# UPDATE: PESTICIDES IN CHILDREN'S FOODS

AN ANALYSIS OF 1998 USDA PDP DATA ON PESTICIDE RESIDUES

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# CONTENTS

| Section | Page |
| --- | --- |
| Contents | ii |
| List of Tables | iii |
| Introduction | 1 |
| Methods: Updating the CU Scoring Scheme | 3 |
| Impacts of Updated EPA Risk Assessments | 3 |
| Changes in Scoring for Endocrine Disruption | 4 |
| Summary of Effects of Revised Scoring Scheme | 6 |
| Highlights of Results of the 1998 PDP Analysis | 7 |
| 1. Scores for Individual Foods | 7 |
| 2. Imported vs. Domestic Produce | 9 |
| 3. An In-Depth Comparison: Tomatoes | 11 |
| 4. Fresh vs. Processed Foods | 12 |
| Risk Drivers | 13 |
| 1. Risk Drivers in the 1998 PDP Survey | 13 |
| 2. Odds of Exceeding a Safe Dose | 15 |
| 3. The Role of Chlorpyrifos in Dietary Risk | 19 |
| 4. Organochlorine Insecticides: A Persistent Problem | 21 |
| Recommendations | 24 |

# LIST OF TABLES

(Tables are posted as individual files on our project web site. Links here go directly to the individual tables.)


Table 1. Number of Samples of Foods Tested by the USDA Pesticide Data Program, 1994-1998.
http://www.ecologic-ipm.com/PDP/Table1_1998.pdf

Table 2. Acute Toxicity of Pesticides Detected by the USDA Pesticide Data Program, 1994-1998.
http://www.ecologic-ipm.com/PDP/Table2_1998.pdf

Table 3. Chronic Toxicity of Pesticides Detected by the USDA Pesticide Data Program, 1994-1998.
http://www.ecologic-ipm.com/PDP/Table3_1998.pdf

Table 4. Toxicity Indices for Foods Tested in the USDA Pesticide Data Program, 1994-1998.
http://www.ecologic-ipm.com/PDP/Table4_1998.pdf

Table 5. Shares of Total Toxicity Index Values Contributed by Individual Pesticides Detected on Each Food by Origin and Year, Pesticide Data Program, 1994-1998.
http://www.ecologic-ipm.com/PDP/Table5_1998.pdf

Table 6. Fresh Tomatoes, Share of TI by Pesticide, California, Florida and Imported, Pesticide Data Program 1998.
http://www.ecologic-ipm.com/PDP/Table6_1998.pdf

Table 7. Odds of Exceeding “Safe” Daily Doses for Selected Food-Pesticide Combinations Based on 1998 PDP Results.
http://www.ecologic-ipm.com/PDP/Table7_1998.pdf

Table 8. Chlorpyrifos Contributions to Dietary Risk: CU’s Toxicity Index (TI) Values and Shares by Food and Origin, Pesticide Data Program, 1994-1998.

http://www.ecologic-ipm.com/PDP/Table8_1998.pdf

Table 9. Significant Organochlorine Contributions to Dietary Risk: CU's Toxicity Index (TI) Values and Shares of Total TI, Pesticide Data Program, 1994-1998.
http://www.ecologic-ipm.com/PDP/Table9_1998.pdf

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## Introduction

This report is an update of our 1999 report, *"Do You Know What You're Eating?,"* available at http://www.ecologic-ipm.com/Do_You_Know.pdf.

In last year's report, we analyzed four years (1994-1997) of data from the US Department of Agriculture's Pesticide Data Program (PDP), assessing problems of pesticides in children's foods and comparing relative residue profiles of different foods. Using a Toxicity Index (TI) that CU invented for this purpose, based on the frequency of detection and mean residue level of each pesticide detected in a food, and on a multi-factor toxicity index for each chemical, we found very large differences in pesticide residue toxicity among foods. High scores on CU's Toxicity Index can result from multiple residues, from residues in a large fraction of samples, from high residue levels, from residues of relatively toxic pesticides, or, in most cases, from a combination of these factors.

We highlighted foods last year that consistently had either especially high TI's, meaning they were relatively heavily contaminated with pesticides, or consistently low scores, meaning they were relatively residue-free. In our 1999 report, and in an article based on it in CONSUMER REPORTS magazine, we ranked PDP-tested foods in order of their relative TI scores. We advised consumers to feed their children plenty of fresh fruits and vegetables, while showing them how to avoid excessive pesticide residue intake. And, based on our analysis of the residue profiles of foods with the high TI scores, we suggested regulatory priorities for the US Environmental Protection Agency (EPA).

This year's Update incorporates the 1998 PDP data into our analysis. The additional year's data expands our database to cover five years, and adds a number of foods not previously tested by the PDP to the list ranked by TI scores. New foods fall in both the high-scoring and low-scoring groups. This year, as last year, we compared TI's for imported and domestically grown samples of foods for which imports are an important part of the market. Within that analysis this year, we have taken a detailed look at the tomato market, breaking it down into imports (Mexico) and U.S. samples from the two major tomato-growing regions, California and Florida.

Last year's report identified 15 specific pesticides that repeatedly accounted for a large share of the TI score for particular foods. We called those high-risk chemicals "risk drivers." This year's report contains four ways to place risk-driving residues and pesticides into perspective. First, we look at the 1998 data and highlight residues in individual foods that account for a significant share of the higher TIs. We then look at those residues that pose a risk of giving a young child more than what the EPA defines as a "safe dose" of one of the more toxic pesticides, as either an acute (one-time) or chronic (repeated) exposure. We next examine chlorpyrifos, the most widely-used organophosphate insecticide in the U.S., describing the role it plays in dietary pesticide exposure and risk. Our final analysis looks at residues of chlorinated hydrocarbon insecticides (dieldrin, heptachlor, etc.). Although most agricultural uses of this pesticide family were banned in the 1970s, residues persist in soils, and they can be taken up through the roots by certain crops, leading to dietary residue problems.

In the year since our last report, we have reviewed and updated our scoring scheme (see Methods section, below). Changes reflect both new toxicity assessments for specific chemicals, published by the EPA in the past year, and our own reassessment of certain aspects of our scoring scheme, in part in response to comments we received after we published last year's report. The revisions have changed the Toxicity Indices for individual pesticides, which in turn changes the TI scores for foods found by the PDP to contain residues of those pesticides.

Since the scoring scheme has changed, TI values for 1998 PDP foods cannot be compared directly with the TI scores we published last year for 1994-97 PDP foods. To do those comparisons, we have re-calculated the scores for 1994-97 PDP foods, using our revised TI values for individual pesticides.

The scores for most foods have changed slightly from the scores published last year; in a few cases the absolute TI score for a food changed markedly. But in virtually all cases, the changes did not significantly affect the *relative* scores for different foods we compared in last year's report.

## Methods: Updating the CU Scoring Scheme

Our 1999 report lays out in detail our methodology for calculating the CU "Toxicity Index" for various foods. In brief, the TI for a given food is based on frequency of detection, mean concentration and toxicity of each residue found in each food. Toxicity indices for individual pesticides are based on a scoring scheme we developed that combines several measures of acute and chronic toxicity.

For this report, we have updated our scoring scheme, in two respects:

**(1) Impacts of updated EPA risk assessments**. As the EPA reviews new toxicity data on individual pesticides under the Food Quality Protection Act (FQPA), it publishes updated risk assessments. Based on these reviews, the EPA has, for example, revised its Reference Doses (RfDs) for certain of the organophosphate insecticides. We have incorporated changes in the EPA's toxicity database into our database. **Tables 2 and 3** of this report present the basis for our Acute and Chronic Toxicity Indices for each pesticide active ingredient. These tables, updated from the comparable tables in last year's report, include the most recent EPA toxicity factors.

A change in the EPA RfD can significantly change our Chronic Toxicity Index for a pesticide. For example, within the past year, EPA has lowered the chronic RfDs for chlorpyrifos-methyl and pirimiphos-methyl 100-fold, lowered the chronic RfD for chlorpyrifos 30-fold, and lowered chronic RfDs for methamidophos, mevinphos and several other active ingredients 10-fold or more. Since the chronic RfD is a component of our toxicity index for a chemical, changes in EPA's RfD values impact our scores—affecting both the overall TI score and the relative share of the total TI attributable to these specific residues, for any food that contains these residues.

The most striking effect of revisions in EPA RfDs on scores for PDP foods involves wheat grain, tested in 1995, 1996 and 1997. In our report last year, wheat received comparatively low TI scores of 18, 29 and 32 for those three years, respectively. But the primary residue found in wheat is chlorpyrifos-methyl, which is used post-harvest, to control insect losses in stored grain. With the EPA's revision of the RfD for chlorpyrifos-methyl (lowering it 100-fold), scores for wheat shot up to 747, 894 and 777 for the three years PDP tested wheat. If wheat had had scores that high last year, we would likely have flagged chlorpyrifos-methyl residues on wheat as an important problem. Residues in stored grain may not represent residues in processed wheat foods eaten by consumers, but scores this high would certainly have led us to call for additional testing of wheat-based foods.

However, shortly after the EPA published its revised risk assessment for chlorpyrifos-methyl, its manufacturer asked the agency to voluntarily cancel this use (i.e., to remove chlorpyrifos-methyl from the market for application to stored grain). EPA and the manufacturer recognized right away that they had a potential dietary exposure problem, given the revised risk assessment, and they took swift action to resolve that problem.

Changes in other EPA RfDs affected our previously-published scores for several other foods, though less dramatically than was the case for wheat. Foods in which chlorpyrifos residues were frequently detected generally have higher scores with our recalculated TIs; this is especially notable for apples from New Zealand and tomatoes from Mexico, for example. Foods that contained frequent methamidophos residues, such as U.S.-grown fresh green beans and tomatoes, saw their scores increase as well. A changed TI for mevinphos tripled the score for Mexican broccoli (1994). However, the impacts of new EPA RfDs on scores for most foods were modest, and did little to change the overall picture revealed in our 1999 analysis.

**(2) Changes in scoring for endocrine disruption**. We made an additional change in our scoring scheme based on a routine review of our methods, in which we considered, among other things, comments received from various analysts in response to our 1999 report. Our Toxicity Index incorporates several dimensions of a chemical's toxicity. It combines an index of acute toxicity, based on the $LD_{50}$, and an index of chronic toxicity, based on multiple parameters. For last year's report, we used a chronic toxicity index that included four factors. The first factor was derived from the EPA RfD, a general measure of chronic toxicity. Two factors addressed carcinogenicity: one based on the quantity and quality of evidence, as reflected in the EPA's carcinogen classification for the chemical, and one based on carcinogenic potency, reflected in the EPA's $Q_1$* value. Finally, we included a factor for endocrine disruption. Pesticides identified as potential endocrine disrupters by Colborn et al. in a ground-breaking 1993 paper (cited in our 1999 report), based on observed effects in wildlife, received an additional factor of three in the RfD component of our 1999 scoring scheme.

We published our detailed methodology in our 1999 report, seeking critical comments from other analysts. Several comments suggested that the current scientific basis for classifying chemicals as endocrine disrupters is relatively weak, and some analysts questioned whether inclusion of this factor in our scoring scheme was fully justified. We agree that there is far less scientific support for a consensus over whether a chemical is likely to have endocrine effects in humans than there is for other components of our chronic toxicity index. While we believe endocrine effects of pesticides are important and deserve to be reflected in any overall toxicity index, we decided to remove the endocrine disruption factor from our scoring system this year. We will consider restoring it in the future, when the scientific community has had more time to develop a consensus approach to identifying, and ranking the relative potency of, hormonally active agents. For now, we are content to compare the relative risks of pesticide residues without including this aspect of toxicity.

Removing the ED factor from our chronic toxicity index reduces a primary component of the chronic TI for any chemical we had classed as an ED, to one-third of its previous value. Since our overall chronic TI for a chemical is the sum of a carcinogenicity component and an RfD/ED component, the effect of removing the ED factor varies. It reduces the chronic TI for a non-carcinogenic pesticide by two-thirds, but has less effect on the chronic TI for a chemical that is classed by EPA as a carcinogen. Likewise, the overall TI for a chemical in our scoring scheme is a weighted sum of chronic and acute toxicity indices (with chronic weighted twice and acute once). Removing the ED factor has a greater effect on the overall TI score for a chemical that is very toxic chronically but not very acutely toxic, and a smaller effect on a chemical with the opposite toxicity attributes.

In sum, while the impact varies from chemical to chemical, the net effect of taking out the ED component is to reduce the toxicity indices for chemicals we had classed as endocrine disrupters, and to reduce the TI scores for foods that contain residues of those chemicals. The most striking example of these effects involves scores for foods containing the organophosphate insecticide methyl parathion. The EPA RfD for methyl parathion is extremely low, and it was also listed as an endocrine disrupter by Colborn et al. Consequently, our TI for this chemical was very high, and foods that contained residues of methyl parathion had very high TI scores. Removing the ED factor from our TI for methyl parathion lowered the scores substantially for several foods.

Most notably, scores for fresh peaches were the highest for any food in our 1999 report, at 4,390, 5,376, and 4,848 for U.S.- grown peaches tested by the PDP in 1994, 1995 and 1996, respectively. Methyl parathion accounted for more than 90 percent of those total scores each year. Without the ED factor, the recalculated scores for peaches are 1,640, 2,050, and 1,773, respectively. These scores are still very high—with all scores for 1994-1997 recalculated (see **Table 4**), peaches remain one of the two foods with the highest scores (along with winter squash, which contains dieldrin residues). U.S. peaches also still have much greater TI scores than imported peaches.

Several other foods that contain methyl parathion residues and had high TI scores in our 1999 report have somewhat lower recalculated scores. They include U.S.-grown apples and pears, U.S. grapes for 1994 only, and frozen U.S. green beans (1997). However, the recalculated scores for these foods are still among the highest of the PDP-tested foods. Even with the ED factor removed, methyl parathion still has an extremely low chronic RfD, and for that reason it contributes substantially to the TI values for foods that contain it. Last August, the EPA announced a ban on uses of methyl parathion on most foods that the PDP data showed have residue problems, a testament to both the chemical's high toxicity the agency's justified decision to make it a priority for risk-reducing tolerance revisions.

In most other cases, removing the ED factor had only modest effects on the relative scores for different foods, because individual pesticides account for only part of the overall TI for any given food.

**Summary of effects of revised scoring scheme.** The combined effects of all the changes in our scoring scheme produced few substantive changes in the results of prior years' analyses. Some changes for individual chemicals (e.g. a lower EPA RfD) led to an increased score, while other changes (such as removing the ED factor) led to a reduced score. Most PDP foods contain multiple pesticide residues, and the changes in our scoring scheme raised the score for some residues, and lowered the score for others. The net effect for most foods was a modest change in absolute numerical score, but there were few changes in relative scores for different foods. Except for the examples noted above, we regard the changes in scores as not very meaningful.

In summary, none of our 1999 conclusions, based on the relative scores of various foods and the roles of particular pesticides in driving the scores for specific foods, need revision. The overall picture revealed by our analysis of the 1994-97 PDP data remains essentially as we described it last year, with recalculated scores for those prior years. Foods that had high scores in last year's report still have high scores, and those that had low scores still have low scores. A few foods that had "medium" scores last year have moved up into the low end of the "high-score" group (e.g., Mexican broccoli in 1994, U.S. and Canadian carrots in 1996, U.S. potatoes in 1995 and 1996), but these changes are still modest. While the importance of some residues has increased because of revised (lower) EPA estimates of the safe dose, those chemicals were generally already on our list of "risk drivers." The revised scoring scheme has shifted the relative importance of some chemicals up or down slightly, but the list is essentially the same as it was last year.

This report, therefore, focuses primarily on highlights of our analysis of the 1998 PDP data.

## Highlights of Results of the 1998 PDP Analysis

### 1. Scores for Individual Foods

**Table 4** presents the 1998 results (along with the recalculated scores for the previous four years). **Table 5** breaks down the TI scores for each food, and shows which residues were found in each food, with what frequency, at what level, and what each residue contributes to the overall TI for the food.

The 1998 PDP survey included additional data on several foods tested in 1997 or prior years—apple juice, orange juice, milk, canned/frozen green beans, pears, canned spinach, tomatoes, winter squash, soybeans. It also included new foods, not previously tested by PDP: Strawberries (fresh and frozen), grape juice, and cantaloupe. As in each prior year, USDA tested imported and domestically grown samples of the foods in rough proportion to their share of the market. Our analysis, as for prior years, showed several foods with very low TI's, and several with high TI's. First, the good news:

Milk, and processed juices kids like to drink, had very low scores. As in past years, **milk** and **orange juice** were extremely "clean," with 1998 scores of 2 and 3, respectively. **Grape juice** can be added to that category, with scores of 2 (for U.S. product) and 1 (for imports, from Argentina.) **Apple juice** again had relatively low TI scores (from 4 to 33, for samples from 6 countries; U.S. samples scored 15), but apple juice contains five to ten times as much residue-toxicity as the other juices tested.

On the other hand, some other foods kids like to eat had high TI's. Three new foods tested this year—fresh and frozen strawberries, and cantaloupe—scored over 100, our cutoff level for calling a food high enough on the TI scale to be a concern to parents. Both U.S. and Mexican **fresh strawberries** had high scores (516, 729 respectively), putting them in the same category with apples, peaches and pears tested in prior years. Based on just this one year's data, strawberries would rank fifth, behind frozen winter squash, fresh peaches, fresh winter squash and wheat grain, among foods with the highest TI's. The high scores for strawberries reflect heavy pesticide use on this crop. The PDP found 34 different pesticides on U.S. strawberries, with the carbamate insecticide methomyl accounting for almost half the total score. Mexican strawberries had 17 different residues, among which a fungicide, anilazine, accounts for 65 percent of the overall score. **Frozen strawberries** (U.S.) had a lower score, but one still high enough to be a concern, 140.

**Cantaloupe**, the other new food tested in 1998, contained fewer residues, but one of them, dieldrin, is especially problematic. Dieldrin, a very toxic and carcinogenic insecticide whose use on crops was banned in 1974 but which persists in soils, is taken up through the roots by members of the cucurbit (melon and squash) family. Dieldrin accounted for two-thirds of the TI of 141 for cantaloupe from Mexico, and for 85 percent of the TI of 161 for U.S. cantaloupe.

As they did last year, fresh and frozen U.S.-grown **winter squash** had high and extremely high scores (732 and 3,366, respectively). As was the case last year, the high scores are attributed to residues of banned chlorinated hydrocarbon insecticides that remain in soils where the U.S. squash crop is produced—particularly, it appears, where squash destined for processing is grown. Residues of dieldrin, heptachlor and chlordane account for these high scores. Winter squash from Mexico, by contrast, seems to be grown largely on uncontaminated soils. Only one of 132 samples tested positive for dieldrin, and Mexican squash had an overall TI of just 33.

**Canned spinach** (from the U.S.) had a high score this year, at 213. The score reflects the use of insecticides on this difficult-to-grow crop, with permethrin accounting for most of the overall total.

The 1998 data for **pears** closely resemble the 1997 data, with the score for Chilean pears dropping somewhat, and the score for U.S. pears increasing, relative to (recalculated) scores from last year. Pears from Argentina had the lowest scores, but as was true last year, pears from all three countries, with TIs of 175 (Argentina), 257 (Chile) and 327 (U.S.), are on the “caution” list.

**Canned/frozen green beans** had a lower score for 1998 than for 1997, for the most part because of decreasing residues of methyl parathion. But this food remains on the “caution” list, with a 1998 score of 286, which is quite high for a processed food.

U.S. **tomatoes** scored a 116, far better than the score for Mexican tomatoes (472). Canadian tomatoes, though, had a very low TI, just 12. Scores for tomatoes (including recalculated scores for 1996 and 1997) are higher in this report than last year, reflecting the revised EPA RfD for methamidophos, the dominant risk-driving residue on the U.S. samples. Mexican tomatoes had more methamidophos than U.S. grown tomatoes, and contain chlorpyrifos, and less often, demeton-S sulfone, a metabolite of the insecticide demeton.

## 2. Imported vs. Domestic Produce

Last year, we examined 39 cases over the four years of PDP data in which we could compare a U.S.-grown food with imports from a specific country. In 26 of those comparisons (67 percent), the U.S.-grown food had the higher Toxicity Index. While the differences were often slight, our examination of actual residue data for imported and domestic produce failed to support the popular stereotype that imported foods are more likely to be contaminated. This assertion has been fed over the years by self-serving statements from some U.S. growers and “circle-of-poison” arguments from environmental activists.

The 1998 PDP data provide 15 additional direct comparisons between U.S.-grown and imported foods, bringing the five-year total to 54 cases. Among the 1998 cases, U.S. foods "won" (had the lower TI) in five cases, and U.S.-grown foods had higher TI's in eight cases. (Two cases were ties.)

Because of changes in our scoring scheme and our recalculation of past scores, there are a few cases in which imported foods that had lower scores than U.S. samples in our 1999 report now have higher scores. New Zealand apples now outscore U.S. apples for 1995 and 1996, and Chilean pears for 1997 outscore U.S. pears. These changes reflect a reduced score for methyl parathion residues in U.S. samples, attributable to our eliminating the ED factor for that insecticide, and an increased score for chlorpyrifos in the imports, due to the EPA's lowered RfD for that chemical. All three years of comparisons between Canadian and U.S. carrots have also changed. In 1999 we showed higher scores for Canadian samples in all three years, but with the changes in TIs for several residues, U.S. samples now have higher scores for 1994 and 1996, and the 1995 scores are tied.

Counting the additional cases and changes in past scores, the new totals are as follows: Of 54 cases over the five-year period, U.S.-grown foods have a higher Toxicity Index (i.e., the U.S. produce has worse residue problems) in 33 cases (61 percent), and imported foods have the higher TI in 18 cases (33 percent). Three cases (6 percent) were ties. The ratio has shifted slightly in the direction of equity; U.S. produce has higher scores less often (61 versus 67 percent of the cases) than we found last year. However, the data still fail to support the view that imported foods have worse residue problems.

In fact, the PDP data continue to show several cases, all highlighted in our report last year, in which U.S.-grown produce had higher TI scores by a very wide margin than imported samples did. These foods include fresh green beans, fresh peaches, pears, spinach, and fresh and frozen winter squash. On the other hand, there are several cases where the imports are slightly or more than slightly worse than U.S. samples, but both U.S. and imported samples had high TI values. These cases include apples, grapes, carrots, strawberries, cantaloupe and tomatoes. The difference is greatest for tomatoes in 1998.

In only one case—broccoli, tested in 1994—did U.S. samples have a very low TI score (6, as recalculated this year) while (Mexican) imports had a much greater score, 152.

Fruit juices provide some interesting comparisons. Both orange juice and grape juice have scores among the lowest received by any foods, regardless of where samples come from. In 1998 tests, grape juice from Argentina scored a 1, and U.S. samples a 2; for orange juice, the U.S., Mexico and Brazil all tied at 3. (In 1997, Brazilian orange juice had a higher score, 21.) Apple juice provided a bit more in the way of contrasts, with scores that ranged from lows of 4 and 7 (Germany and Chile), to highs of 21 and 33 (Argentina and China). U.S. samples were in the middle of the pack, at 15.

The Chinese apple juice is especially interesting. China is just beginning to penetrate the U.S. market for apple juice, and U.S. producers are feeling the competition. The U.S. industry has been abuzz with rumors that Chinese juice is loaded with residues. As this year's PDP data (on just 11 samples) suggest, however, that does not appear to be the case. While Chinese apple juice did have the worst score among the six countries from which samples were tested this year, the score (33) is still quite low. A 33 is comparable to scores for juice from Argentina (34) and Hungary (32) in 1997, and is within the range of "normal" for apple juice. We will have to await another year or two of PDP data on Chinese apple juice before we can conclude that imports from China generally have higher residues than those found in apple juice from the U.S. or other countries that export juice here.

## 3. An In-Depth Comparison: Tomatoes

Tomatoes offer one of the few contrasts between U.S. and imported foods in which residues on imports (from Mexico) are a much greater problem than residues on U.S.-grown samples. In 1998, the PDP tested 717 samples of fresh Tomatoes. Origin data indicate that 240 samples came from Mexico, 23 samples from Canada, and 431 from domestic growers. Among the U.S. samples, the PDP tested enough from the two leading U.S. tomato-growing states, Florida (177 samples) and California (121 samples) to support an additional analysis of regional differences in residue patterns.

**Table 6** extracts the Tomato data from Table 5, and further breaks down the U.S. samples into those from California and Florida. Our TI scores for tomatoes (from all sources) are considerably higher this year than they were in last year's report; recalculated scores for tomatoes tested in 1996 and 1997 (in **Table 4**) are much higher as well. Scores went up because the EPA sharply reduced its chronic Reference Doses for methamidophos and chlorpyrifos, two organophosphate insecticides that account for most of the total TIs for both imported and domestic tomatoes.

The TI scores for 1998 tomatoes are 472 for Mexican samples, 116 for U.S. samples, and 12 for Canadian samples. Within the U.S. samples, the total TIs for samples from Florida (119) and California (109) were quite close. In all three cases, methamidophos and chlorpyrifos accounted for the majority of the Toxicity Index. Mexican tomatoes also contained demeton-S sulfone, an insecticide metabolite found on one of 17 samples tested. That solitary residue accounts for 41 percent of the total TI for the Mexican samples, while methamidophos (found on 37 percent of samples) and chlorpyrifos (found on 31 percent) combined to account for 53 percent of the total.

California and Florida tomatoes have quite similar residue profiles, with methamidophos accounting for 90 percent of the California score and 76 percent of the Florida score. Chlorpyrifos contributes 14 percent of the total TI in Florida samples, only 3 percent in California samples. Methamidophos is used primarily for aphid control, and chlorpyrifos is used against several common insect pests of tomatoes. U.S. tomato growers have actively sought less toxic alternatives to these insecticides, and have made notable progress toward effective lower-risk pest management. In fact, the TI scores for U.S. tomatoes have declined over the three years the PDP has tested them, from 218 in 1996, to 205 in 1997, and 116 in 1998. We believe these declining scores reflect a real trend and should continue to drop, as safer insect pest-management alternatives come onto the market.

The Canadian samples, which represent a very small fraction of the U.S. market, contain neither methamidophos nor chlorpyrifos residues, and in general have few residues at all. This reflects the very different growing conditions in Canada and the absence of pest pressures that affect tomato production in the other regions.

## 4. Fresh vs. Processed Foods

As we observed last year, highly processed fruit juices have low to very low TI's, although there is an order-of-magnitude difference between apple juice and the other juices tested (or milk). Frozen strawberries have a TI about one-fourth as high as fresh (140, vs. 500-700). But not all of the processed foods have low TI scores. Canned and frozen green beans (286), canned spinach (213) and frozen winter squash (3,366) all fall into our "concern" category, with the amount of concern that is justified rising in proportion to the TI.

## Risk Drivers

### 1. Risk Drivers in the 1998 PDP Survey

We apply the term "risk drivers" to residues of pesticides that account for more than 10 percent of the total Toxicity Index for a given food tested by the PDP. To be considered a risk driver, a residue must also account for at least 10 TI points; i.e., we're not concerned with cases in which a residue accounts for a large share of a very low score. For this analysis, we have focused primarily on residues that are risk drivers for more than one food tested by the PDP.

Our 1999 report contains a detailed analysis of risk drivers in the foods tested by the PDP in 1994-1997. That analysis is not repeated here; this section focuses on foods tested in 1998. **Table 5** shows the details of the contributions of various pesticides to the total TI scores for each food. The residues found in different foods differ, but most pesticides that were risk drivers in 1998 were also risk drivers in previous years. **Tables 2** and **3** summarize the acute and chronic toxicity data on the pesticides detected by the PDP, and display the basis for our toxicity indices for each chemical. See those tables for details on the nature of the risk concerns with respect to each individual pesticide classed as a risk driver.

Twelve chemicals stand out as risk drivers in this year's analysis; they are either major factors in the total TIs for multiple foods, or the predominant factor for a single food. A handful of other residues that each account for more than 10 percent of the TI for a single food are not discussed, because their contributions to total dietary risk are less prominent than those of the chemicals that are discussed. See **Table 5** for details on residues that are factors in the TI for some foods but did not qualify as risk drivers this year.

This year's risk drivers include:

**Dieldrin**. This long-banned chlorinated hydrocarbon insecticide persists in soils and is absorbed through the roots by members of the squash and melon family. It is the top risk driver for fresh and frozen U.S. winter squash, fresh

Mexican winter squash, Mexican and U.S. cantaloupe, and U.S. soybeans and sweet potatoes. Its TI contribution ranges from 46 percent for Mexican cantaloupe to 94 percent for U.S. frozen winter squash.

**Methamidophos,** an organophosphate insecticide, was the subject of a new EPA risk assessment in 1999. EPA decreased the Reference Dose, which has increased methamidophos's contribution to our TI scores. It is the first- or second-ranked component of the high TI scores received by Mexican and U.S. tomatoes, U.S. canned green beans, and Mexican cantaloupe, and of the lower score for Chinese apple juice. Its share of the total TI score ranges from 23 percent for Mexican cantaloupe to 75 percent for U.S. tomatoes.

**Chlorpyrifos**. This organophosphate insecticide was also the subject of a new risk assessment by the EPA in the past year, which decreased its RfD and increased its relative importance in our TI scores. In the 1998 PDP tests, chlorpyrifos plays a role in the high TI scores for Chilean pears and Mexican and U.S. tomatoes, accounting for from 11 to 19 percent of the TIs for those foods. (See page 19 for additional details.)

**Azinphos-methyl**. Another organophosphate insecticide, azinphos–methyl was found in pears from Argentina, Chile and the U.S., where it contributed 42, 52 and 40 percent of the score, respectively, for composite samples, and slightly less for pears analyzed as single servings.

**Methyl Parathion**. This organophosphate insecticide, which was the top risk driver in our 1999 report because it was found in several foods tested in 1994-1996, is a top factor in the TI for U.S. grown pears in the 1998 PDP survey, accounting for 61 percent of the score for single-serving samples and 39 percent of the score for composite samples. Methyl parathion accounts for 29 percent of the TI for canned green beans.

**Dicofol** is a chlorinated hydrocarbon insecticide, one of the few members of this family still registered for food uses. In the 1998 PDP data, it contributes 20 percent of the TI scores for Chilean pears and 16 and 21 percent for fresh and frozen strawberries, respectively, from the U.S.

**Methomyl,** a carbamate insecticide, is the top risk driver on strawberries from the U.S., accounting for 47 percent of the score for fresh samples and 33 percent of the score for frozen samples.

**Anilazine**, a fungicide, is the top risk driver for Mexican strawberries, and accounts for 65 percent of the score for that food.

**Iprodione**, a fungicide, was found on fresh and frozen strawberries. It accounted for 10 percent of the score for fresh U.S. samples, and 13 percent of the score for both fresh Mexican and frozen U.S. strawberries.

**Permethrin**, a synthetic pyrethroid insecticide, is the top contributor to the score for canned spinach from the U.S., accounting for 83 percent of the TI.

**Demeton-S sulfone**, a metabolite of an organophosphate insecticide, accounts for 41 percent of the comparatively high TI score for Mexican tomatoes.

**Heptachlor epoxide**, a breakdown product of heptachlor, a long-banned chlorinated hydrocarbon insecticide, contributes to the very high TI score for frozen winter squash from the U.S. Since the dieldrin component of this TI is huge, heptachlor accounts for just 5 percent of the total. But the absolute score for heptachlor epoxide is 181 points, greater than the total TI for all residues combined in most other foods, qualifying it as a risk driver.

## 2. Odds of Exceeding a Safe Dose

A report we published last year explained how *legal limits on* exposure to pesticide residues, defined by EPA tolerances, and *safe* exposures, defined by Reference Doses, are not the same. Our analysis showed many cases in which the legal residue level (tolerance) exceeded the "safe" level (chronic RfD) by from 10- to 200-fold. (See our report "Legal Does Not Equal Safe" at http://www.ecologic-ipm.com/legal_safe.pdf.)

As the EPA has reviewed and reassessed the risks of exposure to pesticides under the FQPA, the agency has lowered its definition of safe exposure to many active ingredients, widening the gap between its definitions of "legal" and "safe" exposure in many cases.

"Safe" exposure, expressed as the EPA Reference Dose (RfD), is defined in the Food Quality Protection Act as a level of exposure that has a "reasonable certainty of no harm" to public health. The RfD is based on tests that found no adverse effects in animals, and includes "uncertainty" or "safety" factors intended to ensure a margin of safety against adverse effects in humans. The chronic RfD describes a dose that should be safe if ingested day after day for a lifetime. The acute RfD describes a dose that should be safe for any single exposure event.

EPA RfDs can be compared with residues in foods, to see whether the actual amounts of pesticides detected in foods approach or exceed levels the EPA has defined as safe. In last year's report, we compared residues from PDP Tests with EPA chronic RfDs, and found many instances in which a large fraction of the samples tested had residues that would give a child a dose of a pesticide that exceeded the RfD. (Table 6 of our 1999 report.) Since the RfDs incorporate a safety margin, a dose above the RfD is not necessarily harmful, per se. But it means that exposure is higher than the level that EPA deems "reasonably certain" to be free of harm, and that the safety margin between actual exposure and that known to be harmful is narrower than the agency, acting for society, has judged acceptable. Exposure above the RfD does not indicate an immediate health hazard, but it does indicate a need to take steps to reduce exposure and restore an acceptable safety margin.

We received some critical comments on our report last year, particularly from Carl Winter of U.C, Davis, to the effect that we erred in comparing residues in single food servings with the EPA's chronic RfDs. Since the chronic RfD defines safe lifetime average exposure, Winter argued, it is not hazardous to health for an occasional residue in a food to exceed that RfD, even by a wide margin, as long as the long-term average remains below the chronic RfD. According to Winter, we should have compared single-serving intakes of residues with EPA's <u>acute</u> RfDs for the pesticides present.

We believe that <u>both</u> chronic <u>and</u> acute exposure to pesticide residues are public health concerns. Children who eat a variety of fresh fruits and vegetables will be exposed to several pesticide residues a day, and the odds are relatively high that, on any given day, they may exceed an RfD for one or more of those residues. Even if no residue exceeds the RfD for a single chemical on a given day, multiple residues with the same mechanism of toxic action may add up to an unsafe exposure. We therefore disagree with Winter's dismissal of chronic exposure concerns. We believe this is a valid public health issue, and have compared residues to chronic RfDs again this year as a useful way to identify individual pesticide uses on specific foods that contribute significantly to chronic overexposure.

We do agree, however, with Winter's suggestion that we should compare residues in single food servings with acute RfDs, where EPA has established them. In this year's analysis, therefore, we have done the comparisons both ways, using chronic and acute RfDs. As we did last year, we have assumed a "standard" scenario in which a 20-kg child consumes a 100-gram serving of a PDP-tested food. Using the EPA RfDs, we have calculated reference concentrations (RfCs, acute and chronic) for each pesticide. The RfC is the residue level that, if present in a 100-g serving of food, would give a 20-kg child the RfD of that pesticide. Using PDP data on residues in individual samples, we counted the number of samples with residues above the chronic or acute RfC, as applicable. That number, expressed as a percent of the total number of samples, yields the "odds" that a child who eats that food would exceed that RfD for that pesticide.

**Table 7** presents our calculations of the odds of exceeding a safe dose, for selected food/pesticide combinations in the 1998 PDP tests. Here are the highlights:

As we reported last year, this year's PDP data again show that the risk of exceeding a **chronic** RfD is greatest for dieldrin residues in frozen winter squash. Our standard 20-kg child eating 100 grams of this food would exceed the EPA chronic RfD for dieldrin 66 percent of the time. (EPA has not set an acute RfD for dieldrin.)

Several other food/pesticide combinations had significant probabilities of exceeding a safe chronic dose in our standard scenario. Methamidophos residues on U.S. canned and frozen green beans and on Mexican and U.S. tomatoes would exceed the RfD about 20, 19 and 13 percent of the time, respectively. Mexican tomatoes also exceed the chlorpyrifos chronic RfD 11 percent of the time. Methomyl residues on U.S. strawberries exceeded the safe chronic dose 2 percent of the time.

In its 1998 tests, the PDP did a dual analysis of fresh pears. Their normal sampling looked at residues in composite (5-pound) samples, and they also tested for residues in single servings (individual pears), at the request of the EPA, to get better data on possible **acute** exposures. Composite samples may average out the residues on single pieces of fruit, and underestimate maximum levels in single servings, an acute exposure concern. Additional tests were done to address this analytical issue.

The PDP analysis of single-serving pears found potential acute and chronic exposure problems with residues of two pesticides. Methyl parathion was present at greater than the chronic RfC on 14 percent of single pear servings and exceeded the acute RfC on nearly 3 percent of the samples. Azinphos methyl exceeded the chronic RfC in 2.5 percent of the samples, and was over the acute RfC in 0.31 percent of the servings. The findings for single servings and composite samples of pears were similar for azinphos methyl with respect to the chronic RfC, but the composite samples showed a higher risk of exceeding the acute RfC (0.82 percent). The composite samples of pears also did not have as frequent or as high methyl parathion residues as the single-serving sampling showed. The implications of the single-serving data in terms of the accuracy of composite samples for identifying potential acute exposure problems remain to be fully explored.

The PDP data show concerns about potential acute exposure to residues of a few other especially toxic insecticides. Residues of methamidophos in U.S. canned/frozen green beans and Mexican tomatoes, and methomyl in U.S. fresh strawberries, exceeded the acute RfCs in 0.30, 1.25 and 0.36 percent of the samples, respectively.

While it may be tempting to conclude that odds of less than 1 percent of exceeding most RfCs indicate "no problem," this analysis in fact shows a significant acute exposure risk. About 20 million U.S. children are six years old or younger. Of a million of those children who eat a serving of canned green beans, 3,000 of them (0.3% times 1,000,000) would get more than the acute RfD for methamidophos. If a million children ate a fresh pear, 27,800 would get more than the acute RfD of methyl parathion, and 3,100 would get too much azinphos methyl. (The odds say that 83 children would get too much of <u>both</u> pesticides in their pear.) These estimates reflect a simplifying assumption that the RfC for a given residue is uniform for the entire child population; in fact, an individual child's RfC depends on both body weight and food serving size, so these figures are approximate, and may understate actual risks. (Our 20-kg child represents a five-year-old; smaller children would have greater odds of getting an excessive dose.) While the odds that any individual child will be overexposed are small, the odds that significant numbers of children who eat certain foods with high residues will exceed an acute safe intake of pesticides are substantial. This analysis also examined only single food/pesticide combinations. Likely additive effects of multiple residues with the same mechanism of toxicity in children's overall daily diets would increase the magnitude of the problem.

The Environmental Working Group has done an analysis, using Monte Carlo simulation techniques, of the odds that the combination of all residues in all foods typically consumed by children would add up to exposure above their estimated safe acute intake for the organophosphate insecticides as a class. The EWG found that on a typical day, about 600,000 U.S. children age 5 and younger get a dose of OPs that exceeds the acute "safe" dose."

Chronic overexposure to pesticide residues is also a clear public health risk. As **Table 7** shows, children who consume tomatoes, strawberries, pears, green beans or winter squash have odds ranging from 2 to 66 percent that they will get more than a safe chronic dose of at least one pesticide. These foods and residues by no means exhaust the list of potentially problematic exposures; they are simply selected examples from foods tested by the PDP in 1998. When the presence of residues on multiple foods that children eat and the additive nature of exposures to pesticides with the same mechanism of toxicity are considered, it is clear that many children are being repeatedly exposed to doses of pesticides that exceed "safe" chronic intake. When the Environmental Working Group modeled multi-residue dietary exposure in a 1998 report (http://www.ewg.org/pub/home/reports/ops) they estimated that one million U.S. children—five percent of the population less than six years old—exceed safe chronic cumulative intake of organophosphate insecticides on any given day. Since EWG made that estimate, the EPA has substantially lowered chronic RfDs for several of the OPs, which would tend to increase the magnitude of the overexposure problem.

## 3. The Role of Chlorpyrifos in Dietary Risk

The EPA has recently published a revised risk assessment for chlorpyrifos, and is expected to announce soon (in June 2000) its regulatory strategy for this widely used insecticide. Chlorpyrifos is an ingredient in a vast array of pesticide products designed for professional and consumer use around the home, lawn and garden, and EPA's risk assessment shows that most if not all of those uses pose unacceptable exposure risks. Chlorpyrifos is also an agricultural insecticide, used against many different pests on a wide variety of crops, in the U.S. and around the world. Thus, chlorpyrifos residues are commonly detected on many foods tested by the PDP.

**Table 8** presents data on chlorpyrifos residues detected by the PDP in all foods tested from 1994 through 1998. We have extracted the chlorpyrifos data from **Table 5**, and arranged it to show the foods in which chlorpyrifos is found, its frequency of detection and mean residue levels, and the share of the toxicity index for each food/country combination that this insecticide accounts for.

As the table shows, chlorpyrifos was detected in 22 different foods the PDP tested from 1994 through 1998, and is commonly detected in both imported and domestic samples. Chlorpyrifos is a major risk driver (a TI of over 100 points from chlorpyrifos residues alone) in seven cases, with imported foods, apples from New Zealand and Mexican tomatoes, showing the highest TIs and highest or most prevalent residues. There are eleven additional cases in which the TI score for chlorpyrifos contributes from 25 to 100 points to the overall score for a particular food from a particular country. Most of these cases involve U.S. apples and Chilean grapes, pears and peaches. A third tier of 12 additional cases had lower or less frequent chlorpyrifos residues, which contributed from 10 to 21 points to the overall TI score. In 33 more cases, chlorpyrifos residues were detected, but contributed less than 10 TI points to the overall score for that food/country of origin.

Chlorpyrifos residues on single foods in some cases exceed safe doses for children (see previous section), and chlorpyrifos makes major contributions to the cumulative risk of exposure to the organophosphate insecticides as a class, in the diet as a whole. To reduce these exposures and risks, tighter restrictions on chlorpyrifos applications on crops that are major sources of dietary intake are needed, both here and abroad.

One of the most striking findings evident from **Table 8** is that 15 of the top 20 TI scores for chlorpyrifos residues (and 7 of the top 8) are for ***imported foods***. As this report is being written, the EPA is poised to announce its regulatory strategy for reducing the risks of chlorpyrifos exposure. The U.S. apple industry has said it expects tighter restrictions on chlorpyrifos use on apples, probably in the form of an extended pre-harvest interval (PHI), i.e., limiting chlorpyrifos use to early-season applications that should leave no detectable residues on the fruit.

Extending the PHI could achieve lower residues on U.S.-grown fruit, while allowing EPA to avoid the political costs of banning use of this insecticide on a major crop like apples. But EPA also must also lower its tolerances for chlorpyrifos, to a level consistent with the “reasonable certainty of no harm” standard of the FQPA. Extending the PHIs applicable to U.S. growers while leaving current (very high) tolerances on the books will reduce residues on domestic produce, while allowing imported produce to contain much higher residues. U.S.-grown apples dominate the market here, and residues in U.S. fruit account for most population exposure to chlorpyrifos from apples, even though U.S. apples contain residues less often than New Zealand apples do. Unless the EPA substantially lowers the chlorpyrifos tolerance for apples, however, imported apples could become the primary source of chlorpyrifos exposure from this key children’s food. Mexican tomatoes, Chilean pears, peaches and grapes are already the largest sources of chlorpyrifos exposure from those foods, and EPA must take steps to reduce these imported foods’ contributions to overall dietary risk by lowering the tolerances, not merely adjusting application limits for U.S. growers.

## 4. Organochlorine Insecticides: A Persistent Problem

The prominence of dieldrin residues as risk drivers for winter squash and cantaloupe in the 1998 PDP data (and in winter squash in 1997 PDP tests, (see **Table 5**) suggests a larger general problem. Dieldrin uses on foods were banned in the early 1970s, as were uses of several other chlorinated hydrocarbon insecticides, including DDT, aldrin, endrin, heptachlor and chlordane.

These chemicals were banned both because of suspected of risks to public health (primarily, cancer risk), and because of ecological hazards; they are toxic to a wide range of organisms and very persistent in the environment. Organochlorine pesticide residues last for decades in soils, accumulate in food chains, adversely affect the reproduction of raptorial birds and other wildlife, and accumulate in human body fat. Bans on the organochlorine insecticides were among the EPA’s most prominent early decisions on pesticide risks.

A few members of this chemical family are still registered today for use on U.S. crops. Residues of dicofol, endosulfan and methoxychlor may reflect current applications, instead of or in addition to persistent residues from past uses. But residues of dieldrin, endrin, heptachlor, chlordane, and DDT and its breakdown products DDE and DDD, are detected in foods tested by the PDP because of persistent environmental contamination, not current use.

The problem of persistent residues in soils is aggravated by the tendency of certain food crops, members of the family that includes squash and melons, to extract the organochlorine residues from soil, absorbing them through their roots, translocating them within the plant, and accumulating the residues in the edible portions. The most feasible solution for this problem is to avoid growing crops like squash on soils contaminated with these pesticides. As the PDP data show clearly, U.S. squash growers, in particular, have yet to adopt that strategy.

**Table 9** summarizes the data on organochlorine insecticide residues in PDP-tested foods.

**Dieldrin** residues in squash stand out as the largest single factor in any food's overall toxicity index, and dieldrin is also a risk driver for U.S. and Mexican cantaloupe and a significant factor in scores for soybeans, sweet potatoes and U.S. spinach. In 1994, but not in subsequent test years, dieldrin residues substantially increased scores for U.S. potatoes and U.S. carrots. Such sporadic impacts on scores reflect geographic variation in dieldrin levels in soils.

**Dicofol**, used for mite control on fruit crops, shows up as a problem residue on apples, grapes, peaches, pears, strawberries, and tomatoes. It is either the top or second-ranked risk driver on U.S. grapes and Chilean pears.

**Heptachlor**, in the form of its epoxide breakdown product, was detected in both fresh and frozen U.S. winter squash in both 1997 and 1998 tests. The TI's for these foods are overwhelmed by dieldrin, but the heptachlor score would warrant concern even if no other problem residues were present.

**DDT**, and its breakdown products, **DDE** and **DDD**, are ubiquitous in the global environment, and are detected in 21 of the 28 foods listed in **Table 9**. In most cases, these residues contribute only a small amount to overall TI scores, but carrots and spinach are exceptions. DDT and its byproducts are primary risk drivers for carrots, and account for 10 to 17 percent of the total score for spinach.

**Endosulfan** and its breakdown products are also found in many foods, and generally contribute in minor ways to overall TI scores. Mexican spinach and green beans are exceptions, with endosulfan accounting for from 17 to 43 percent of the TIs for those foods.

Other chlorinated organics, including **aldrin**, **methoxychlor**, **chlordane, lindane** and **benzene hexachloride** all show up occasionally in PDP-tested foods, but generally not at frequencies or levels comparable to those for the residues discussed above.

The high TI scores for dieldrin and heptachlor epoxide, in particular, are consequences of the comparatively great toxicity of these residues. Each has a very low chronic Reference Dose, and they are also the two most potent carcinogens among the carcinogenic pesticides detected by the PDP. These attributes of toxicity account for the high TI scores of winter squash, even though the mean residues are quite low (0.03 ppm for dieldrin, 0.004 ppm for heptachlor).

The EPA can manage the risks of currently-used pesticides by setting strict tolerance limits, designed to keep residues within the "reasonable certainty of no harm" range required by the FQPA. The dietary risk contributions of dicofol and endosulfan, for example, could be managed this way. But for a banned chemical, such as dieldrin or heptachlor, EPA tolerances are already set at zero. Unavoidable residues caused by environmental contamination are legal, and are governed by "action levels," set by the Food and Drug Administration. An action level defines a level of contamination that may render a food "injurious" and warrants keeping it off the market.

Current action levels for the banned organochlorine insecticides are relatively high; the action level for dieldrin is 0.1 ppm. High action levels sanction serious residue problems, such as those observed in winter squash. As long as it remains legal, squash growers will continue to sell product that contains significant dieldrin and heptachlor residues. If these action levels were lowered, say to 0.01 ppm, growers would have an incentive to seek out uncontaminated cropland, for food crops that take up organochlorines as effectively as squash does. FDA depends on EPA for risk assessments on pesticides. To provide a basis for setting more health-protective action levels for the banned organochlorine insecticides, the two agencies need to work together. Under the FQPA, ensuring a wider safety margin for these residues should be a high priority.

## Recommendations

**Advice for Consumers**: The presence of pesticide residues in fresh fruits and vegetables is *not* a reason for parents to feed their children less of these healthy foods. The benefits of consuming ample amounts of these foods do outweigh the risks. But our TI scores can help consumers make informed food choices. It is possible to have a diet rich in fresh produce *and* choose foods that have relatively modest pesticide toxicity burdens. We spelled out how to do that in detail in our 1999 report, and need not repeat all those details here.

As we said last year, foods with TI scores above 100 warrant caution on a parent's part, i.e., one should avoid feeding large amounts of these foods to small children, with the amount of caution warranted increasing with the TI score. Foods with scores below 20 can be fed to kids without much concern. Consumers should wash all fruits and vegetables before eating them, and for fruits like apples, peaches and pears, should remove the peel before feeding them to children. Removing the outer few leaves of a head of lettuce serves the same purpose. These simple steps will remove most of the pesticide residues present.

The 1998 PDP tests add two foods to the "caution" list, strawberries (both fresh and frozen, with greater residue toxicity by far on the fresh berries), and cantaloupe, which contains enough dieldrin to give it scores in the 150 range. The 1998 data also add grape juice to the "clean" list, with some of the lowest TI scores received by any foods. Strawberries are relatively fragile, which makes it difficult to wash them vigorously or peel them, and the TI scores of cantaloupe come from dieldrin that is absorbed inside the edible portion, not on the rind, so neither of these foods is especially easy to cleanse of residues.

It is probably worth the extra cost and effort to buy organic fruits and vegetables in these two cases. If your children eat significant amounts of other foods that have very high TI scores, such as winter squash, peaches, apples, pears, grapes, green beans, spinach, potatoes, or tomatoes, organic may be an appealing alternative there as well.

**Policy Recommendations**. As it did last year, our analysis shows that most of the pesticide toxicity found in most foods tested by the PDP is associated with residues of a few widely used, very toxic chemicals. In practical terms, roughly 100 uses of about 20 pesticides account for about 99 percent of the total dietary risk. This means that to reduce dietary risks, the EPA needs to focus selectively on uses identified by the PDP data as risk drivers. There are over 9,000 crop pesticide tolerances on the EPA's books, but only about one percent of them need to be top priorities for the EPA's risk-mitigation strategies.

Whether one uses our scoring scheme or other ones with similar goals, it is clear that a small number of pesticide uses drive risk. The EPA has had four years now, since the passage of the FQPA, to sort through the data on the relative toxicity of and exposure to different pesticides. EPA can analyze the PDP data itself and knows which chemicals on which foods pose the biggest risks. The agency has been cautiously developing many "science policies," from which will emerge final risk assessments and the justification for risk-reduction actions. To date, unfortunately, too much effort has gone into debate over science and policy, and not enough has been done to actually reduce risks and help growers with the transition away from risk-driving uses.

It's time for action. Last year, on the third anniversary of passage of the FQPA, EPA announced that it was ending the use of one of the most toxic organophosphates, methyl parathion, on most foods on which its use was permitted. That was a significant step, but only a step. As this report, and our 1999 analysis show, about 20 specific chemicals, most belonging to the organophosphate and carbamate insecticide families, are responsible for the lion's share of risk and need effective regulation to meet the health-based safety standard of the FQPA. Some long-banned organochlorine pesticides are also still serious dietary exposure problems on certain crops. EPA and FDA need to work together to set lower action levels for compounds like dieldrin and heptachlor.

To fully meet the goals of the FQPA, EPA still needs to address the issues of cumulative risks, from all residues combined, a difficult assignment. But the difficulty of that longer-term objective should not delay steps to curtail clear high-risk uses of very toxic individual chemicals. Ample data already exist to identify problem uses, and EPA should restrict the obvious ones as rapidly as is feasible.