USDA PESTICIDE DATA PROGRAM: PESTICIDE RESIDUES ON FRESH AND PROCESSED FRUIT AND VEGETABLES, GRAINS, MEATS, MILK, AND DRINKING WATER

John S. Punzi*, Martha Lamont, Diana Haynes, Robert L. Epstein, US Department of Agriculture, Agricultural Marketing Service, Science and Technology Programs, Monitoring Programs Office, Manassas, VA 20110 describe the USDA Pesticide Data Program and summarise the data that have been collected over the last decade which indicate that there have been few pesticide residue problems in home-grown or imported fresh and processed crops

Keywords

Pesticides, Residues, Monitoring, Food Safety, Risk Assessment, Fruit and Vegetables

The use of trade, firm, or corporation names in this publication, references to published work, and analytical methodology is for the information and convenience of the reader. Such use does not constitute an official endorsement or approval by the US Department of Agriculture of any product, service, or analytical method to the exclusion of others that may be suitable.

Introduction

In 1991, the US Department of Agriculture (USDA) developed a monitoring program designed to determine the levels of pesticide residues in fresh and processed foods. This monitoring program was referred to as the Pesticide Data Program (PDP). The program is administrated within the Agricultural Marketing Service (AMS) which employs specialists that provide standardization, grading, and market news services for many major commodities vital to US agriculture (cotton, dairy, fruit and vegetable, livestock, and poultry). AMS also services other USDA agencies, several Federal departments, and the private sector food industry for consultation and analytical testing services. Because of the historically valued association between food producers and AMS, it was anticipated that by developing PDP within this organization of USDA, food producers and the scientific community would consider the pesticide residue data impartial.

Over the last decade PDP has evolved from a cursory survey of a few commodities to being the primary source of realistic pesticide residue data which uniquely support the dietary exposure component of risk assessments performed by the Environmental Protection Agency (EPA). PDP data support international marketing of US food products, and maintain the ability of both State and Federal governments

*To whom correspondence shall be addressed; Phone: 1 703 330 2300; Fax: 1 703 369 0678; E-mail: john.punzi@usda.gov.

DOI: 10.1564/16jun12

and the agricultural community to respond to food safety and marketing issues. Unlike tolerance enforcement programs, PDP provides pesticide residue data for washed, ready-to-eat produce from representative nationwide sampling over significant time periods, focusing on high consumption items. The pesticide residue data produced by PDP are reported in a printed annual summary and are available on the USDA Web site (http://www.ams.usda.gov/ science/pdp).

Commodity sampling and analyses are carried out with the support of State and Federal agriculture laboratories. The USDA Food Safety and Inspection Service (FSIS) provides sample collection services for beef, pork, and poultry. Participating water utility companies provide the drinking water samples. PDP food sampling is based on a rigorous statistical design that ensures the data are reliable for use in dietary exposure assessments and can be used to draw various conclusions about the presence of pesticide residues in the Nation's food supply (Kott & Carr, 1997). Current funding allows for approximately 20 commodities to be analyzed per year and each commodity is generally in the program for at least 2 consecutive years. The sampling sites include terminal markets and large chain store distribution centers from which food commodities are released to supermarkets and smaller grocery stores. Samples are selected from more than 500 sites and are chosen without regard to country of origin or organic labeling.

The PDP laboratories monitor pesticides, metabolites, degradates, and isomers using multiple residue methods (MRMs). MRMs are used to detect numerous compounds in a single analytical run and more than 30 methods are used in this program to detect various organochlorines, organophosphates, organosulfurs, organonitrogens, *N*-methyl carbamates, pyrethroids, triazines, and conazoles/triazoles. Nearly 200 different insecticides, herbicides, fungicides, plant growth regulators, and metabolites/degradates/isomers of parent compounds have been determined. In recent years, nearly 1,000,000 discrete pesticide commodity pairs (i.e. azinphos-methyl-apple) are determined per year. Almost 10,000,000 measurements have been made during the course of the program.

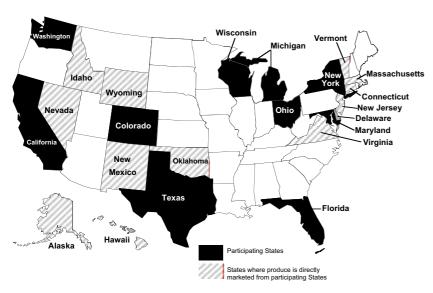


Figure 1. Map of the United States Indicating States Participating in the PDP Program and Associated Food Distribution Areas.

Sample Collection

Sample collection is done in 10 States participating in PDP. Twelve additional, mainly neighboring States, are in the direct food distribution networks of the participating States (Figure 1). Together, they represent the major domestic producers of fruit and vegetables, about 50% of the Nation's population, and all 4 census regions of the US The States provide AMS and USDA's National Agricultural Statistical Service (NASS) with annual volume information for commodities distributed at each sampling site to be used in a probability-proportionate-to-size method of site selection. A weight of 10 is given to a site that distributes 100,000 kilograms of produce annually and a weight of 1 given to a site that distributes 10,000 kilograms, resulting in the larger site being 10 times more likely to be selected for sampling than the smaller site. Collection of commodities is randomly assigned to weeks of the month, prior to selection of specific sampling dates within a week. State population figures are used to assign the number of samples scheduled for collection each month (California, 14; Colorado, 2; Florida, 7; Maryland, 4; Michigan, 6; New York, 9; Ohio, 6; Texas, 8; Washington, 4; and Wisconsin, 2). This schedule results in a monthly target of 62 samples per commodity, or 744 samples of each commodity per year. Grains, beef, pork, and poultry are collected by USDA employees using a weighting scheme based on annual crop production estimates (grains) and production volumes at slaughter houses (meats). Drinking water has been sampled at sites in California and New York which reflect two highly populated regions with divergent climates and hydrogeological features. More rural sites in Colorado, Kansas, and Texas have been sampled when EPA specifically requested monitoring data in those areas.

Twenty seven different types of fresh fruit and vegetables, 21 different types of processed commodities, 5 types of grain and wheat flour, cow's milk, butter, beef adipose, beef liver, beef muscle, chicken adipose, chicken liver, chicken muscle, and drinking water samples have been analyzed since the inception of the program (Table 1). These items represent foods which are consumed in relatively high amounts, often by children, and, with the exception of meats and frozen commodities, can be eaten raw. The samples are generally composite samples ranging from 1-5 lbs (450-2250 grams). although pilot studies of sampling and analysis of single serving-sized apples, pears, and peaches (i.e 0.5 lbs or 200 gram) have been performed (Lamont, 2002).

Analysis of Pesticides

Upon arrival at the testing facility samples are prepared by emulating consumer practices. The inedible portions of fresh fruits and vegetables are removed and the sample is peeled and washed under fresh running water before being chopped and homogenized. Juices are diluted with water according to the label directions and canned and frozen fruit and vegetables are homogenized with any liquid present. Grains and meats are homogenized in the uncooked form. Homogenized

samples are frozen at -40° C or lower if they are not analyzed immediately.

Various types of detection systems and gas and/or liquid chromatography are used for the identification and quantifi-

Table 1. The Comprehensive List of Commodities Sampled and Analyzed by USDA PDP from 1993 Through 2003

Fresh Commodity	Processed Product
Apples	Apple Juice
Asparagus	Apple Sauce
Bananas	Butter
Broccoli	Corn Syrup
Cantaloupe	Grape Juice
Carrots	Green Beans, canned/frozen
Celery	Orange Juice
Cherries	Peaches, canned
Cucumbers	Peanut Butter
Grapefruit	Pears, canned
Grapes	Peas, canned, frozen
Green Beans	Spinach, canned, frozen
Lettuce	Strawberries, frozen
Mushrooms	Sweet Corn, canned, frozen
Nectarines	Tomato Paste, canned
Onions	Tomatoes, canned
Oranges	Winter Squash, frozen
Peaches	
Pears	Grains
Pineapples	Barley
Potatoes	Oats
Spinach	Rice
Strawberries	Soybeans
Bell Peppers	Wheat (grain and flour)
Sweet Potatoes	
Tomatoes	Meats (Beef, Chicken:
Winter Squash	muscle, adipose, and liver)
	Other (Milk, Water)

Year	Samples	Detects	% Detects	Imported (into U.S.)	Over tolerance	No tolerance
1993	7,328	5,171	71	1,237	14	90
1994	7,589	4,671	62	1,260	4	92
1995	7,524	4,973	67	1,143	9	293
1996	5,771	3,899	68	593	7	221
1997	7,835	4,349	56	804	7	406
1998	8,500	4,683	55	1,305	12	267
1999	9,125	5,837	64	1,791	19	301
2000	10,907	6,215	57	2,032	19	134
2001	12,264	6,882	56	2,100	14	217
2002	12,899	5,425	42	2,411	45	355
2003	12,316	6,845	56	1,477	35	157
Overall	102,058	58,950	58	16,153	185	2533

Table 2. A Summary of PDP Data. The Overall Percent of Samples with Detectable Pesticide Residue is Indicated

cation of pesticides. Laboratories exclusively rely on MRMs which are efficient analytical procedures collectively consisting of organic solvent extraction of a sample matrix, removal of interfering natural components, and analysis by chromatographic means (Luke *et al*, 1975). The laboratories are routinely improving extraction procedures to improve efficiency (Hsu *et al*, 1991; Fillion *et al*, 1995; Sheridan & Meola, 1999).

All MRMs were found, through method validation procedures, to produce reliable data for EPA risk assessment purposes. PDP laboratories establish limits of detection (LODs) and report any instrumental response below the LOD as a "non-detect". LODs are established experimentally for each pesticide/commodity pair, are reported with each data set, and are verified periodically. Specific commodities are generally analyzed in only one or two laboratories to minimize any variation in LOD's (which are typically less than a factor of 2) and to ensure the same pesticides can be determined reliably. In one extreme (rare) case, two different laboratories determined an LOD with an approximate 10 fold difference in the values (0.0029 ppm vs 0.025 ppm); the number of detections differed by ~10% (diphenylamine-apples).

All residues identified must be verified by mass spectrometry or a second detection system. Strict quality control and quality assurance protocols are based on EPA's good laboratory practice guidance and include written standard operating procedures (SOPs) to provide uniform administrative, sampling, laboratory procedures, on-site laboratory reviews, proficiency testing samples, and quality control procedures, which include reagent blanks, matrix blanks, matrix spike(s), process control spikes and method performance measures.

Sample Results

To date PDP has collected and analyzed more than 100,000 samples, of which about 65% are fresh fruit and vegetables. Approximately 82% of all samples were from US growers and 16% were imported. Of the total, nearly 21,000

samples were processed commodities, roughly 6,000 were grains, 3,400 beef and chicken, 1,900 cow's milk, 700 butter, and 1,700 were drinking water.

For the period 1993–2003, the overall percent of samples with detectable pesticide residues was 58% (Table 2). The detection rate varied substantially, ranging from 71% in 1993 to 42% during 2002. Although no rigorous attempt was made to correlate these data with pesticide usage, with the exception of 1999 and 2003 the detection rates have been 55 +/-2% for 5 out of the last 7 years. This result is noteworthy considering that different groups of commodities are analyzed each year and not all the same pesticides are measured on each commodity. Commodities having residues with no current EPA tolerances were found in 1.2–5.1% of the samples. In each year, less than 1% of the samples had residues above established EPA tolerances.

As expected, pesticide residues were more abundant in fresh fruit and vegetables than processed foods, meats, or milk. Approximately 65% of the fresh fruit and vegetable samples had detectable pesticide residues in the washed, edible tissues. Pesticide residues were detected in 34% of the processed commodities, approximately 47% of the grain samples, 15% of the milk samples, and 10% of beef and chicken tissue samples. Fifty-one percent of the water samples contained detectable pesticide residues, although it should be noted that the detection levels were typically on the order of low parts per trillion which is many times lower than levels of pesticides found in typical food matrices (ppm).

The percent of commodities with detectable residues varied substantially ranging from <1% (onions) to 97% (nectarines). Although the majority of fresh fruit and vegetables have residue detection rates greater than 50%, only six commodities that have been sampled for two or more years, consistently had detectable residues on 90% or more of the samples (apples, celery, cherries, nectarines, peaches, strawberries).

Interestingly, the percentage of samples with detections was remarkably similar for several commodities over, in some cases, nearly a 10-year period (Table 3). For example, the percent detectable residues in peaches and oranges ranged from 91–99% and 80–86%, respectively. This relatively

Table 3. Pesticide Residue Detection Rates for Selected Commodities.

Commodity					Per	cent detect	tions				
	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	All years
Apples	97	95	95	98	_	_	90	79	91	91	93
Bananas	61	55	62	_	_	_	_	_	45	39	51
Carrots	65	69	71	78	-	_	_	80	81	85	75
Grapes	75	75	80	80	_	_	_	69	73	-	75
Green beans	66	61	57	_	-	_	_	69	62	-	63
Lettuce	51	53	_	-	-	-	38	37	49	-	47
Oranges	80	86	84	84	-	_	_	80	83	-	83
Peaches	91	93	92	96	-	_	_	94	99	98	95
Pears	_	-	_	-	95	85	74	_	_	-	85
Potatoes	79	78	83	_	_	_	_	70	82	90	80
Spinach	_	_	83	88	79	_	_	_	-	74	82
Strawberries	-	_	_	-	_	91	92	91	_	_	91
Tomatoes	-	_	_	64	63	62	67	_	-	_	63
Winter squash	_	_	_	_	40	42	41	_	_	_	41

narrow range for these commodities was unexpected, as season to season pest pressures, variable weather conditions, and geographic extent of production are expected to influence pesticide use significantly both in number of seasonal applications and types of pesticides needed.

A thorough examination of the distinct pesticide commodity pairs for data trends is beyond the scope of this review, however, a few general observations can be noted. Post-harvest use of fungicides may be expected to contribute both to the relatively high and relatively consistent detection rates where year to year application rates are not likely to vary for established compounds. When recent data for several commodities were examined, PDP data demonstrate that the fungicides thiabendazole and iprodione were the most frequently detected pesticides in/on oranges during 2001 and peaches during 2002, respectively. Thiabendazole is the most frequently detected pesticide on bananas and detected in more than 60% of the apple samples over the entire sampling period.

Generally, samples with detectable pesticide residues were less abundant in processed foods (i.e. canned, frozen, juiced). Notable exceptions were canned green beans and canned spinach, which have similar detection rates for some compounds compared with the fresh food form. In 2002, for example, thiabendazole was detected in approximately 72% of fresh apples, but was detected in only 28% and 24% of the apple juice and apple sauce samples, respectively (Table 4). Azinphos-methyl was detected in about 37% of fresh apples, but residues were detected in only 0.1% and 0.6% of the of the apple juice and apple sauce samples, respectively. Diphenylamine was reported in about 76% of fresh apples, but was only detected in 8.5% of apple juice samples and 40% of apple sauce samples. In contrast, captan was reported in 10% of fresh apples, but no residues were detected in apple juice or apple sauce. Phosmet was not detected in apple juice or apple sauce, but was detected in 13% of fresh apples.

Pesticide residues detected in spinach showed less variation in detection rates regardless of whether samples were fresh, frozen, or canned (compared with the apple

Table 4. Comparison of Pesticide Residues in Fresh and Processed Apple and Spinach.

	Fresh Apples	Apple Juice	Applesauce
Pesticide	Percentage of	Samples with D	Detections
Azinphos methyl	37	0.1	0.6
Captan	10	nd	nd
Diphenylamine	76	8	40
Phosmet	13	nd	nd
Thiabendazole	72	28	24
	Fresh	Canned	Frozen
	Spinach	Spinach	Spinach
DDE p,p´	28	21	43
Methomyl	6	nd	10
Permethrin	61	79	61

Apple data was collected during a single year (2002) Spinach data was collected in 1998 (canned), 1999 (frozen), 2002 (fresh)

nd=not detected

example above) presumably due to the nature (chemical heat and environmental stability) of the chemical residue (Table 4). For example, DDE p,p' was detected in 28% of fresh spinach samples, 21% of canned spinach, and 43% of frozen spinach. Permethrin was detected in 61% of fresh spinach samples, 79% of canned spinach, and 61% of frozen spinach. Methomyl was detected in fresh and frozen spinach samples, but not in canned spinach. Several other comparisons of fresh and processed commodities demonstrating similar results have been reported (Punzi, 2004).

Title 21 Code of Federal Regulations Part 110.110 allows the US Food and Drug Administration (FDA) to establish maximum levels of natural or unavoidable defects in foods for human use that present no health hazard. Due to the environmental persistence of some organochlorines, residues

of some of these compounds may be detected in foods and animal feed. Residues of DDE p,p´, a DDT metabolite, and DDT have been detected in foods even though the uses of DDT as a pesticide have been prohibited in the US since 1972. From 1993–2003, approximately 37% of carrot samples, 39 percent of spinach samples, 7% of potato samples, 44% of beef adipose, and 15% of cow's milk samples contained DDE p,p´. Residues of DDE were occasionally found in other commodities, although much less frequently. The maximum residue value found was approximately 1 part per million (ppm) in one sample of beef adipose and a few others near 0.5 ppm; however, the residue values are typically much less and all detections of DDT metabolites were below the established action levels set by FDA.

With the exception of DDE, PDP data for cow's milk shows that no pesticide residues were detected in more than 3% of the samples. Pesticide residues were not detected in beef muscle or beef liver in the nearly 600 samples analyzed to date. Similarly, pesticide residues were rare in chicken muscle and liver, but a few adipose samples contained DDE and dieldrin up to 0.005 ppm.

The data generated by PDP reflect pesticide residues in foods available to the US consumer, including both domestic and imported products. Many commodities are almost entirely of domestic origin with only a minor import component. However, some fresh commodities, such as grapes, peaches, and pineapples, are from domestic growers during part of the year and imported during the remaining months. When PDP samples are collected, the country of origin information is obtained allowing imported versus domestic produce to be compared. For example, detection rates of selected US and imported commodities from Chile and Mexico were compared for at least 1 full year (Table 5). The percent of peaches with detectable residues averaged 95% and 98% for the domestic and Chilean crop, respectively. Similarly, detection rates for imported versus domestic winter squash and green beans were approximately equal. Chilean grapes, however, averaged 92% detection rates as compared with 65% for domestic grapes. Mexican cucumbers showed 92% detection rates compared with 62% for the domestic crop.

Table 5. Comparison of Pesticide Residues in Selected Commodities from US, Chile, and Mexico.

Origin	Commodity	Samples Analyzed	Detections	%
US	Peaches	812	779	95
Chile		808	791	98
US	Grapes	1,379	898	65
Chile		1,085	994	92
US	Green Beans	1,137	726	64
Mexico		243	177	73
US	Cucumbers	780	487	62
Mexico		618	566	92
US	Winter squash	605	236	39
Mexico		331	139	42

Although detection rates in some commodities were approximately the same, the distributions of pesticide types are clearly dissimilar (Table 6). Considering recent data, about 20% of Chilean peaches were found to contain residues of methamidophos compared with <1% for domestic peaches. Conversely, Chilean peaches were found to contain no residues of dicloran, compared with 24% detected in the US product. Fludioxonil was found on 49% of domestic peaches and none of the Chilean products. The differences in pesticide detection could reflect different uses because of varying pest pressures, agricultural practices, and/or economic choices.

Table 6. Comparison of the Distribution of Selected Pesticides Residues in Peaches from Chile and US

Pesticide	Origin	Samples Analyzed	Detections	%
Azinphos methyl	United States	812	117	14
	Chile	808	636	79
Carbaryl	United States	812	158	19
	Chile	808	236	29
Chlorpyrifos	United States	812	109	13
	Chile	808	432	53
Dicloran	United States	812	194	24
	Chile	808	4	< 1
Esfenvalerate	United States	537	34	6
	Chile	680	93	14
Fenvalerate	United States	537	31	6
	Chile	680	122	18
Fludioxonil	United States	539	265	49
	Chile	548	0	0
Iprodione	United States	789	287	36
	Chile	808	692	86
Iprodione isomer	United States	802	140	17
	Chile	808	475	59
Methamidophos	United States	812	1	< 1
	Chile	808	158	20
Phosmet	United States	812	561	69
	Chile	808	331	41

The data collected by PDP are useful not only for single chemical risk assessments and future cumulative assessments based on common modes of toxicity, but will be fundamental to assessing dietary exposure and subsequently estimating the risks associated with exposure to multiple pesticides of varying modalities and degrees of toxicity. The most recent data available indicate that more than one residue was detected in 23% of all samples tested. Although exceedingly rare, some samples contained up to 12 different pesticide residues. During 2003 for example, 7 samples were found to contain 11 different pesticide residues. While 6,091 samples analyzed during 2003 contained no detectable residue, more than 700 samples contained 4 or more residues. Most multiple residue detections result from application of

more than one pesticide on a crop during a growing season. However, other possible sources contributing to the number of multiple residue detected are: pesticide formulations containing two or more isomers, degradation of a pesticide resulting in one or more metabolites, spray drift, uptake through crop rotation, contamination at packing facilities, and persistent environmental residues like DDE.

Summary and Conclusions

Since its inception PDP has collected and analyzed more than 100,000 samples of a large variety of fruit, vegetables, grains, meats, milk, and drinking water for pesticide residues providing realistic data for dietary exposure assessments. During this period the overall percent of samples with detectable pesticide residues was approximately 58% although the rate varies substantially by commodity. The percentage of samples with detectable residues was remarkably similar for several commodities over numerous growing seasons suggesting consistent pesticide usage.

We found commodities having residues with no current EPA tolerance in 2.6% of the samples perhaps due to inadvertent contamination of a crop by spray drift from adjacent fields. In no year have more than 1% of the samples demonstrated residues above established EPA tolerances which suggests that illegal pesticide uses on foods is rare.

Generally, samples with detectable pesticide residues were less abundant in processed foods where extensive washing, processing and /or heating is expected to remove or reduce residues. Notable exceptions of canned green beans and canned spinach demonstrate that some residues are more tolerant of processing than others presumably based on the chemical stability. A classic example of a compound with well know environmental stability is DDE p,p' and we have found that residues of DDE p,p' continue to be detected in significant amounts of foods especially spinach, root crops, and beef adipose more than 30 years after its use was prohibited.

Although detection rates in some commodities imported into the US were approximately the same as the domestically produced variety, the distributions of pesticide types are clearly different. These differences in use patterns could be due to economic considerations, dissimilar pest pressures or local growing practices.

PDP data have been useful for prediction of dietary exposure for a number of single chemical assessments and are suitable for assessing exposure to multiple compounds

John Punzi obtained his Ph.D. degree in biochemistry in 1991 from the State University of New York at Buffalo. He obtained postdoctoral training in biophysics, pharmacology, and macromolecular crystallography at the Hauptman-Woodward Medical Research Institute in Buffalo, New York and the University of Rochester, Rochester, New York studying protein-ligand interactions. In 1993 Dr. Punzi was recruited to build a biochemistry laboratory for research and training in the Eastman Dental Center at the University of Rochester where he developed Federally funded research programs to study proteinhydroxyapatite interaction. In 1997 John began his career with the US Federal government at the Environmental Protection Agency where he began to use pesticide structural data to model toxicity and residue data to estimate exposure. The novel work was awarded the EPA's gold and bronze medals in 1999 and 2000, respectively. In 2002 Dr. Punzi moved to the U.S. Department of Agriculture to advance the Pesticide Data Program, assist in developing a microbial monitoring program, and participate in other food safety issues. Dr. Punzi has published more that 40 chapters, papers, and abstracts.

Diana Haynes obtained her bachelor's degree in chemistry, graduating summa cum laude with a minor in mathematics in 1988 from Central Washington University, Ellensburg, Washington. She began working in the Quality Control chemistry section of TreeTop, Inc., located in Selah, Washington. In 1989, she began working for the Washington State Department of Agriculture (WSDA), analyzing pesticide residues in agricultural products. Ms. Haynes served as the Food Chemistry section supervisor and WSDA Technical Program Manager for the U.S. Department of Agriculture Pesticide Data Program (PDP). During this time, Ms. Haynes was also the lead chemist for WSDA Interregional Regional Research Project Number 4 (IR-4) projects and worked as a lead mass spectroscopist. She was a member of the first national PDP Quality Assurance Committee in 1992 that worked to develop initial program Standard Operating Procedures and as a member of the national PDP Mass Spectrometry Committee in 1992 and 1993 that developed program criteria. In 1992, Ms. Haynes was selected as the WSDA Professional Employee of the Year. In 1996, Ms. Haynes was appointed as the Quality

Assurance Officer (QAO) for the USDA PDP in Manassas, Virginia and worked as the QAO for the USDA Microbiological Data Program (MDP) from 2002-2004. Since 2004, Diana serves as the Deputy Director for the USDA Monitoring Programs Office, which oversees both the USDA MDP and PDP programs.

Martha Lamont has a Bachelor of Science degree in Chemistry. Ms. Lamont has nearky twenty years of experience as a bench Chemist, during which she performed analysis of environmental contaminants in various matrices. In 1991, she joined the U.S. government and worked initially for the Environmental Protection Agency and later joined the U.S. Department of Agriculture. In her current capacity as Director of the Monitoring Programs Office, Ms. Lamont directs activities for two programs that collect data for pesticides and food borne pathogens in food: the Pesticide Data Program and the Microbiological Data Program. Data collected by these two programs are used mainly for risk assessments.

Dr. Robert Epstein received his M.S. and Ph.D. degrees in analytical chemistry from the Polytechnic University (formerly Brooklyn Polytechnic Institute) and a B.S. in chemistry from the City College of New York. Dr. Epstein has served as deputy administrator for the Agricultural Marketing Service (AMS) Science and Technology Programs, since June 2000. With 26 years of service at USDA, Dr. Epstein has held various leadership positions involving food safety, laboratory services, international trade, toxicology, residue chemistry, and quality assurance. From 1979-1990, Dr. Epstein served as a Branch Chief at the Food Safety and Inspection Service. In 1990 was promoted to associate deputy administrator for Science and Technology Programs and as Science and Technology Programs deputy administrator. Dr. Epstein oversees laboratory services for AMS' commodity programs, the Department's Pesticide Data and Microbiological Data Programs, the Pesticide Recordkeeping Program, the Plant Variety Protection Office, and AMS information technology, technical support and statistical services. Dr. Epstein also serves as the alternate U.S. delegate to the Codex Committee on Pesticide Residues. During 1999, Dr. Epstein served as Science Advisor to Secretary of Agriculture with responsibility for science issues in trade.

from single sources. Clearly, the most challenging risk assessments are forthcoming and methods to estimate and quantify dietary exposure are currently being developed to incorporate these novel data. PDP data are complimentary to those generated by FDA's total diet study which examines prepared foods for nutritional as well as toxic contaminants and pesticide residues (Yess et al, 1993).

Acknowledgements

The Authors gratefully recognize the contributions of the USDA PDP staff and the administrative, sampling and analytical efforts of the participating States.

References

Copies of the 2003 PDP Annual Summary can be obtained by writing to the Monitoring Programs Office, Science and Technology, Agricultural Marketing Service, USDA, 8609 Sudley Road, Suite 206, Manassas, VA 20110, by faxing (703) 369-0678, by calling (703) 330-2300, extension 10, or by submitting an e-mail request to amsmpo.data@usda.gov. Copies of other annual summaries and pesticide data can be downloaded from the USDA PDP web site: http://www.ams. usda.gov/science/pdp/Download.htm

- Fillion, J., Hindle, R., Lacroix, M., and Selwyn, J., (1995) Multiresidue Determination of Pesticides in Fruit and Vegetables by Gas Chromatography-Mass –Selective Detection and Liquid Chromatography with Fluorescence Detection. J. AOAC INTERNATIONAL 78, 1252–66.
- Hsu, R., Biggs, I., and Saini, N.K., (1991) Solid-Phase Extraction Cleanup of Halogenated Organic Pesticides. J. Agri. Food Chem. 39, 1658-66.
- Kott, P.S. and Carr, D.A., (1997) Developing an Estimation Strategy for a Pesticide Data Program. J. Official Statistics, 17, 367-83.
- Lamont, M., (2002) Variability of Pesticide Residue Concentrations in Single Servings. 4th European Pesticide Residue Workshop, Abstract. Rome, Italy.
- Luke, M.A., Froberg, J.E., and Masumoto, H.T., (1975) Extraction and Cleanup of Organochlorine, Organophosphate, Organonitrogen, and Hydrocarbon Pesticides in Produce for Determination by Gas-Liquid Chromatography. J. AOAC INTERNATIONAL 58, 1020-6.
- Punzi, J., 2004, USDA Pesticide Program 1993-2002. 41st Annual Florida Pesticide Residue Workshop, Abstract. Orlando, Florida Sheridan, R. S., and Meola, J., (1999) Analysis of Pesticide
- Residues in Fruits, Vegtables, and Milk by Gas Chromatography/ Tandem Mass Spectrometry. J. AOAC INTERNATIONAL 82,
- Yess, N.J., Gunderson, E.L., and Roy, R.R., (1993) US Food and Drug Administration Monitoring of Pesticide Residues in Infant Foods and Adult Foods Eaten by Infants/Children. J. AOAC INTERNATIONAL, 76, 492-507.

Other articles on residues in food published in *Outlooks on Pest Management (Pesticide Outlook)* appeared in 1997 **8(2)** 6; 1999 **10(3)** 121; **10(5)** 190; 2002 **13(4)** 142; **13(5)** 209.

Take out a subscription to International Pest Control ... and get a copy of the International Pesticide Directory each year in Acrobat format - free!



CEPA/FAOPMA Members

Reduced subscription rates to International Pest Control are available to members of CEPA (Confederation of European Pest Control Associations) and FAOPMA (Federation of Asian and Oceania Pest Managers Associations).

Complete the form opposite and fax or post back to: The Subscription Manager, Research Information Ltd, 222 Maylands Avenue, Hemel Hempstead, Herts. HP2 7TD, UK. Tel: +44 (0)20 8328 2471. Fax: +44 (0)1442 259395. Email: info@researchinformation.co.uk. Web: www.researchinformation.co.uk

Subscription Order Form

Please send me International Pest Control (six issues) for one year @

- []£140 (US\$308) Institutional
- [] £79 (US\$138) Personal
- [] £49 (US\$85) CEPA/FAOPMA Member

Name / Job title:

Dept:

Organisation:

Address:

Postcode:

Tel:

- [] Please send a proforma invoice
- [] I enclose a cheque drawn on a UK bank

Please charge my:

[] Mastercard [] Visa [] Amex

Card no:

Expiry date:

Name on card:

Signature: