US FOOD AND DRUG ADMINISTRATION PESTICIDE PROGRAM AND ASSOCIATED ANALYTICAL METHODOLOGY

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I want to thank the Conference organizers and government of Spain for this opportunity to present and discuss the US Food and Drug Administration's Pesticide Program and the associated analytical method development to carry out such an effort.

FDA PESTICIDE PROGRAM

FDA's Pesticide Program is made up three parts: Regulatory surveillance of domestic and imported foods, Total Diet Study and Monitoring. Each of these requires analytical methodology, technologies and data acquisition. Consequently, the Pesticide Program is continually growing and expanding as research and instrumentation improve capabilities.

REGULATORY SURVEILLANCE

Surveillance of domestic and imported foods requires analysis of a wide variety of common and unusual foods and commodities for their compliance with US tolerances which are set by the US Environmental Protection Agency. FDA laboratories are required to test these foods for compliance, that is whether the level of the pesticide found on this food is within tolerance limits. Each food or food group may have more than 30 individual tolerances. For example, grapes has more than 70 individual pesticide tolerances ranging from 0.05 - 60 ppm; strawberries has over 40 pesticide tolerances and so on.

Consequently, the task of determining not only the identity but quantity of each pesticide residue and to determine it's compliance with a specific food tolerance is extensive. In addition, a pesticide may have been applied to a particular food for which there is no US EPA tolerance. The absence of a food tolerance makes this finding and food item violative, i.e. the food item contains an adulterant, namely an unapproved pesticide residue.

This entiere scenario describes the extensive and difficult challenge facing the pesticide analytical chemist today. The challenge is ever increasing as more pesticides are developed and wider variety of international foodstuffs are imported. Non-traditional foods are becoming a larger proportion of the US food supply. Foods such as: chimoya, clementine, carambola, winter melon, duck eggs, snow peas, etc. are more routinely analyzed today versus 5 years ago. How should these foods be analyzed and which pesticides are likely to be applied and found as residues? What constitutes the edible portion, what should be removed prior to analysis and what levels should be expected are common questions when presented with a "new" food item.

The FDA analyst receives guidance on the preparation and suggested analysis method through the Pesticide Analytical Manual (PAM).

The portion of commodity section of the PAM directs the chemist to prepare the sample according to 1) tolerance directions, for example, analyze pineapples without crown or for beets- analyze beet tops and the beet separately or for grapes anlyze without stems; or, 2) if no tolerance exists for a food item, the whole product is prepared and analyzed (note: stones or pits are discarded in all cases). FDA routinely analyzes the whole fruit or vegetable unless the tolerance expressly instructs otherwise. Adherence to these instructions results in consistent analysis of foods and calculated levels of contaminants whether or not we are familiar with the food commodity.

TOTAL DIET PROGRAM

The Total Diet Study program is FDA's market basket survey, which many countries have instituted. The market basket represents the National diet from which certain age/sex group diets may be constructed and monitored for contaminant and nutrient intake. For example, this Fiscal Year, October 1- September 30, 1991, FDA will initiate a new diet comprising 264 individual foods. The prior market basket contained 254 foods. The specific items

contained in a market basket are determined based on a national food survey conducted every 10 years by the US Department of Agriculture Nutritional Survey unit. The survey summarizes interviews from a statistical number of homes in the US. The interviews detail the foods eaten during a 2 week period by the family. The data is summarized and then prioritized by grouping and aggregates are constructed to represent food groups and items. For example, desserts are prioritized and one subcategory of desserts - pies, are represented by the type of pie most often consumed. Apple, cherry, berry pies represent the types of pies consumed by US families. The most frequently consumed type of pie would represent the subcategory in the food item list for the diet. The US Total Diet Study has seen a great change in the eating habits of the US consumer over the years. "Fast foods" consumption has increased. These are foods such as Mc Donald's hamburgers, pizza, Chinese foods and other foods which are available ready-to-eat at restaurants or food stores. Consequently, Total Diet analytical methodology has had to adapt to determine pesticide residues in such foods.

The Total Diet Study market basket and the selected foods within it which represent the eight age/sex groups: (infant; toddler; adolescent male; adolescent female; adult male; adult female; elderly male; and elderly female) are analyzed table-ready. Table-ready means the foods are prepared as the US consumer would do so prior to eating. Preparation may include: baking, defrosting, grilling, boiling, frying, toasting, warming and other food preparation steps. Analysis of these prepared foods for pesticides, industrial chemicals and trace elements (nutrients or toxic elements), supplies FDA with the information and data to assess the amounts and types of contaminants being consumed within the US population diet as well as nutrient intake. The Total Diet data are very valuable in assessing the effectiveness of US food regulations, such as pesticide tolerances, and it is the only mechanism to compare the relative contaminant intake by consumers in other countries. Each country conducting market basket surveys may compare their data with US FDA's, World Health Organization's allowable daily intake levels, or any other countries with similar programs. This concept of a national diet allows food regulatory policy to be evaluated at the consumer level rather than the farm gate. The ultimate contaminant burden which the consumer receives may be directly determined.

The analytical chemistry to effectively determine contaminant levels is a significant undertaking given that the levels of interest are parts per million

and usually parts per billion. Accordingly, FDA has devoted a significant amount of resources to maintaining expertise, technology and methodology to meet these rigorous demands.

MONITORING

The third effort within the Pesticide program is monitoring. Monitoring is strictly an effort to gather data on particular pesticide/commodity combinations. Data from monitoring efforts may support in the reregistration of a pesticide on a particular food commodity or group of foods, support a change in regulatory policy or provide current information not available otherwise.

This fiscal year, FDA is embarking on a new monitoring effort, a Statistical Sampling initiative. FDA will monitor pesticide levels on two high volume food commodities, tomatoes and pears. Sixteen hundred samples of pears and the same number of tomatoes will be collected and analyzed for pesticides having US tolerances and for pesticides known to be used in foreign countries on these foods whether or not US tolerances exist. This effort is being undertaken provide the FDA with statistical confidence (95% or greater) that these commodities' tolerance violation rates are within or below regulatory surveillance violation rates.

To explain further, FDA has continually been criticized that its Surveillance Program which annually analyzes 15,000 - 20,000 samples, domestic and imports, is not statistically sound and this level of sampling neither provides the consumer nor the US Congress with a high level of confidence. The violation rate for the past fiscal years has remained fairly constant for all samples analyzed. Our critics postulate that this violation rate level, 3-5%, is unsubstantiated given the large volume of produce entering the country from abroad, the large volume of domestic produce, and FDA's relatively small number of samples. Theresfore, FDA is undertaking the statistical program I have described. Again, the analytical methodology, instrumentation and data handling require specific attributes to accomplish this effort in a timely manner.

FDA PESTICIDE FIVE-YEAR RESEARCH PLAN

In 1988, the US Congress passed the Trade Bill which contained legilation affecting the FDA Pesticide Program, especially our surveillance of imported foods. The Bill directed FDA to institute a number of management, research and data compilation initiatives to enhance the pesticide program. In response, FDA developed: Regional Sampling planning mechanism; developed a computerized database of pesticide findings and established a long-range pesticide research program. I will discuss the research program, now.

FDA has maintained a high degree of analytical expertise in current techniques while exploring new technologies, automation, expanding methods to more chemicals, development of new methods over the last twenty five years. However in 1989, FDA developed a Five-Year Research Plan to document and give direction to the Program's overall research efforts. This Plan is updated yearly by removing projects which have been accomplished, adding new proyects, changing targets and so on.

The Plan includes four basic goals with specific objetives. Research projects are identified within the respective goal/objective and estimate is made on equipment and timeline to accomplish the project goal. The Plan details projects anticipated over a five-year timeframe. The Plan four major goals are to:

1) Acquire efficient and practical analytical methods for pesticide residues,

2) Increase the number of pesticides and food samples covered by the FDA program,

3) Assess the capabilities of new analytical technologies,

4) Validate selected methods by collaborative study or other inter-laboratory processes.

The Five-Year Plan serves to summarize prior research accomplishments and to plan in a priority setting manner the current research projects for methods, techniques and new chemicals. I would like to discuss the Plan and some of the specific projects as they relate to the overall Pesticide Program I outlined earlier.

GOAL 1: ACQUIRE EFFICIENT AND PRACTICAL ANALYTICAL METHODS

The objectives of this goal are:

1) Test pesticide chemicals with appropriate chemical structures using applicable existing FDA Multiresidue Methods (MRMs).

2) Develop additional selective MRMs for those chemicals not recovered by existing MRMs; validate through interlaboratory trials.

3) Evaluate Single Residue Methods (SRMs) for chemicals not recovered by MRMs.

4) Develop SRMs for chemicals for which no existing MRM or SRM is suitable; validate.

To explain the process and the concept behind this Goal and its four objectives, I must first discuss the PESTRAK database. PESTRAK is a computer database developed by FDA. The database contains more than 650 parent pesticide compounds and more than 900 parent and related chemicals such as, degradation products, isomers, metabolites and associated chemicals. PESTRAK identifies FDA multiresidue methods (MRMs) which are applicable to the specific parent pesticide residue. PESTRAK also identifies chemicals for which no MRM method exists or no routine analytical method exists that accurately determines the chemical residue at tolerance levels. Consequently, PESTRAK serves to identify chemical/method research needs.

These research needs may include a lack of a method for all commodity types (applicable to citrus except oranges; or applicable to root vegetables except onions) for which the pesticide is applied, only some commodity types (such as fatty foods) or methods which exist but do not reach the necessary lower level(s) of concern. Consequently, GOAL 1 identifies in a priority manner those chemicals which FDA must develop, expand or enhance methods to improve the scope of FDA's Pesticide Program.

FDA has five MRMs which are used routinely to determine pesticide residues on fruits and vegetables. These five MRMs are:

1) Pesticide Analytical Manual Volume 1 (PAM I) 232. 4 - Luke procedure

2) PAM I 232.3 - Storherr procedure

3) PAM I 211.1 - Fatty Food procedure

4) PAM I 212.1 - Nonfatty food procedure

5) PAM I 242.1 - Carbamate procedure Krause

Chemicals are continually being tested through these methods for applicability. Chemicals not recovered are then prioritized for SRM method development research.

I would like to share some of our current accomplishments and research efforts to expand FDA's pesticide program. Examples of such efforts are:

OBJECTIVE 1- New chemicals are tested and data generated to document an MRM applicability

- aramite- PAM I 232.4
- deltamethrin- PAM I 232.4
- haloxyfop- Chlorphenoxi acid method
- terbufos sulfone- PAM I 211.1

OBJECTIVE 2- Development of New MRMs

New MRMs are also developed when current MRMs are not applicable or do not recover the residues quantitatively. Likewise, new classes of compounds, metabolites or residues are identified requiring better techniques or lower levels. Examples of these efforts are:

- Aniline residues, e.g. alachlor metabolites
- Validate synthetic pyrethroids method
- Test carbamates through phenylurea method
- Complete interlaboratory trial of benzimidazole method

Within this objective, methods which are successfully developed are subjected to validation. Validation may include verification of the written instructions, recovery studies, interlaboratoy trials and ultimately collaborative studies. We acknowledge these efforts within the Five-Year Plan. FDA anticipates that during the validation period an MRM or SRM method is further shaped, rewritten and enhanced to produce a better analytical product.

OBJECTIVE 3- Evaluate SRMs

• No projects currently underway

OBJECTIVE 4- New SRMs

Not all chemicals are easily handled by MRMs. Some require special conditions, manipulations, chromatography or other considerations so that the methods to recover them are unique. Such methods are denoted as Single Residue Methods (SRMs). Examples of current SRM efforts are:

• SRM method for phosphine, replacement for EDB

• SRM method for glyphosate

GOAL 2: INCRESED COVERAGE OF FOODS AND CHEMICALS

The Pesticide Program requires that analytical methods be efficient. Importation of foods at the border or entering through Custom at the docks, requires analytical tests to provide answers on the compliance of those foods in very short timeframes. The commodities may be perishable and delaying distribution to products test is not practical. Consequently, FDA has, in GOAL 2, acknowledged the need for expedited analysis.

OBJECTIVE 1- Develop rapid methods

• Develop inmunoassays for thiophanate methyl

• Develop Enzyme Induction Analysis method for paraquat and fenamiphos; validate.

Rapid methods are not necessarily "rapid". They are, however, anticipated to require less effort, less-training and may be taught to non-technical personnel to "screen" samples. This type of analysis, though commonplace in natural toxins (alfatoxins) and trace elements (lead and cadmium in glazed pottery), has not been very successful in the pesticide residue arena. Rapid test kits are usually specific to a pesticide rather than general, except for cholinesterase inhibition tests. Because of this specificity, numerous individual tests must be employed to comprehensively "screen" for the possible residues. Rapid test kits are best applied when a single or small number of pesticides are suspected.

OBJECTIVE 2- Commercial test kits

- Evaluate cholinesterase inhibition test.
- Evaluate commercial kits for metalaxyl, 2, 4-D

Food marketing has progressed to such an extent over the past 10 - 15 years that today we now find our inspectors at airports, borders, docks sampling perishable or specially containerized food samples. The response time now must be reduced so that commerce is not impeded while at the same time protecting the public health. Automation and data handling techniques have become a necessity rather than a luxury. Combining these techniques while preserving quality control and quality assurance are difficult tasks. FDA research is focussing on ways to improve sample testing timeframes and data reporting. Some examples are:

OBJECTIVE 3- Automation of existing methods

- Apply robotics to PAM I methods
- Assess computer assisted data handling for identification/quantitation

One effort which may greatly improve analytical efficiency is to replace or improve outdated, outmoded methods. By utilizing state-of-the-art techniques, lower levels of concern and shorter sample timeframes may more easily be achieved. We at FDA recognize the challenges facing us today and we are exploring ways of changing the status quo. At times, we have employed "old" methods to handle an emergency or individual situation without searching for the best method or technique. Or we have applied well-documented methods which were not intended for a specific application. Sooner or later, we must become more efficient; efforts must be made to change and to more capably determine pesticide residues in the products of interest. Objective 4 deals with these situations.

OBJECTIVE 4- Improvement of outdated methods

- Improved method for infant formula
- Improved method for EBDCs

Infant formula was considered to be similar to milk. So we employed fatty food methods, but those of us who have analyzed it know the difficulties

with this approach. Or if you've had to analyze vegetables, spinach for instance, to determine ethylene bis-dithiocarbamates via carbon disulfide generation. Both the analysis and result were less than ideal. We hope to make improvements in both cases.

OBJECTIVE 5- Development of comprehensive analysis scheme

• Expand PAM I 232.4 to carbamates

In keeping with the concept that it is more efficient to analyze samples with a few MRMs rather than a battery of SRMs, FDA devotes a great deal of time to adapt or apply MRMs to new chemicals and classes. The ideal method would be to comprehensively recover all pesticide residues. This is not a reality given the different chemical structures and properties exhibited by fungicides, acaricides, nematocides, and insecticides, Nevertheless, efforts are continuing to expand, when possible, the relatively few MRMs to these chemicals or metabolites, see Objective 5.

FDA, in performing analytical methods, is constantly reminded of the flammable solvents, hazardous waste and inefficiency inherent in the way we have analyzed for pesticides. We recognize the need to reduce the size and scale of our extraction, partitioning and cleanup techniques to reduce these hazards and to accommodate automation. Accordingly, we continuing to explore and miniaturize our analytical techniques.

OBJECTIVE 6- Apply miniaturization concepts

• Miniaturize the Hydromatrix solid phase partitioning column

• Complete miniaturized method for polar pesticides in oil

The Hydromatrix column is used to remove water from the extraction solvent. It speeds the analysis time when used in conjunction with PAM I 232.4 Luke procedure for fruits and vegetables. This column was developed for use in the Total Diet program and has shown great utility throughout our pesticide laboratories. The second project listed here is of particular interest because it was not so long ago that it was nearly imposible to recover polar pesticides from oils or fatty foods. Now we have progressed to where a miniaturized procedure is possible and practical.

GOAL 3: ASSESS CAPABILITY OF NEW TECHNOLOGY

Goal 3 acknowledges the need to expand pesticide methodology to new frontiers. New technology can assist in the extraction, detection and data handling of pesticide residues. FDA has for more than 25 years tested, evaluated and incorporated new technology into our pesticide methodology scheme. We strive to make our pesticide methodology state-of-the-art. Under this goal, FDA has mapped out new frontiers which show promise.

OBJECTIVE 1- Assess new technologies

- Supercritical Fluid extraction technology.

The Total Diet program, as I mentioned earlier, contains market baskets which are made up of 264 food items which must be analyzed at levels far below tolerance limits. Total Diet contaminant levels of interest are 5-20 ppb. Consequently, time and effort to extract and partition pesticide residues is greater here than for other surveillance type analyses. Supercritical fluid extraction affords an opportunity for low level (trace) residue analysis. Its time savings, solvent savings and corresponding "cleaner" estract should benefit the overall quality of determining pesticide residues at these levels. Total Diet researchers are currently building a prototype SFE estractor and testing its parameters for the program. The success of this research is far reaching for low level pesticide residue analysis.

OBJECTIVE 2- Assess new technologies for residue isolation

- No current projects

OBJECTIVE 3- Assess new technologies for residue determination

- Incorporate widebore capillary GC
- Evaluate Ion Trap GC-MS to routine pesticide determination
- Evaluate Atomic emission detector
- Assess chemiluminescence detectors (sulfur, nitrogen)

Technology is evolving rapidly and we in pesticide residue analysis must consider its utility, application and promise. Mass spectrometers have

been used for more than 20 years in the confirmation of contaminants, especially pesticides. However, the routine application of MS as a primary detector for residue analysis has not generally been accepted. Its relative high cost, maintenance and data interpretation via computer has impeded its routine incorporation into everyday use. FDA is exploring this capability with the Ion-Trap detector. Atomic emission detectors have been used in trace element analysis for many years. The advent of a gas chromatograph linked to an emission detector with ppm and ppb element levels of detection capability make this detector very promising too.

GOAL 4: VALIDATE METHODS AND TECHNIQUES

OBJECTIVE 1- Collaborate existing methods

- Collaborate phenylurea method

OBJECTIVE 2- Collaborate or otherwise test other methods as developed

- Test formetanate hydrochloride HPLC method
- Test paraquat, diquat HPLC method
- Test immunoassay method for paraquat

The final goal, Goal 4, speaks to the validation of methods and technologies (Note: Goals 2 and 3 also include validation as a criterion for successful method development). As we talk here today about analyses of foods: vegetables, fruits, feeds, etc., we must be cognizant of the fact that methods must be tested, retested, verified, interlab tested, and if applicable collaboratively tested. Why?. Pesticide residue analysis has become an international science where foreign governments, private firms, importers, exporters, and others have commodities in international commerce. Methods to assess compliance with US EPA tolerances, CODEX, country tolerances, and other specific food regulations must be validated so that experienced scientists throughout the world may apply them equally. Recent experiences have reinforced this extremely important aspect of analytical method development.

Procymidone in grapes and wine presented such an experience for the US, Europe, Australia, etc. Procymidone, a fungicide, had no US tolerance

in 1990. FDA, through its Fiscal Year 90 National Pesticide Sampling Plan, identified imported wine for collection and analysis (FDA develops a yearly national sampling plan to target a wide range of imported and domestic commodities for analysis. The Plans are developed at FDA regional offices using Battelle Agrochemical Databank information of foreign produce and pesticides applied; current methodology capabilities; volume and type of commodities in local commerce during particular seasons). Italian sparkling wine, then French and Spanish white and red table wines were sampled and found to contain procymidone at levels greater than 20 ppb (Note: US wine was also analyzed. No procymidone was found, but legal levels of iprodione were detected. Iprodione is an alternative fungicide with US EPA tolerance on grapes). This was a violation of the Food, Drug and Cosmetic Act and consequently, all wines found to contain this residue at or above the limit of determination, LOD= 20 ppb, were detained or seized.

US EPA, having no toxcological data nor residue data, requested such from the manufacturer, Sumitomo. FDA and EPA had numerous discussions and exchanged samples with foreign, state and private laboratories. We explained not only our methodology but our residue calculations and limits of determination based on analytical methodology and instrumentation. The method, findings and quality control aspects were under great scrutiny by importers, wine producers, and foreign laboratories. While laboratories were allowed to employ any comparable methodology with accompanying validation data, FDA had existing and well documented procedures in place. Assessing the recovery and perfomance of the method with respect to procymidone was routine. Therefore, FDA and US EPA were able to deal with this regulatory issue with confidence.

Validation of methods is needed to both show the method is applicable and that the laboratories are capable. FDA's Pesticide Program relies on the fact that each of its 13 pesticide servicing laboratories is capable of analyzing samples for these residues at tolerance levels and below. While we enforce tolerances, we also generate enormous amounts of monitoring data at levels far below those set by tolerance. This monitoring data shows not only residues actually present and their amounts, but also pesticides which are not present. By this I mean, FDA must be capable of determining pesticides accurately at tolerance levels down to limits of determination whether the residue is present or not. FDA pesticide residue methods must be capable of answering the question-If a pesticide was applied would FDA have detected it and at what level?

PESTICIDES RECOVERED THROUGH MRMs

In assessing our monitoring and surveillance data, FDA draws conclusions based on our capabilities to determine more than 292 parent pesticides through its MRMs. This number is substantially increased when we include new MRM methods: such as chlorphenoxy acids, phenylureas, benzimidazoles, paraquat and diquat.

FDA's research efforts will be contained in the new 3rd Edition of the PAM which is being drafted in 1991-1992. The 3rd Edition PAM will employ desktop publishing techniques which should improve the readability and access to the methods of interest. PAM will never be a static reference but continually updated to describe FDA's current analytical methods, techniques and systems.

I would like to now show the effect of our research efforts through our Fiscal Year 1.990 Residues in Foods Report. Again, the data captured here was generated using the latest in FDA methods, techniques and instrumentation. Increasing capabilities to determine residues of benzimidazoles, daminozide, carbamates, methyl bromide and expanding our capabilities to aquaculture, processed foods have enhanced the FDA pesticide program.

FDA has enbarked on this ambitious analytical research effort to enhance our capability to determine pesticide residues at lower levels, on new food items, and more efficiently. As this continuing research effort produces and evaluates new technologies, the US consumer as well as the consumers around the world should have greater confidence in their food supply and that unwanted and illegal pesticide residues are not present. FDA's pesticide residue research efforts are critical to maintaining our capabilities, while increasing our ability to assess the food supply, develop sound regulatory policy and protec the consumer.

SUMMARY BOXES

US FDA PESTICIDE PROGRAM ANALYTICAL METHODOLOGY

- REGULATORY SURVEILLANCE: IMPORTED AND DOMESTIC FOODS
- TOTAL DIET/MARKET BASKET SURVEY
- MONITORING

REGULATORY SURVEILLANCE IMPORTED AND DOMESTIC FOODS

- US EPA TOLERANCES
- FOREIGN USES BATELLE AGROCHEMICAL DATABANK
- FOODS
  - NON-TRADITIONAL
  - TRADITIONAL

TOTAL DIET/MARKET BASKET SURVEY CONTAMINANTS - PESTICIDES AND TRACE ELEMENTS

- NUTRITIONAL SURVEY
- 264 FOOD ITEMS
  - AGGREGATED-DESSERTS
- AGE/SEX GROUPS
- ALLOWABLE DAILY INTAKE

MONITORING

- PESTICIDE/COMMODITY COMBINATION
  - REREGISTRATION
  - CURRENT INFORMATION
- STATISTICAL SAMPLING: 3.200 SAMPLES
  - TOMATOES
  - PEARS

FDA PESTICIDE PROGRAM FIVE - YEAR RESEARCH PLAN GOALS

- ACQUIRE EFFICENT AND PRACTICAL METHODS
- INCREASE NUMBER OF PESTICIDES AND FOODS COVERED
- ASSESS CAPABILITIES OF NEW TECHNOLOGIES
- VALIDATE METHODS

FIVE YEAR RESEARCH PLAN: ACQUIRE EFFICIENT AND PRACTICAL METHODS

- TEST CHEMICALS THROUGH MRMs
- DEVELOP ADDITIONAL MRMs; VALIDATE
- EVALUATE SRMs
- DEVELOP SRMs: VALIDATE

GOAL 1

MULTIRESIDUE METHODS (MRM) PESTICIDE ANALYTICAL MANUAL (PAM)

- PAM 1 232.4 LUKE PROCEDURE
- PAM 1 232.3 STORHERR PROCEDURE
- PAM 1 211.1 FATTY FOOD PROCEDURE
- PAM 1 212.1 NONFATTY FOOD PROCEDURE
- PAM 1 242.1 CARBAMATE PROCEDURE

FDA FIVE-YEAR RESEARCH PLAN: GOAL 1-OBJECTIVE 1 PROJECTS

- MRM PAM 1 232.4
  - -ARAMITE
  - -DELTAMETHRIN
- MRM PAM 1 211.1
  - -TERBUFOS SULFONE
  - -TERBUFOS SULFOXIDE
- MRM CHLORPHENOXY ACID METHOD
  - -HALOXYFOP

FDA FIVE-YEAR RESEARCH PLAN: GOAL 1-OBJECTIVE 2 PROJECTS

- ANILINE RESIDUES; E.G. ALACHLOR METABOLITES
- TEST CARBAMATES THROUGH PHENYLUREA METHOD
- COMPLETE TRIAL OF BENZIMIDAZOLE METHOD
- VALIDATE SYNTHETIC PYRETHROID METHOD

FDA FIVE-YEAR RESEARCH PLAN: GOAL 1-OBJECTIVE 4 PROJECTS

- PHOSPHINE
- GLYPHOSATE

FIVE YEAR RESEARCH PLAN: INCREASED COVERAGE OF FOODS AND CHEMICALS

- DEVELOP RAPID METHODS
  - -INMUNOASSAYS FOR THIOPHANATE METHYL
  - -EIA METHOD FOR PARAQUAT, DIQUAT
- EVALUATE COMMERCIAL KITS
  - -EVALUATE CHOLINESTERASE KITS
  - -EVALUATE METALAXYL KIT
- AUTOMATION OF EXISTING METHODS
  - -APPLY ROBOTICS TO PAM I METHODS
  - -ASSESS COMPUTER-ASSISTED DATA HANDLING
- IMPROVE OUTDATED METHODS
  - -INFANT FORMULA
  - -EBDCs

GOAL 2

FIVE YEAR RESEARCH PLAN: ASSESS CAPABILITY OF NEW TECHNOLOGY

- ASSESS NEW TECHNOLOGY
  - -SUPERCRITICAL FLUID EXTRACTION
- ASSESS NEW TECHNOLOGY FOR ISOLATION
- ASSESS NEW TECHNOLOGIES FOR RESIDUE DETERMINATION
  - -INCORPORATE WIDEBORE / CAPILLARY CHROMATOGRAPHY
  - -EVALUATE ION TRAP GC/MS FOR ROUTINE ANALYSIS
  - -EVALUATE ATOMIC EMISSION DETECTOR
  - -ASSESS CHEMILUMISESCENCE DETECTOR

GOAL 3

FIVE YEAR RESEARCH PLAN: VALIDATE METHODS AND TECHNIQUES

- COLLABORATE EXISTING MRM METHODS
  - -PHENYLUREA METHOD
- VALIDATE OR TEST OTHER METHODS
  - -FORMETANATE HYDROCHLORIDE
  - -PARAQUAT, DIQUAT
  - -IMMUNOASSAY METHODS FOR PARAQUAT, FENAMIPHOS
  - -INTERLABORATOY TESTING OF WIDEBORE CAPILLARY COLUMNS WITH ON-COLUMN INJECTION

GOAL 4

NUMBER OF PARENT PESTICIDES RECOVERED: MULTI-RESIDUE METHODS

PAMI 211.1	PAMI 212.1	PAMI 232.3	PAMI 232.4	PAMI 242.2
111	139	79	244	24

TOTAL FOR ALL
5 MRMs
292*

* NUMBER OF INDIVIDUAL PESTICIDES