The Effectiveness of Farm and Private Sector Initiatives to Reduce Children's Pesticide Exposures

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In recent years there has been encouraging growth and maturation in the scope and effectiveness of private sector and farmer-driven initiatives designed to reduce children's pesticide risks. These include:

- Significant progress in the discovery and registration of reduced risk, biologically based pesticides;
- Coordinated efforts to develop and implement biointensive Integrated Pest Management systems;
- Marketplace efforts to reward progress toward reduced risk pest management systems through ecolabels and price premiums; and
- Strong growth in the production, processing, and marketing of organic food.

Public policy reforms, initiatives, and investments have played a role in encouraging constructive change in each of these areas. The Environmental Protection Agency adopted a reduced risk pesticide registration program in the mid-1990s that cut about two years, on average, off the time from receipt of a registration application to the granting of registrations. In recent years, a majority of the new active ingredients approved by the EPA are reduced risk and/or biopesticides[1]. For example, in FY 2004, 26 new active ingredients were approved: five conventional pesticides, and 21 reduced risk chemicals, including 14 biopesticides. The EPA has also supported IPM innovation through its "Pesticide Environmental Stewardship Program."

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[1] "Biopesticides" include naturally occurring substances that control pests (biochemical pesticides), microorganisms that control pests (microbial pesticides), and pesticidal substances produced by plants containing added genetic material. Biochemicals work through a non-toxic mode of action and include microbial pesticides, pheromones, and a host of plant regulators. Most "biochemical" pesticides also qualify for expedited review under the EPA's "reduced risk policy.

The U.S. Department of Agriculture has funded over the last several years three competitive grant programs designed to support private sector development and adoption of biointensive IPM systems – the CAR (“Crops at Risk”), RAMP (“Risk Avoidance and Management Program”), and PMAP (“Pest Management Alternatives Program”). While well designed and highly competitive, the programs have been funded at very low levels, allowing only a handful of projects to move forward each year.

There are at least 50 important crops grown in the U.S., each in at least five major production regions facing unique pest management challenges. All 250 crop-region combinations face important weed, insect and disease management challenges in progressing along the IPM continuum, yet the USDA is able to invest through its IPM competitive grant programs in less than a dozen crops and regions in most years, with most projects focusing on one of the three major classes of pests.

Adoption of organic farming systems, and orderly organic certification has been advanced by the USDA’s implementation of the Organic Food Production Act, passed as part of the 1991 farmbill. The “National Rule” governing organic production and certification was finalized by USDA in 2001, and has put in place clearer rules governing the necessary steps to prevent conventional pesticides moving into organic production fields. It has improved and broadened compliance and enforcement efforts.

Private foundations have played a key and catalytic role in supporting new partnerships focused on adoption of biointensive IPM. The Pew, C.S. Mott, W. Alton Jones, and Joyce Foundations have, in particular, invested heavily in IPM innovation for more than a decade as a way to reduce environmental damage and public health risks stemming from high-risk pesticide use. The emergence of agricultural biotechnology as a high-visibility issue, however, led most of these foundations to redirect investments in IPM to work on the impacts of biotechnology.

Several food companies have encouraged IPM innovation and rewarded it in the marketplace. The Wegman’s chain of supermarkets developed the first credible IPM food product-labeling program in New York State, in cooperation with the Cornell Statewide IPM program. The Raley’s supermarket chain on the west coast, and H.E. Butt supermarkets in the southwest, both adopted pesticide residue testing programs in the early 1990s. Other chains have followed.

The Gerber Products Company has invested steadily since the 1980s in IPM systems and quality control procedures designed to assure no detectable pesticide residues in finished product. Stemilt Growers in the Pacific Northwest is a major grower of tree fruit crops. In 1989 it started to develop the first program in the U.S. designed to encourage grower adoption of IPM, coupled with use of lower risk pesticides, through what is still called the “Responsible Choice” program.[2] The company remains a leader in supporting development and adoption of IPM. It has a growing presence in the organic market, and has achieved positive results in the marketing of high-quality, value-added fruits to food-safety sensitive markets in the Pacific Rim.

The Wisconsin potato industry initiated one of the more ambitious, broadly supported biointensive IPM programs in 1995 involving the World Wildlife Fund, the state's potato grower association, and the University of Wisconsin.[3] The WWF-WPVGA-UW collaboration is still going strong after a decade and has led to the creation of an ecolabel certification program called "Protected Harvest." Protected Harvest has received the highest rating possible by the Consumers Union's ecolabel project.[4]

It is difficult to rigorously quantify the relative contributions of these various private sector initiatives in reducing children's dietary pesticide risks, just as it is challenging to document fully the impacts of the Food Quality Protection Act on risk levels and the distribution of risks across foods. Fortunately, the USDA's "Pesticide Data Program" (PDP) database of pesticide residues in children's foods, "as eaten," provides a foundation for tracking changes in dietary risks over time.

A first key task is to draw on the PDP database, coupled with information on pesticide toxicity from the EPA's pesticide registration program, to establish a baseline of pesticide dietary risks in the mid 1990s when the FQPA passed. Then, changes in risk levels from that baseline can be projected, based on changes in residues, and to the extent possible, linked to private sector initiatives, the impacts of EPA regulatory decisions, or both working in concert.

Empirical work reported herein on changes in dietary risk levels since 1996 are drawn from a report prepared by Benbrook Consulting Services in 2004-2005, under contract to the EPA Office of Inspector General (Benbrook 2005b). The EPA-OIG has been assessing the impacts of the FQPA over the last three years and has issued two of three reports offering findings and recommendations.

The first EPA-OIG evaluation report is entitled "Changes Needed to Improve Public Confidence in EPA's Implementation of the FQPA" (OIG Report No. 2006-P-0003, October 19, 2005) and the second report is called "Opportunities to Improve Data Quality and Children's Health through the FQPA" (OIG Report No. 2006-P-0009, January 10, 2006). The third report is due out in

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[2] For more information on "Responsible Choice," see http://www.stemilt.com/story/rc.php?t=1

3 For complete project information and accomplishments, see http://ipcm.wisc.edu/bioipm/

4 Access the Consumers Union rating of Protected Harvest by going to http://www.eco-labels.org/home.cfm, and then search for "Protected Harvest." For more information, go to http://www.protectedharvest.org/

spring 2006 and will assess the impacts of the FQPA on various measures of dietary risks, among other impact indicators.

I. A Methodology to Track Pesticide Dietary Risk Levels

The need to track the impact of the FQPA on children's dietary exposure was recognized in the fall of 1996, as the EPA initiated the implementation process. Consumers Union (CU) was successful in securing foundation funding for a multi-year FQPA evaluation project that ran from 1997 through 2001. Charles and Karen Benbrook served as lead consultants; see www.ecologic-ipm.com for a complete record of that project's activities and work products.

The Consumers Union project team developed a methodology to track changes in pesticide dietary risks (Consumers Union 2001; Groth et al., 2000).[5] We calculated a "toxicity index," or TI score for specific pesticide-food combinations in a given year, based on the frequency and mean concentrations of residues found in PDP testing, and EPA's then-current assessment of pesticide "Reference Doses" (RfDs) and "Population Adjusted Doses" (PADs).[6]

The EPA-OIG asked Benbrook Consulting Services to refine and update the original CU analysis of the impact of the FQPA on dietary risks. In the OIG project, the methodology was modified, the toxicology database was updated to reflect Reference Doses and PADs in 2004, and three more years of PDP residue data were included. The OIG analysis covers pesticide residue and risk levels from 1994 through 2003. See Appendix A for a description of the methodology.

Trends in Dietary Risk Index Levels Since 1994

The EPA-OIG analysis of the impacts of the FQPA on dietary risks focused on 16 fresh fruits and vegetables that had been tested four or more years in the PDP. For each food, DRI scores were estimated for each pesticide found in the food, and then aggregated across all pesticides found. The analysis was carried out for three sets of residues: those in domestically grown food, imported foods, and all PDP samples combined.

Figure 1 shows the average DRI scores per food tested in a given year for both import and domestic PDP samples tested. This is the most reliable indicator of the overall impact of the FQPA on risk levels from 1994 to 2003. In 2003, only five of the 16 crops analyzed in the OIG report were tested by PDP, whereas in

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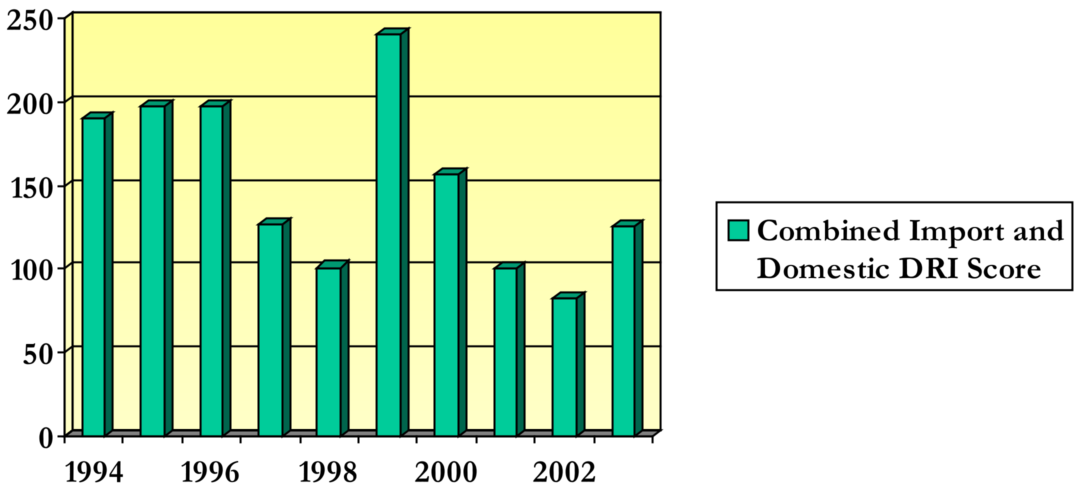
5 Consumers Union issued four major reports on the FPQA implementation process – "Worst First," "Do you Know What You're Eating?", "Update – Pesticide Residues in Children's Food," and the "Report Card" report. All are accessible on the CU FQPA website at http://www.ecologic-ipm.com/findings_CU.html

[6] A pesticide's "Population Adjusted Dose" is equal to its Reference Dose divided by any applicable FQPA safety factor imposed as a result of the FQPA's 10-X provision.

the two years before, 10 of the 16 crops were included in PDP sampling. These differences clearly would bias aggregate DRIs from one year to the next, and are why the average DRI score per food tested is the best indicator to track over time.

FIGURE 1. Average DRI Levels per Food Tested, 1994 to 2003

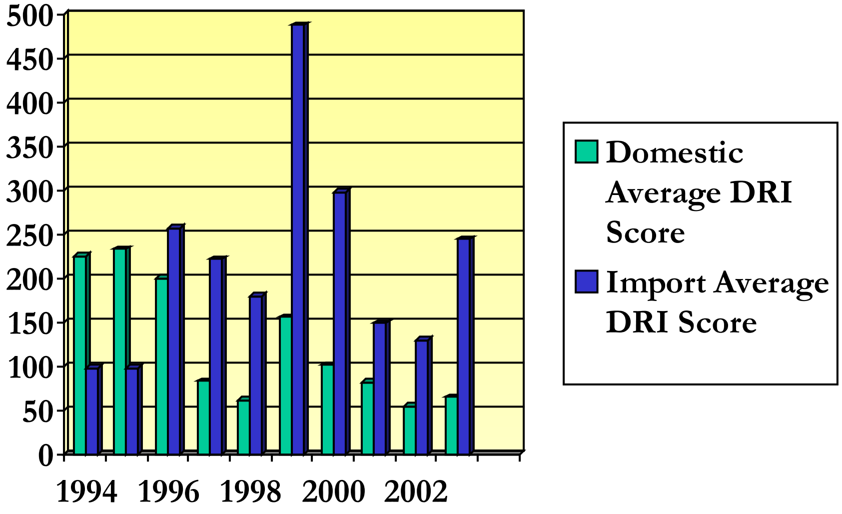


The average DRI score per food tested in a given year, as shown in Figure 1, fell from 191 in 1994 to 126 in 2003, about a 34 percent drop.

Figure 2 illustrates the average DRI scores per food for domestically grown and imported foods. The domestically grown food's DRI score fell from 225 in 1994 to 65 in 2004, whereas the imported food's DRI score increased from 98 in 1994 to 244 in 2003. Clearly, these data show a pronounced shift in residues and risk from domestically grown food to imports over the last decade, a shift that will be discussed in more detail in the next presentation.

Substantial progress has been made in reducing exposure and risks in some foods. For example, apple DRI scores have dropped from around 300 to less than 50, a reduction that was largely brought about by regulatory actions taken to end methyl parathion use on apples and severely restrict chlorpyrifos use. The next presentation offers more details on the impact of EPA actions on DRI scores.

FIGURE 2. Average DRI Levels per Food Tested for Domestic and Imported Samples, 1994-2003



II. New Chemistry

Registration of reduced risk and biochemical pesticides has heped reduce pesticide dietary risks over the last 15 years. Passage of the FQPA has accelerated somewhat the shift away from a few high-risk organophosphate (OP) insecticides, especially methyl parathion and chlorpyrifos, and to a combination of reduced risk chemistries and biointensive IPM.

Important reduced risk insecticides include the following classes and active ingredients:

- Nicotinyl insecticides including imidacloprid (Admire), acetamiprid (Assail), and thiamethoxam (Actara);
- Insect growth regulators including tebufenozide (Confirm), methoxyfenozide (Intrepid), buprofenzin (Knack) and pyripoxyfen (Courier);
- The actinomycete-based biopesticide spinosad (SpinTor, Concerve, Tracer for conventional farmers; Entrust for organic producers);
- Spiromesifen (Oberon);
- Pymetrozine (FulFill);
- About ten pheromone confusion products used in mating-disruption systems;
- About six microbial biopesticides containing various *Bacillus thuringiensis* toxins; and
- Indoxycarb (Avaunt).

Of the 27 insecticides noted above, all but spinosad virtually never appear as residues in food. Each acre of crops treated with these products lessens the likelihood that an OP or carbamate would be used, and hence reduces the likelihood of detectable residues.

Most of the dietary risk reduction achieved by the FQPA stems from regulatory actions taken against methyl parathion on six food crops and chlorpyrifos on apples, grapes, and tomatoes. Farmers switching from these two high-risk OPs typically used a combination of IPM tactics and mating disruption, an IGR, and spinosad to achieve comparable control. The regulatory actions clearly accelerated the shift because of significant differences in the cost of an acre treatment with either methyl parathion or chlorpyrifos, and an acre treatment with a combination of newer, usually more expensive reduced risk insecticides.

III. Shift to Biointensive Pest Management

Integrated Pest Management (IPM) systems range from relatively simple to highly complex. In a given region and on farms producing a given crop, it is useful to think of, and measure IPM adoption along a continuum from “no” or “low-level” IPM, to “moderate” or “medium” levels of adoption, to “high” or biointensive IPM. As growers progress along the IPM continuum, the sophistication and effectiveness of the preventive practices within their IPM systems tends to increase, and their reliance on pesticides, especially highly disruptive products, tends to decrease.

The measurement of IPM is challenging because across crops and regions, the nature and number of IPM practices needed in a given year are driven by levels of pest pressure, the availability and performance of resistant plant varieties, the cost and efficacy of registered pesticides, and the cost and efficacy of cultural, mechanical and biocontrol options.

Biointensive IPM systems encompass sufficient preventive practices to shift a major share of the pest control burden away from chemicals.[7] Even in organic production systems, some use of organically acceptable pesticides is often required to sustain adequate control and avoid major economic losses in high-value fruit and vegetable crops.

Systems to measure the degree of adoption of IPM have been developed to:

- Track the progress of growers along the IPM continuum and identify technical hurdles;
- Assess relative dependence on plant resistance (genetics) and cultural, mechanical, biological, and chemical pest management interventions;
- Identify linkages between IPM adoption and pesticide use and impacts;
- Analyze the impacts of specific new technologies or policy innovations; and
- Develop and utilize IPM standards as part of ecolabel programs.

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[7] For an in-depth discussion of the nature of biointensive IPM, and methods to measure adoption, see Chapter 7 in *Pest Management at the Crossroads* (Benbrook et al., 1996).

Measurement of IPM is facilitated by information on pest complexes and levels of pest pressure, and in particular, by factors triggering ***changes*** in pest pressure. A few crop-specific projects have measured levels of IPM adoption and linkages to pesticide use and found highly significant differences between the toxicity of pesticides applied at "low" end of the IPM continuum, compared to the biointensive end (for example, see the technical reports of the WWF-WPVGA-UW potato IPM collaboration at http://ipcm.wisc.edu/bioipm/).

As part of the National IPM Initiative started in the 1994, the USDA identified the importance of developing a credible, data-driven IPM measurement system (Benbrook et al., 1996; Benbrook 2000; Benbrook 2005a). Progress toward an IPM measurement system has been slow, however, and no national assessment has been undertaken. The USDA has not made the investments needed in measurement methodology and data that will be required in order to estimate the percentage of acreage farmed at various points along the IPM continuum.

Based on my reading of IPM project status reports and accomplishments and visits with farmers and IPM practitioners, I estimate that 10 percent to 25 percent of the acreage producing high-value fruit and vegetable crops is farmed in or near the biointensive zone along the IPM continuum. About the same share of acreage is still managed with chemical-intensive systems at the "low" end of the IPM continuum, and the balance of acreage lies between these two extremes.

Clearly, IPM has made important contributions to reducing reliance on high-risk pesticides, but progress along the IPM continuum requires much effort and occurs slowly. Sustaining progress requires ongoing investment and system innovation, especially when and as new pests become established or resistance undermines a once-effective and safe pesticide.

Public and private investments in IPM are clearly falling far short of need and are probably falling overall. The infrastructure required to profitably practice IPM in the field is at best holding its own. Funding for and interest in the USDA's new IPM competitive grant programs seems to have plateaued. For these reasons there is little reason to expect major additional reductions in pesticide dietary risks from IPM innovation on conventional farms and ranches, at least not without some additional pressure or inducements for change (i.e. regulation, new technology, or marketplace incentives).

IV. Food Marketplace Incentives and Ecolabels

Marketplace incentives for pesticide risk reduction currently play a very modest role in reducing pesticide risks because the acreages enrolled in all ecolabel programs combined likely represent less than 3 percent of harvested crops. “Certified organic” is by far the major ecolabel in terms of acreage enrolled and share of total food sales, accounting for about 2 percent of sales. Still, food companies large and small are actively pursuing a number of ecolabels and health-claims to win and hold market share. The scope and impact of ecolabel programs, especially “certified organic,” are bound to expand significantly and perhaps exponentially.

The wild card that will determine how fast organic production and other ecolabels expand their reach into the American food industry is the public’s perceptions of the causes of food and diet-related diseases and health problems. Rates of growth could rise dramatically if consumers become convinced that how food is grown impacts the quality and safety of food, in turn impacting prenatal and infant development, rates of degenerative disease, and the aging process.

Current food ecolabel programs make two sorts of claims regarding pesticide use and risks. One set is based on food safety outcomes. The second set of claims refers to how a crop was produced. The three broad categories of food ecolabels are:

- “Pesticide free” or “No Detectable Residues” in food (NDR);
- Food grown using IPM systems and/or environmentally friendly pesticides and management systems; and
- Certified organic.

Pesticide use and risks are dealt with in markedly different ways across these categories. Empirical data on the impact of these three types of programs on pesticide residue levels and frequency can be obtained from the USDA’s “Pesticide Data Program.”

The information recorded on each sample of food tested by the PDP is supposed to include any market claim associated with a given food item, such as “organic,” “IPM-grown,” “No Detectable Residues” or “pesticide free.” In the first years of the PDP, market claim data was not consistently recorded or reported, whereas in recent years, this information is provided for most samples. As a result, PDP results make it possible to compare the frequency and levels of pesticide residues by market claim.

The first peer-reviewed study comparing pesticide residues in organic, IPM-grown and NDR, and conventional foods was published in *Food Additives and Contaminants* (Baker et al., 2002). It draws on three data sets: 1994-1999 PDP data, residue testing by the California Department of Food and Agriculture, and Consumers Union testing of four foods. Baker et al. concluded that residues are far more frequent in conventional and IPM/NDR foods than organic samples; multiple residues are more common in conventional and IPM/NDR samples, compared to organic; and, levels found in conventional and IPM/NDR samples were significantly higher than corresponding levels in positive organic samples.

Consistent and statistically significant differences were found in each of the three data sets, lending confidence to the overall results. The pattern of residues in IPM and NDR samples was closer to conventional food than organic.

A similar, updated comparison of pesticide residues in conventional, IPM/NRD, and organic foods was carried out in 2004 by The Organic Center (TOC) in its first "State of Science Review" (Benbrook 2005b). The Center's analysis covered PDP results through 2002. One or more residue was found in 69 percent of conventional fresh fruit and vegetable samples, 46 percent of IPM/NDR grown foods, and 18 percent of organic samples.

Certified organic food is grown in compliance with a comprehensive set of standards that include prohibition against the use of most synthetic pesticides. Organic farmers may and often do apply sulfur, oils, copper fungicides, pyrethrins, *Bacillus thuringiensis (Bt)*, soaps, certain microbial pesticides, spinosad, and pheromones.

By volume, the major pesticides used in organic and conventional agriculture are sulfur and horticultural/petroleum distillates and oils. Copper-based fungicides are also important for conventional and organic fresh fruit and vegetable growers. Sulfur is the most common pesticide residue present on conventional and organic produce, but it is never tested for because it is exempt from the requirement for a tolerance and poses essentially no risk through the diet. Copper residues are not measured because copper is an essential nutrient and regarded by EPA as harmless at the levels ingested as food residues.

Government pesticide residue monitoring programs do not test for most other natural and biochemical pesticides approved for use by organic farmers because the EPA has exempted these products from the requirement for a tolerance and because there is no basis for food safety concerns given how these products are used on organic farms and their typically short environmental half-lives.

Pyrethrins are the only currently used botanical pesticide of potential concern in organic production. Pyrethrins are toxic but degrade rapidly (within hours) after spraying and hence rarely leave detectable residues. Also, they are applied at very low rates, on the order of one to two one-hundredths of a pound per acre. A survey of organic farmers carried out by the Organic Farming Research Foundation found that only 9 percent of 1,045 organic 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).

Why Are Prohibited Residues Sometimes Found in Organic Foods?

As the data cited above shows, organic food is not free of pesticide residues, despite rules prohibiting applying most synthetic chemicals to organic crops. About 15 percent to 20 percent of organic fruits and vegetables tested by the PDP in recent years are found to contain residues of prohibited synthetic pesticides, a percentage that has declined in recent years.

Why do organic samples sometimes contain residues of synthetic pesticides? Pesticides are ubiquitous and mobile across most agricultural landscapes. Positive organic samples typically contain low levels of pesticides used on nearby conventional fields. Contamination in organic fields arises in most cases as a result of pesticide drift, use of contaminated irrigation water, soil-bound residues of persistent pesticides, or cross-contamination with post-harvest fungicides in storage facilities (Baker et al., 2002). The very small share of organic samples that are found to contain a residue at a level comparable to conventional food likely reflects inadvertent mixing of produce, laboratory error, mislabeling, or fraud.

NDR Based Ecolabels

Some ecolabels are based on claims of “No Detectable Residues,” and are often called “NDR” or “pesticide free” programs. The best known NDR programs is run by Scientific Certification Systems (SCS), an Oakland, California based company. During the 1994-2002 period covered in the Organic Center analysis, the SCS “NutriClean” program used an NDR standard of 0.05 ppm for a given residue in a given food.

The “pesticide free” claims associated with NDR programs are vulnerable to legal challenge since such claims can be misleading. This is because “pesticide free” actually means “free of pesticides above a given level (i.e. 0.05 ppm) at the time food is purchased in a store.” Residues are often considerably higher than 0.05 ppm when the food is harvested. Residue data on NDR and conventional produce suggests that pests in fields meeting an NDR standard are often managed in much the same way as pests in nearby conventional fields growing the same crop.

The 0.05 ppm level that corresponds to “No Detectable Residues” actually masks some pesticide residues of toxicological concern. Azinphos-methyl residues in apples are among the major contributors to contemporary OP dietary risk, yet the mean residue level found in PDP testing ranges annually between 0.03 ppm and 0.06 ppm. Methamidophos in tomatoes is another risk driver, with mean residues typically in the same range. A majority of the 100 food-pesticide combinations ranking highest in DRI scores in the OIG analysis involve cases where mean residues are under the 0.05 ppm NDR standard.

For the approximately two-dozen pesticides with acute or chronic Reference Doses at or below 0.0001 mg/kg per day, tolerance levels must be set at 0.01 ppm or lower to protect infants and children and meet FQPA science policies. EPA actions on high-risk OPs have, in general, adhered to this rule of thumb; in the case of chlorpyrifos residues in grapes and apples, the EPA lowered the existing tolerances 100-fold and 150-fold to 0.01 ppm for both crops upon the completion of its FQPA-driven risk assessment.

NDR-based programs must confront another problem arising from the uses and residue profiles of recently registered biopesticide alternatives. Spinosad, kaolin clay, and harpin proteins are examples of reduced risk biopesticides with attractive environmental and toxicity profiles. These biopesticides are approved for organic production, yet many fruit and vegetable uses will routinely result in residues above 0.05 ppm.

Eco-friendly Farming System Claims

Some ecolabels are based on claims regarding the use of eco-friendly production systems and pesticides, sometimes coupled with assurances that certain high-risk pesticides are not used. The goals addressed in some ecolabel programs are expansive, even comprehensive, and may include:

- Pesticide use and risks;
- Erosion control and sedimentation;
- Manure management and livestock husbandry;
- Water quality, and water use and conservation;
- Riparian area management;
- Preservation of wildlife habitat; and
- Worker safety and worker quality of life issues.

The Food Alliance is the best-known example of a comprehensive program. Other programs are more focused and narrow in terms of the crops and regions covered and the types of environmental issues addressed. The Pacific Northwest’s “Salmon Safe” program is an example of a narrowly focused program that strives to achieve a single, well-defined outcome of broad interest to people in the region. An excellent overview of existing ecolabel programs, and an evaluation of their basis, can be found on the Consumers Union ecolabel website, www.eco-labels.org.

Ecolabel programs based on production system claims typically focus on adoption of prevention-based, biointensive IPM. Programs strive to identify core biointensive IPM practices. Certification standards are linked to the adoption of some portion of identified, proven bioIPM practices.

The requirement for adoption of biointensive IPM practices can serve an educational function and allows farmers to project what program enrollment will entail and cost, and whether alternative systems and technology will work acceptably within their farming system. In practice, biointensive IPM systems are extraordinarily complex and dynamic and are difficult to capture in a “check list” of practices. Differences from one season to the next, or one production region to another, can dramatically alter pest pressure and the efficacy of various pest management practices. Some ecolabel programs penalize farmers for not adopting practices that they do not need in a given year, because of a lack of pest pressure.

“Do Not Use” Lists

Some ecolabel programs incorporate a “Do Not Use” (DNU) list, as well as what amounts to a “Use with Restrictions” list. The WWF-WPVGA-UW potato IPM project initially identified a dozen “Do Not Use” pesticides in 1996, as well as another half-dozen that could be used only “with restrictions.”

Ecolabel programs that adopt risk-averse, conservative criteria for placement of pesticides on a DNU list can dramatically reduce risks. Any program in the late 1990s, for example, that placed fruit and vegetable crop uses of methyl parathion and chlorpyrifos onto their DNU list could have locked in substantial risk reduction in advance of EPA actions in 1999 and 2000.

The DNU lists incorporated in most ecolabel programs to date, however, include mostly high-risk pesticides that are obsolete and rarely used. The Gerber Products DNU list is a notable exception, as is the list adhered to by the WWF-WPVGA-UW collaboration. Several programs are considering adoption of more risk-averse DNU lists, or expansions of existing lists.

“Use with Restrictions” lists typically set out a specific set of circumstances in which a moderate to high-risk pesticide may be used. The two principal criteria leading to placement on the WWF-WPVGA-UW collaboration’s “Use with Restrictions” list are:

- Dealing with a “pest management emergency;” or
- The need to incorporate a pesticide within a rotation of active ingredients as called for in a university-recommended resistance management plan.

Incorporation of a “Use with Restriction” list can complicate annual administration of ecolabel programs, but can also markedly enhance the willingness of farmers to join programs.

Essential Ingredients to Reduce Risks Through Ecolabels

While ecolabel programs currently have a modest impact on pesticide risk reduction measured at the level of the food industry, their importance and impact could grow appreciably. Accordingly, it is important to sharpen focus on the claims made by ecolabel programs, and link claims to changes in farm management practices required of program participants.

The Consumers Union administers the most comprehensive ecolabel evaluation program[8] in the country. CU applies five criteria in rating the meaningfulness of ecolabels:

- Is the label verified?
- Is the meaning of the label consistent?
- Are the label standards publicly available?
- Is information about the organization publicly available?
- Is the organization free from conflict of interest?

Building on the criteria set forth by CU and the experience and accomplishments of existing ecolabel programs, there appear to be six essential ingredients for a pesticide-related ecolabel program to deliver meaningful pesticide risk reduction.

1. There must be scientific basis and data-driven process to identify the pesticide risks that the program is striving to reduce, and hence the pesticides that may and may not be used.

2. Risks targeted for reduction must be quantifiable at the field or farm level in some sort of baseline from which reductions in risk can be calculated.

3. Credible risk indicators must be established that can serve as a proxy for the real-world risks that an ecolabel program is striving to reduce (e.g. impacts on salmon or birds, farm worker poisonings, dietary risks, or a combination of multiple risks).

4. Standards must set forth acceptable and unacceptable levels of risk stemming from pesticide applications on a given field. The standards can be based on direct measures of risk – poisoning episodes, residues in food, bird kills – or on indicators of risk, such as aggregate pesticide toxicity units per acre.

5. Compliance with standards must be independently verified by a third party that is granted access to information needed to assess field-level performance relative to stated standards and requirements.

6. All aspects of the program must be transparent and accessible to growers, consumer and environmental organizations, interested members of the public, the farm community, and regulators.

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[8] Access the Consumers Union ecolabel ratings at http://www.eco-labels.org/home.cfm

V. Conclusions and Emerging Challenges in Reducing Children's Pesticide Risks Through Private Sector Initiatives

There has been progress in reducing pesticide dietary risks since the passage of the Food Quality Protection Act. Private sector initiatives have played a major role in facilitating this progress, although it is almost certain that the regulatory pressures imposed by the FQPA accelerated adoption of reduced risk, biopesticide, and biointensive IPM-based pest management systems.

The pesticide industry deserves credit for the investments it made and foresight it displayed by making the effort in the 1980s required to discover, register, and bring to market in the 1990s over two-dozen effective, reduced-risk and biochemical insecticides. These new products have allowed U.S. fruit and vegetable farmers to lessen reliance on high-risk OP and carbamates insecticides. They have provided farmers essential tools to deal with resistant pest populations and lower farm worker risks, and they have provided alternatives when regulation has driven older, but still effective pesticides off the market.

Government and private efforts to expand adoption of IPM have had modest impact on pesticide dietary risks in the last decade because projects have focused on very few crop-region-pest combinations, and the acreages impacted by project results remain limited. IPM programs and infrastructure are grossly under funded and must struggle just to keep up with emerging challenges.

Only a small percentage of growers have adopted prevention-based biointensive IPM systems. The dominant focus of most IPM research remains sustaining the efficacy and affordability of chemical-based systems. IPM remains a necessity for successful pest management, but has not proven to be a major force for change in terms of reducing pesticide dietary risks. The impact of IPM innovation has surely been dwarfed by the impact of new synthetic chemistry and biopesticide technology.

The impact of ecolabel programs on pesticide dietary risks is also modest relative to the whole food system, largely because less than 3 percent of harvested acreage is enrolled in such programs, with certified organic cropland accounting for about two-thirds of this total. On the other hand, cropland transitioned to certified organic production essentially eliminates pesticide dietary risks on each acre enrolled. It offers the strongest guarantee that pesticide risks will be decisively reduced.

The Role of Economics

Economics has played, and will continue to play a major role in shaping the impact of private sector initiatives to reduce pesticide dietary exposures.

For most fruit and vegetable crops, growers could have adopted low-risk pesticide alternatives in the mid-1990s, but many did not do so because the cost of older, higher-risk pesticides was usually less than half of the cost of systems based on safer, newer alternatives. Only a small percentage of growers were willing to adopt safer technology when first available, despite the increase in costs and reduction in per acre profits.

The combined effects of pest resistance to pesticides and regulation have been important in many areas in driving major changes in pest management systems, and have forced growers to move along the IPM continuum toward more prevention-based systems.

Recent consumer surveys show clearly that a lack of supply and high price premiums are holding back growth of the organic food sales. If economies of scale common in the conventional food processing, distribution, and marketing systems become accessible to organic farmers and food companies, price premiums will narrow appreciably and demand will grow. Whether and how supply will grow in step with demand remains to be seen, given the three year transition period required to convert conventional cropland to certified organic production.

Deeper consumer awareness of the impacts of food production systems and diet on health could trigger very strong growth in organic demand and production. If faster growth is concentrated in high-value fruits and vegetables that are important in children’s diets, organic production could lead to significant reductions in pesticide dietary exposure and risks across the whole population. Most of the fresh produce and milk served to children could be produced organically within one to two decades, if a concerted effort was made to accomplish this milestone. There is no other conceivable scenario in which pesticide dietary risks facing infants and children could be largely eliminated in the same time frame.

Appendix A. Dietary Risk Methodology Used in the Benbrook OIG Report

The basic unit of measure used to track pesticide dietary risks in the EPA-OIG report is called the "Dietary Risk Index" (DRI). DRI values or scores are calculated for each pesticide-food combination covered in annual PDP testing. For a given food and year, DRI values for each pesticide found in the food are added together, to form an aggregate, food-level DRI score; aggregate pesticide DRI scores can also be calculated by adding DRI values from all foods a given pesticide is found in.

Single-food and aggregate DRI scores are calculated for three sets of residue data: food grown, harvested, and processed in the U.S. (domestic production); residues in food that is imported into the U.S.; and, all PDP samples (domestic plus imported samples, plus samples of unknown origin). Trends over time in aggregate food-level DRI scores provide insights into changes in overall risk levels, as well as the crops and pesticides contributing most significantly to risk.

The basic formula to calculate the DRI score for a given pesticide-food combination is –

DRI = ("Percent Positive") x ("Chronic Risk Share")

Where:

- "Percent Positive" is the number of samples of a given food found to contain a quantifiable level of a given pesticide residue, divided by the total number of samples of the food tested for that residue; and
- "Chronic Risk Share" is the level of risk associated with the residues of a pesticide found in a food, taking into account the pesticide's toxicity, the amount of food typically eaten by children, and the mean of the residues found in positive samples.

The "Percent Positive" variable is calculated from PDP data. For each pesticide-food combination, there are up to three "Percent Positive" values: one representing the results for domestic samples, one for imports, and one for all samples combined.

DRI values can be calculated based on acute Reference Doses (aRfD) and acute Population Adjusted Doses (aPAD), as well as chronic Reference Doses (cRfD) and chronic PADs (cPAD). The analysis of dietary risk trends in the EPA-OIG report is based on chronic risks, because EPA has not established acute Reference Doses for a majority of pesticides.

Chronic Risk Share

The "Chronic Risk Share" (CRS) is designed to help answer a key question – "How risky are the pesticide residues found in a given food, or across all foods?" The "Chronic Risk Share" is a measure of the degree to which the residues found in the food, as reported in PDP results, fills up the pesticide's "risk cup" for a person of known weight.

EPA introduced the "risk cup" concept to help explain the impact of the provisions of the FQPA on allowable levels of exposure to pesticides. The "risk cup" is a graphical representation of the acceptable amount of exposure to a given pesticide for a person of known weight. The size of the risk cup is typically reported in milligrams of pesticide per day.

The "Chronic Risk Share" for a given pesticide-food combination is calculated as follows –

$$\text{Chronic Risk Share} = \frac{(\text{“Projected } 99^{\text{th}} \text{ Residue Level”})}{(\text{“Single-Food cRfC”})}$$

The "Projected 99th Residue Level" (PRL_{99}) is an estimate of the 99th percentile level of the distribution of residues of that chemical in that food, ranked from the highest to lowest. To estimate PRL_{99} values, we analyzed the differences in PDP residue levels for 53 pesticide-food combinations at the 99.9th, 99th, 95th, and mean levels. The average difference between the 99th residue and the mean of the positives was about 7. We estimated PRL_{99} levels for all pesticide-food combinations by multiplying the mean residue level by 7.

The PRL_{99} level of exposure is modestly less conservative than the EPA's science policy for dietary risk assessment that calls for the "threshold of regulation" to be set at the 99.9th percentile of the distribution of risks. Pesticide-food combinations resulting in risks that exceed the applicable EPA Reference Dose or PAD at the 99.9th level of the distribution are said to exceed the agency's "level of concern," and may trigger risk mitigation efforts.

The second component used to calculate the CRS is the pesticide's single-food chronic Reference Concentration (cRfC). Four variables are needed to calculate a single-food cRfC for a child of known weight – the average amount of food consumed by the child, the child's weight, the toxicity of the pesticide, and the magnitude of exposures from other foods, beverages, or pesticide uses around the home, schools, or in other residential settings. A single-food cRfC is an estimate of the concentration of a pesticide that can be present in a serving of a given food, without exceeding the person's chronic PAD.

In cases where the PRL_{99} exceeds the applicable single-food chronic Reference Concentration, the value of the CRS will be greater than one. In such cases, a small portion of the people consuming the food in a given day are likely to receive a dose of the pesticide above the level EPA regards as acceptable from that food alone. The smaller the value of the CRS, the less worrisome the dietary risks stemming from the residues present in a given food.

Single-Food Chronic Reference Concentrations

The single-food chronic Reference Concentration, or $cRfC_{sf}$, is an estimate of the maximum level of a pesticide that can be present in a given food without violating the FQPA's basic "reasonable certainty of no harm" standard. This key concept is useful in tracking changes in pesticide dietary risks, as well as when setting the maximum levels for "safe" pesticide tolerances in food as eaten.

A $cRfC_{sf}$ for a given pesticide will change as a function of the weight of a child and the amount of a specific food that the child consumes during a day. In analyzing changes over time in pesticide dietary risks, the assumptions used to calculate $cRfC_{sf}$ levels are less important than using the same assumptions across all foods.

The formula[9] to calculate a cRfC for all foods and routes of exposure is:

$$\text{cRfC (mg/kg)} = \frac{\text{Weight of Child (kg)} \times \text{cPAD (mg/kg/day)}}{\text{Serving Size Food}_y \text{ (kg/day)}}$$

The weight of the child used in this report to calculate cRfC values is 16 kilograms, the weight roughly corresponding to mid-range growth for a four-year-old male, as reported in the Centers for Disease Control Growth Chart.

EPA sets pesticide cPADs based on animal experiments, after applying a set of safety factors to the "No Observable Adverse Effect Level" (NOAEL) for the most sensitive biological impact considered relevant in assessing a pesticide's toxicity.

In order to track dietary risks using a methodology grounded in EPA's FQPA science policies, we estimated the serving size for each food at the 95th percentile of the food distribution curve. The combination of food consumption at the 95th percentile level and pesticide residues at the 99th level produces estimates of risk comparable to the 99.9th level that EPA uses as the threshold for regulation.

Children are typically exposed to a given pesticide through more than one food and beverage. Pesticides are also sometimes used in and around the home, schools, or play areas, leading to non-food routes of exposure. The FQPA requires EPA to set tolerance levels, and regulate pesticides such that

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[9] The formula for a cRfC is derived by solving the following equation: cRfC (mg/kg) x Serving Size Food_y (grams/day) = Weight of Child (kg) x cPAD for Pesticide_x (mg/kg/day).

total aggregate exposures from all foods, beverages, and other routes fit within each pesticide's "risk cup," thereby meeting the statute's basic "reasonable certainty of no harm" standard.

A huge amount of data and considerable analytical work is required to rigorously estimate single-food cRfCs for all pesticides. Based on past analyses of PDP residue levels and food consumption survey data, we estimated that most pesticides appear in from three to about a dozen foods commonly consumed by children. Perhaps one-quarter of pesticides also are found in drinking water and residential environments, but resulting exposure levels vary a great deal, and sometimes dwarf exposures in food.

We approximated the share of an "all-routes-of-exposure" cRfC that can be taken up by a single food by dividing the cRfC by ten. This value was recommended previously to EPA in October 13, 2000 Consumer Union comments on EPA's chlorpyrifos risk mitigation plan.[10] CU recommended that EPA not allow any single food use of a pesticide to account for more than 10 percent of the pesticide's risk cup, at least not until the EPA completed its cumulative risk assessment of the organophosphates and had taken all regulatory actions needed to meet the FQPA's "reasonable certainty of no harm" standard.

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[10] Accessible at http://www.ecologic-ipm.com/Chlorpyrifos_comments_2000.pdf

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