Biotech, Inc.	Restricted
Oils – nonsynthetic sources	GC-Mite™	JH Biotech, Inc.	Restricted
Oils – nonsynthetic sources	Golden Pest Spray Oil™	Stoller Enterprises, Inc.	Allowed
Oils – nonsynthetic sources	Green Cypress Organic Spreader	Monterey AgResources	Restricted
Oils – nonsynthetic sources	Lilly Miller® Vegol™ Year-Round Pesticidal Oil	Lilly Miller Brands	Restricted
Oils – nonsynthetic sources	Trendcide	Agri-Trend, LLC	Restricted
Oils – nonsynthetic sources	Vegol™ Insecticidal Oil	W Neudorff GmbH KG	Restricted
Oils, Petroleum-Based – narrow range	BVA Spray 10	BVA, Inc.	Restricted
Oils, Petroleum-Based – narrow range	BVA Spray 13	BVA, Inc.	Restricted
Oils, Petroleum-Based – narrow range	Organic JMS Stylet-Oil®	JMS Flower Farms, Inc.	Restricted
Oils, Petroleum-Based – narrow range	PureSpray™ Green	Petro Canada	Restricted
Oils, Petroleum-Based – narrow range	Sparrow 888 Plus®	Sparrow Oilz P., Ltd.	Restricted
Parasiticides – nonsynthetic, external	Equicite Fly, Flea & Tick Control	ACM-Texas, LLC	Allowed
Pheromones	CheckMate® CM	Suterra, LLC	Restricted
Pheromones	CheckMate® CM-OFM Duel	Suterra, LLC	Restricted
Pheromones	CheckMate® CM-WS	Suterra, LLC	Restricted
Pheromones	CheckMate® CM-XL 1000	Suterra, LLC	Restricted
Pheromones	CheckMate® OFM Dispenser	Suterra, LLC	Restricted
Pheromones	CheckMate® OFM-SL	Suterra, LLC	Restricted
Pheromones	CheckMate® OLR	Suterra, LLC	Restricted
Pheromones	CheckMate® PTB-XL Dispenser	Suterra, LLC	Restricted
Pheromones	CheckMate® SF Dispenser	Suterra, LLC	Restricted
Pheromones	CheckMate® TPW	Suterra, LLC	Restricted
Pheromones	EXOSEX- CM®	Exosect Limited	Restricted
Pheromones	EXOSEX- OFM®	Exosect Limited	Restricted
Pheromones	Isomate® - C Plus	Pacific Biocontrol Corp.	Restricted
Pheromones	Isomate® - C TT	Pacific Biocontrol Corp.	Restricted
Pheromones	Isomate® - M 100	Pacific Biocontrol Corp.	Restricted
Pheromones	Isomate® - M Rosso	Pacific Biocontrol Corp.	Restricted
Pheromones	Isomate® - OFM TT	Pacific Biocontrol Corp.	Restricted
Pheromones	Isomate® - OmLR	Pacific Biocontrol Corp.	Restricted
Pheromones	NoMate® CM-O Spiral	Scentry Biologicals, Inc.	Restricted

Category	Product Name	Company	Status
Pheromones	PB-Rope L	Pacific Biocontrol Corp.	Restricted
Pheromones	Red Scale Down™	HBB Partnership	Restricted
Plant Extracts	Comcat®	AgraForum AG	Allowed
plant extracts	Tecnocitric	Aromaticos Quimicos Potosinos, S.A. de C.V. (Grupo Tecnaal)	Restricted
Plant Pesticides	Ant Out™	JH Biotech, Inc.	Restricted
Plant Pesticides	Cedar Gard	Natural Resources Group	Restricted
Plant Pesticides	Cinnamon Extract Tecnocinna	Aromaticos Quimicos Potosinos, S.A. de C.V. (Grupo Tecnaal)	Restricted
Plant Pesticides	ECOTEC™ AG	ClawEl Specialty Products a Division of Brandt Consolidated, Inc.	Restricted
Plant Pesticides	ECOTROL® EC	EcoSMART Technologies, Inc.	Restricted
Plant Pesticides	EcoTROL® G	EcoSMART Technologies, Inc.	Restricted
Plant Pesticides	Green Light Bioganic® Home & Garden Insect Spray	Green Light Company	Restricted
Plant Pesticides	Green Light Bioganic® Lawn & Garden Spray Multi-Insect Killer	Green Light Company	Restricted
Plant Pesticides	Green Light Bioganic® Organic Insect Control Concentrate	Green Light Company	Restricted
Plant Pesticides	Green Light Organic Rose & Flower Spray	Green Light Company	Restricted
Plant Pesticides	Green Light Organic Rose & Flower Spray Ready to Use	Green Light Company	Restricted
Plant Pesticides	Mildew Cure™	JH Biotech, Inc.	Restricted
Plant Pesticides	No Moss™	JH Biotech, Inc.	Restricted
Plant Pesticides	Nutrastick - Plus	Gassin Pierre PVT. LTD.	Restricted
Plant Pesticides	Organic BioLink® Insecticide	Westbridge	Restricted
Plant Pesticides	Pest Out™	JH Biotech, Inc.	Restricted
Plant Pesticides	Phyta-Guard™ Citronella Natural Insecticide/Repellent Oil	California Organic Fertilizers	Restricted
Plant Pesticides	Phyta-Guard™ Concentrate Liquid Natural Repellent Oil	California Organic Fertilizers	Restricted
Plant Pesticides	Phyta-Guard™ EC Fungicide/Insecticide Natural Insecticide/Repellent Oil	California Organic Fertilizers	Restricted
Plant Pesticides	Phyta-Guard™ Phyta-Oil Garlic & Citronella Natural Insecticide/Repellent Oil	California Organic Fertilizers	Restricted
Plant Pesticides	Phyta-Guard™ Phyta-Oil Garlic Natural Insecticide/Repellent Oil	California Organic Fertilizers	Restricted
Plant Pesticides	Phyta-Guard™ Phyta-Oil Natural Insecticide Oil	California Organic Fertilizers	Restricted
Potassium Bicarbonate	Bi-Carb Old Fashioned Fungicide	Lawn and Garden Products, Inc.	Restricted
Potassium Bicarbonate	Kaligreen® Potassium Bicarbonate Soluble Powder	Otsuka Chemical Co., LTD	Restricted
Potassium Bicarbonate	MilStop™ Broad Spectrum Foliar Fungicide	BioWorks, Inc.	Restricted
Pseudomonas	Bio-Save® 10 LP	JET Harvest Solutions	Allowed
Pseudomonas	Blight Ban® A506	NuFarm Americas, Inc.	Restricted
Pyrethrum	PyGanic® Crop Protection EC 1.4 II	MGK Co.	Restricted
Pyrethrum	PyGanic® Crop Protection EC 1.4 II	MGK Co.	Allowed
Pyrethrum	PyGanic® Crop Protection EC 5.0 II	MGK Co.	Restricted
Pyrethrum	PyGanic® Crop Protection EC 5.0 II	MGK Co.	Allowed
Pyrethrum	PyGanic® Pro	MGK Co.	Allowed
Pyrethrum	PyGanic® Pro	MGK Co.	Restricted
Pyrethrum	Safer® Brand Yard & Garden Insect Killer Concentrate II	Woodstream Corporation	Restricted
Pyrethrum	Safer® Brand Yard & Garden Insect Killer II	Woodstream Corporation	Restricted
Repellents, Vertebrate Animal – nonsynthetic	Deer Away® Deer & Rabbit Repellent II	Woodstream Corporation	Allowed
Repellents, Vertebrate Animal – nonsynthetic	Deer Stopper® Concentrate	Messina Wildlife Management	Allowed
Repellents, Vertebrate Animal – nonsynthetic	Deer Stopper® Ready To Use	Messina Wildlife Management	Allowed
Repellents, Vertebrate Animal – nonsynthetic	Havahart® Critter Ridder®	Woodstream Corporation	Allowed
Repellents, Vertebrate Animal – nonsynthetic	Havahart® Critter Ridder® Concentrate	Woodstream Corporation	Allowed
Repellents, Vertebrate Animal – nonsynthetic	Havahart® Critter Ridder® Ready to Use Spray	Woodstream Corporation	Allowed
Repellents, Vertebrate Animal – nonsynthetic	Havahart® Deer Away® Deer & Rabbit Concentrate	Woodstream Corporation	Allowed
Repellents, Vertebrate Animal – nonsynthetic	Plantskydd® Repellent Deer • Rabbits• Elk Soluble Powder Concentrate	Tree World Plant Care Products, Inc dba Tree World®	Allowed
Repellents, Vertebrate Animal – nonsynthetic	Plotsaver™ Liquid Deer Repellent	Messina Wildlife Management	Allowed
Soap	Moss-Aside™	W Neudorff GmbH KG	Restricted
Soap	M-Pede®	Dow Agrosciences, LLC	Restricted
Soap	Neudorff's Insecticidal Soap Concentrate	W Neudorff GmbH KG	Restricted
Soap	Neudorff's Insecticidal Soap Ready-to-Use	W Neudorff GmbH KG	Restricted
Soap	Safer® Brand 3 in 1 Concentrate II	Woodstream Corporation	Restricted
Soap	Safer® Brand 3 in 1 Garden Spray II	Woodstream Corporation	Restricted
Soap	Safer® Brand Fast Acting Weed & Grass Killer	Woodstream Corporation	Restricted
Soap	Safer® Brand Fruit & Vegetable Insect Killer II	Woodstream Corporation	Restricted
Soap	Safer® Brand Houseplant Insect Killing Soap Concentrate II	Woodstream Corporation	Restricted
Soap	Safer® Brand Houseplant Insect Killing Soap II	Woodstream Corporation	Restricted
Soap	Safer® Brand Insect Killing Soap Concentrate II	Woodstream Corporation	Restricted
Soap	Safer® Brand Insect Killing Soap with Seaweed Extract II	Woodstream Corporation	Restricted
Soap	Safer® Brand Moss & Algae Killer & Surface Cleaner Ready to Spray II	Woodstream Corporation	Restricted
Soap	Safer® Brand Moss & Algae Killer & Surface Cleaner Ready to Use II	Woodstream Corporation	Restricted
Soap	Safer® Brand Rose & Flower Insect Killer II	Woodstream Corporation	Restricted
Soap	Safer® Brand Tomato & Vegetable Insect Killer II	Woodstream Corporation	Restricted
Soap	Safer's® Insecticidal Soap	Woodstream Canada Corporation	Restricted
Soap	Safer's® Insecticidal Soap Concentrate	Woodstream Canada Corporation	Restricted
Soap	Safer's® Insecticidal Soap Ready to Use	Woodstream Canada Corporation	Restricted
Soap	Safer's® Rose & Flower Insecticide Ready to Use	Woodstream Canada Corporation	Restricted
Spinosad	Conserve™ Fire Ant Bait	Dow Agrosciences, LLC	Restricted
Spinosad	Conserve™ Professional Fire Ant Bait	Dow Agrosciences, LLC	Restricted
Spinosad	Entrust™	Dow Agrosciences, LLC	Restricted
Spinosad	GF-120 NF Naturalyte™ Fruit Fly Bait	Dow Agrosciences, LLC	Restricted
Spinosad	Green Light® Fire Ant Control With Conserve®	Green Light Company	Restricted
Spinosad	Green Light® Lawn & Garden Spray Spinosad®	Green Light Company	Restricted
Spinosad	Justice™ Fire Ant Bait	Dow Agrosciences, LLC	Restricted
Spinosad	Monterey Garden Insect Spray	Lawn and Garden Products, Inc.	Restricted
Spinosad	Safer® Brand Fire Ant Bait Ready to Use	Woodstream Corporation	Restricted
Spinosad	Spinosad 0.5% SC	Dow Agrosciences, LLC	Restricted
Sticky Traps and Barriers	Stikem Special	Seabright Laboratories	Restricted
Sticky Traps and Barriers	Tangle-Trap® Insect Trap Coating	The Tanglefoot Co.	Restricted
Sticky Traps and Barriers	Tree Tanglefoot Pest Barrier™	The Tanglefoot Co.	Restricted
Streptomycin Sulfate	Agri-Mycin® 17 Agricultural Streptomycin	NuFarm Americas, Inc.	Restricted
Streptomycin Sulfate	Firewall™ Fungicide/Bactericide	Cerexagri-Nisso, LLC	Restricted
Sulfur – elemental	Ben-Sul 85	Wilbur-Ellis Company	Restricted
Sulfur – elemental	Britz Bt 25 Sulfur Dust	Britz Fertilizers, Inc.	Restricted
Sulfur – elemental	Britz Dryout Dust	Britz Fertilizers, Inc.	Restricted
Sulfur – elemental	Britz Magic Sulfur Dust	Britz Fertilizers, Inc.	Restricted
Sulfur – elemental	BT 320 Sulfur 25 Dust	Wilbur-Ellis Company	Restricted
Sulfur – elemental	Cosavet DF	Sulphur Mills, Ltd.	Restricted
Sulfur – elemental	CSC 80% Thiosperse	Martin Operating Partnership, L.P.	Restricted
Sulfur – elemental	CSC Dusting Sulfur	Martin Operating Partnership, L.P.	Restricted
Sulfur – elemental	Dusting Sulfur Fungicide-Insecticide	Loveland Products, Inc.	Restricted
Sulfur – elemental	IAP Dusting Sulfur	Independent Agribusiness Professionals	Restricted
Sulfur – elemental	INTEGRO MAGNETIC SULFUR DUST	InteGro, Inc.	Restricted
Sulfur – elemental	Kumulus DF	Micro Flo Co.	Restricted
Sulfur – elemental	Micro Sulf®	NuFarm Americas, Inc.	Restricted
Sulfur – elemental	ProNatural® Micronized Sulfur	Wilbur-Ellis Company	Restricted
Sulfur – elemental	Safer® Brand Garden Fungicide II	Woodstream Corporation	Restricted
Sulfur – elemental	Signal™ Dusting Sulfur	Wilbur-Ellis Company	Restricted
Sulfur – elemental	Special Electric®	Wilbur-Ellis Company	Restricted
Sulfur – elemental	Sulfur DF	Wilbur-Ellis Company	Restricted
Sulfur – elemental	Thiolux® Jet	Syngenta Crop Protection	Restricted

Category	Product Name	Company	Status
Sulfur – elemental	Wilbur-Ellis Dusting Sulfur	Wilbur-Ellis Company	Restricted
Tetracycline	Mycoshield® Fungicide	NuFarm Americas, Inc.	Restricted
Trichoderma spp.	Plant Shield® HC Biological Foliar and Root Fungicide	BioWorks, Inc.	Restricted
Trichoderma spp.	RootShield® Granules	BioWorks, Inc.	Restricted
Trichoderma spp.	T-22™ HC	BioWorks, Inc.	Restricted
Trichoderma spp.	T-22™ Planter Box	BioWorks, Inc.	Restricted
Virus Sprays	CLV LC	Certis USA	Allowed
Virus Sprays	CYD-X®	Certis USA	Allowed
Virus Sprays	Gemstar® LC	Certis USA	Allowed
Virus Sprays	Spod-X® LC	Certis USA	Allowed
Virus Sprays	Virosoft CP4	Biotepp, Inc.	Allowed
Yucca	Tecno-nina	Aromaticos Quimicos Potosinos, S.A. de C.V. (Grupo Tecnaal)	Restricted

Appendix 3. Table 2 Pesticide Products Approved for Use in Organic Farming and Widely Used Conventional Pesticide Alternatives: Acute and Chronic Mammalian Toxicity and Environmental Impact Units (EIUs)

Organic pesticide	Conventional alternative	Trade Name	LD50	cPAD	aPAD	PEAS EIU	EIU Crop
Bacillus thuringiensis		Xentari, Dipel	5000	0.1	0.1	0.04	Peach
	Azinphos-methyl	Guthion	16	0.00149	0.003	209.97	Peach
	Endosulfan	Thiodan	80	0.00006	0.0015	93.29	Peach
	Thiamethoxam	Platinum	1453	0.0006		0.09	Strawberry
	AVERAGE CONVENTIONAL		**516.3**	**0.00071667**	**0.00225**	**101.12**	
Bacillus subtilus		Serenade, Rhapsody	5000	0.1	0.1	0.16	Grape
	Azoxystrobin	Abound	5000	0.18	0.67	0.17	Grape
	Zoxamide	Gavel	5000	0.48		NA	
	Captan	Captan	5000	0.13	0.1	2.3	Grape
	AVERAGE CONVENTIONAL		**5000**	**0.26**	**0.385**	**1.235**	
Spinosad		Entrust	3738	0.268		100.14	Snap bean, proc
	Cypermethrin	Ammo, Cymbush	86	0.01		13.92	Snap bean, proc
	Methomyl	Lannate	17	0.008	0.02	57.02	Snap bean, proc
	AVERAGE CONVENTIONAL		**51.5**	**0.009**	**0.02**	**35.47**	
Beauveria bassiana		Mycotrol, Naturalis	5000	0.1	0.1	<1.0	Grape
	Chlorpyrifos	Lorsban	135	0.00003	0.0005	270.82	Grape
	Imidacloprid	Admire	450	0.019	0.14	1.94	Grape
	AVERAGE CONVENTIONAL		**292.5**	**0.0095**	**0.07**	**136.38**	
Pheromones		Multiple products	5000	0.1	0.1	0.0001	Peach
	Pyriproxyfen	Esteem	5000	0.35		0.03	Peach
	Methoxyfenozide	Intrepid	5000	0.1		0.35	Peach
	AVERAGE CONVENTIONAL		**5000**	**0.225**		**0.19**	
Pyrethrum		Pyganic, Safer	500	0.064		3.27	Grape
	Dimethoate	Dygon	150	0.0005	0.02	19.92	Grape
	Carbofuran	Furadan	8	0.005		174.31	Grape
	AVERAGE CONVENTIONAL		**79**	**0.00275**	**0.02**	**97.1**	
Rotenone		Rotenone	1620	0.004		0.11	Strawberry
	Acephate	Orthene	945	0.0012	0.005	122.08	Snap bean, proc
	Chlorpyrifos	Lorsban	135	0.00003	0.0005	191.9	Strawberry
	AVERAGE CONVENTIONAL		**540**	**0.0006**	**0.00275**	**156.99**	
Azadirachtin (neem)		AZA-direct, Neemix	5000	0.1		0.07	Grape
	Carbaryl	Sevin	300	0.014		17.62	Grape
	Phosmet	Imidan	113	0.011	0.045	70.88	Grape
	AVERAGE CONVENTIONAL		**206.5**	**0.0125**	**0.045**	**44.25**	
Copper products		Champion	1000	0.1		5.54	Tomato
	Chlorothalonil	Bravo	5000	0.2		2.83	Tomato
	Mancozeb	Manzate	5000	0.003		0.7	Tomato
	AVERAGE CONVENTIONAL		**5000**	**0.1015**		**1.765**	
Bicarbonate (K and Na)		Kaligreen	3358	0.1		0.45	Grape
	Maneb	Manex	5000	0.005		1.51	Grape
	Metam sodium	Vapam	285	0.01		1.99	Grape
	AVERAGE CONVENTIONAL		**2643**	**0.0075**		**1.75**	
Sulfur products		Multiple products	3000	0.1		2.94	Grape
	Maneb	Manex	5000	0.005		1.51	Grape
	Captan	Captan	5000	0.13	0.1	2.3	Grape
	AVERAGE CONVENTIONAL		**5000**	**0.0675**	**0.1**	**1.905**	
Kaolin clay		Surround	5000	0.1		1.87	Tomato
	Methomyl	Lannate	17	0.008	0.02	8.85	Tomato
	Esfenvalerate	Asana	67	0.02		17	Tomato
	AVERAGE CONVENTIONAL		**42**	**0.014**	**0.02**	**12.925**	
Petroleum oils		JMS Stylet, Purespray	5000	0.1		8.96	Winter squash
	Malathion	Fyfanon, Malixol	2100	0.02	0.5	59.06	Winter squash
	Bifenthrin	Capture, Brigade	55	0.015	0.01	33.23	Winter squash
	AVERAGE CONVENTIONAL		**1078**	**0.0175**	**0.255**	**46.145**	
Soaps		M-Pede	5000	0.1		0.33	Grape

Organic pesticide / Conventional alternative	Trade Name	LD50	cPAD	aPAD	PEAS EIU	EIU Crop
Permethrin	Pounce, Ambush	500	0.05		6.89	Pear
Lambda-cyhalothrin	Karate	56	0.001	0.0025	7.6	Pear
AVERAGE CONVENTIONAL		**278**	**0.0255**	**0.0025**	**7.245**	

NOTES:

1. LD50 s are measured in mg/kg of bodyweight and are the dose at which 50% of the experimental animals die after exposure to a chemical. The smaller the number, the more toxic the pesticide.

2. cPAD is the Chronic Population Adjusted Dose set by the U.S. Environmental Protection Agency. cPAD equals the chronic "Reference Dose" (RfD) for a chemical divided by any applicable additional safety factor triggered by the Food Quality Protection Act's 10-X provision.

3. aPAD is the Acute Population Adjusted Dose set by the U.S. EPA.

4. EIU is the acronym for Environmental Impact Units derived from the Pesticide Environmental Assessment System (PEAS). EIUs are based on acute and chronic mammalian exposure and toxicity, and risks to birds, daphnia and honeybees. EIUs reflect relative risk associated with a given pesticide use rate and use pattern. The higher the EIU, the greater the potential for adverse impacts on non-target organisms.

5. cPADs and aPADs for microbial and biological pesticides approved for organic production have not been set by the U.S. EPA because of the granting of exemptions from the requirement for tolerances. A default value of 0.1 is used for all untested microbial and biological pesticides approved for organic production.

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