Cooperative State Research, Education, and Extension Service
United States Department of Agriculture

Plant Protection Portfolio Review

USDA Goal 3.
Enhance Protection and Safety of the Nation's Agriculture and Food Supply

CSREES Objective 3.2A. Develop and Deliver Science-based Information and Technologies to Reduce the Number and Severity of Agricultural Pest and Disease Outbreaks

For the period 1999-2003

Portfolio Review March 1-3, 2005

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BOOK I:

INTRODUCTION

Plant Protection Portfolio Process

A. Introduction

This report was developed by the Plant Systems Section of Plant and Animal Systems (PAS), the National Research Initiative (NRI) Section of Competitive Programs (CP) and Economic and Community Systems (ECS), Natural Resources and Environment (NRE), Cooperative State Research, Education, and Extension Service (CSREES), United States Department of Agriculture (USDA). It is submitted to the Portfolio Review Panel, which is convened by the CSREES Administrator, in order to assess the effectiveness of these units as they lead efforts to address national problems and/or issues related to the nations agriculture and food supply. The report covers a wide variety of programs conducted from 1999–2003 that are related to CSREES Strategic Goal 3, and Objective 3.2A, to Develop and Deliver Science-based Information and Technologies to reduce the Number and Severity of Agricultural Pest and Disease Outbreaks.

The portfolio self-study is comprised of five books. *Book I* contains an introduction to the portfolio review process. *Book II* includes an organizational structure and a general description of the CSREES vision, mission, functions, and funding authorities. *Book III* is an analysis of the portfolio and Problem Areas (PAs). *Book IV* describes cross-cutting issues in this portfolio and *Book V* is the Conclusion and Summary.

Problem areas (PA) covered in this portfolio include:

PA 211 Insects, Mites and Other Arthopods Affecting Plants
PA 212 Pathogens and Nematodes Affecting Plants
PA 213 Weeds Affecting Plants
PA 214 Vertebrates, Mollusks and Other Pests Affecting Plants
PA 215 Biological Control of Pests Affecting Plants
PA 216 Integrated Pest Management Systems

Cross-cutting issues covered in this portfolio include:

Higher Education	Basic Science
IR-4	406 Programs
Pesticide Safety	Biosecurity and Invasive Species
Sustainable Agriculture and Organic Agriculture	IPM and NPDN Centers

Each PA discussion is composed of research, education, and extension activities across various units within CSREES. A specific program, often conducted by a single program unit or even a single National Program Leader (NPL), may address several PAs and several objectives of the CSREES Strategic Plan. Write-ups on these areas are compressed and do not cover all the activities within a portfolio. Additional information can be found in the Evidentiary Material that will be available at CSREES review. The CSREES website (www.csrees.usda.gov) also contains information on this portfolio's programs.

During the portfolio review meetings, NPLs with responsibility for each PA will provide the Panel with a brief presentation on the highlights of their PA. This introduction provides background information useful to prepare the reader for the remaining Book Sections. Main topics covered include:

- Background on the Portfolio Review Expert Panel (PREP) Process
- Background on CSREES and its funding authorities
- Portfolio Self-Review document organization

B. Background on the Portfolio Review Expert Panel (PREP) Process

(1) New Accountability Requirements

The executive Office of Management and Budget (OMB) now requires Agencies to systematically examine and rate, via OMB's Program Assessment Rating Tool (PART- explained below), Agency efforts and ability to achieve the objectives, goals, and mission of the Agency. Agencies are also directed to conduct "independent" evaluations of their programs and report on these in the PART. This CSREES Portfolio Review Expert Panel (PREP) review is independent on several levels, as the Office of the Administrator has designed the PREP process, and has convened the external panels, commissioning self-review papers from relevant topic area managers as a key input into the process, and receiving the panel's report recommendations. The focus of the PREP is on OMB's primary interest, the outcomes and impacts of agency work, not on agency processes, such as the grants process, peer reviews to select proposals to be funded, or administrative functions such as hiring. OMB created the PART as a means to link budget and performance, improve programs, and revise or eliminate those which are not meeting their goals. All agencies must report quantitative performance measures in Budget and Performance Integration (BPI) charts as part of the annual budget justification process as well. The BPI is required by the President's Management Agenda (PMA), described below.

The four sections of OMB's PART are:

1) Program Purpose & Design
2) Strategic Planning
3) Program Management
4) Program Results

CSREES Goal 1 Portfolio was reviewed in 2004; Goals 3 & 5 will be revised in 2005; as well as Goals 2 & 4 in 2006. The full PART checklist of questions to which the Agency must respond is available in the evidentiary materials. The score from this panel review will serve as a quantitative performance measure in the PART.

The President's Management Agenda (PMA) is comprised of five goals, including budget and performance integration:

1) Strategic Management of Human Capital
2) Competitive Outsourcing
3) Improved Financial Management
4) Expanded Electronic Government
5) Budget and Performance Integration

The PMA document is available in the evidentiary materials.

This review is an indicator of the emphasis the Agency places on good accountability and evaluation, and data availability that can be used to both meet external requirements and inform managers with feedback that they need to properly manage and improve their programs.

(2) Using the Strategic Plan and Portfolios to Address Issues

In 2004, CSREES adopted a new Strategic Plan which is fully integrated with the USDA Plan, that is, the goals are the same and CSREES objectives are written to show how the Agency uniquely supports the same USDA objectives. Because the Agency must conduct and write a PART submission for each of its five goals, portfolios were created which best cover the work under each strategic objective. Portfolios of topically-linked issues are aligned to support the 14 USDA/CSREES Strategic Objectives, which support the five USDA/CSREES Strategic Goals. The portfolio and its component PAs demonstrate the complementary nature of research, education, and extension to solve national problems and to ensure that public investment is effective and efficient. The current Strategic Plan was used, although two other strategic plans were publicized by USDA during the 1999-2003 timeframe. Table A (found on page 4) presents a crosswalk of the two most recent USDA Strategic Plans, illustrating that, although the goals and objectives had undergone some rewriting, the underlying focus was quite similar. The PAs that serve as the basis for classifying work have remained essentially constant, although the list was reviewed and updated in 2004. (The CSREES Strategic Plans for 1997 – 2002, and 2004 – 2009 are included in the Evidentiary Materials.)

Table A
Crosswalk Comparison of CSREES Strategic Goals and Objectives in the 2004-2007 and 1997- 2002 Strategic Plans

2004-2009	1997-2002	Objective
Goal 1 Enhance Economic Opportunities for Agricultural Producers	Goal 1 An Agricultural Production System That is Highly Competitive in the Global Economy	Objective 1.1, 2004-2009 Provide Information, Knowledge and Education to Help Expand Markets and Reduce Trade Barriers Objective 1.4, 1997-2002 To Improve Decision Making on Public Policy Issues Related to the Productivity and Global Competitiveness of the U.S. Agricultural Production System
		Objective 1.2, 2004-2009 Support International Economic Development and Trade Capacity Building Through Research and Technical Assistance
		Objective 1.3, 2004-2009 Provide the Science-Based Knowledge and Technologies to Generate New or Improved High Quality Products and Processes to Expand Markets for the Agricultural Sector Objective 1.1, 1997-2002 To Produce New and Value-added Agricultural Products and Commodities.
		Objective 1.4, 2004-2009: Provide Science-Based Information, Knowledge and Education to Facilitate Risk Management by Farmers and Ranchers
		Objective 1.5, 2004-2009 Contribute Science-based Information, Analysis, and Education to Promote the Efficiency of Agricultural Production Systems Objective 1.2, 1997-2002 To Increase the Global Competitiveness of the U.S. Agricultural Production System
		Objective 1.3, 1997-2002 To Recruit and Educate a Diverse Set of Individuals for Careers as Future Scientists, Professionals and Leaders Who Are Well-trained in Agricultural Sciences
Goal 2 Support Increased Economic Opportunities and Improved Quality of Life in Rural America	Goal 5 Enhanced Economic Opportunity and Quality of Life for Americans	Objective 2.1, 2004-2009 Expand Economic Opportunities in Rural America by Bringing Scientific Insights into Economic and Business Decision Making Objective 5.1, 1997-2002 To Increase the Capacity of Communities and Families to Enhance Their Own Economic Well-being
		Objective 2.2, 2004-2009 Provide Science-based Technology, Products and Information to Facilitate Informed Decisions Affecting the Quality of Life in Rural Areas Objective 5.2 1997-2002 To Increase the Capacity of Communities, Families, and Individuals to Improve Their Own Quality of Life
Goal 3 Enhance Protection and Safety of the Nation's Agricultural and Food Supply	Goal 2 A Safe, Secure Food and Fiber System	Objective 3.1, 2004-2009 Reduce the Incidence of Foodborne Illnesses and Contaminants Through Science-based Knowledge and Education Objective 2.2, 1997-2002 To Improve Food Safety by Controlling or Eliminating Foodborne Risks
		Objective 3.2, 2004-2009 Develop and Deliver Science-based Information and Technologies to Reduce the Number and Severity of Agricultural Pest and Disease Outbreaks
Goal 4 Improve the Nation's Nutrition and Health	Goal 3 A Healthy, Well Nourished Population	Objective 4.1, 2004-2009 Improve the Nutritional Value of the U.S. Food Supply by Enhancing the Health Promoting Properties of Food Products
		Objective 4.2, 2004-2009 Promote Healthier Food Choices and Lifestyles Through Research and Education Objective 3.1, 1997-2002 To Optimize the Health of Consumers by Improving the Quality of Diets, the Quality of Food, and the Number of Food Choices Objective 3.2, 1997-2002 To Promote Health, Safety and Access to Quality Health Care
Goal 5 Protect and Enhance the Nation's Natural Resource Base and Environment	Goal 4 Greater Harmony Between Agriculture and the Environment	Objective 5.1, 2004-2009 Provide Science-based Knowledge and Education to Improve Management of Forest and Rangelands Objective 4.1, 1997-2002 To Develop, Transfer & Promote the Adoption of Efficient and Sustainable Agricultural, Forestry and Other Resource Conservation Policies, Programs, Technologies & Practices That Ensure Ecosystems Integrity and Biodiversity
		Objective 5.2, 2004-2009 Provide Science-based Knowledge and Education to Improve Management of Soil, Air, and Water to Support Production and Enhance the Environment Objective 4.2, 1997-2002 To Develop, Transfer and Promote Adoption of Efficient and Sustainable Agricultural, Forestry and Other Resource Policies, Programs, Technologies and Practices that Protect, Sustain and Enhance Water, Soil and Air Resources Objective 4.3, 1997-2002 To Improve Decision Making on Public Policies Related to Agriculture and the Environment

In designing an evaluation system to meet the new PART and Budget and Performance Integration requirements, the CSREES Office of the Administrator (Planning and Accountability) conducted an extensive review of the approaches used to assess federal research efforts and concluded that reviewing and evaluating the thousands of research grants funded in terms of portfolios was the most logical and fruitful approach. In addition, CSREES, unlike its sibling research agencies in USDA, has outreach education and higher education support components, adding considerably to its complexity. Not only are there thousands of grants focused on solving national problems, there are also three main programmatic areas. CSREES-sponsored research, education, and extension work is funded from multiple authorities and funding sources (CSREES has 57 Congressional funding lines, 23 within this portfolio). The use of portfolios to describe and evaluate CSREES work, therefore, is new and requires a broader, more integrated perspective than Deputy Administrators and NPLs have previously employed. These self-review papers are the first time that packages of Agency work have been conceived, described, and evaluated using a portfolio/ Problem Area component approach. Therefore, although some component program-oriented performance measures may be available, other, new portfolio and PA-focused measures may be new and not yet available for analysis. Initiatives are already underway to improve data availability for portfolio review.

CSREES-sponsored research, education and extension work is funded from multiple authorizations and funding sources. To fully appreciate this integrated, mission-focused work, portfolios of topically-linked issues are aligned with the five USDA Strategic Goals, and 14 CSREES Strategic Objectives. Each objective has one or more portfolios composed of related Problem Areas (PA) that fully integrate research, education and extension, regardless of authorization or funding line. The portfolios, and their related PA, demonstrate the complementary nature of research, education and extension that is integrated to solve national problems, and to ensure that the public investment is effective and efficient. This review format also allows for a more comprehensive application of the review criteria of relevance, quality and performance. A full description of the strategic goals, objectives, and portfolios, and the Problem Area Classification for Research, Education, and Extension are included in the Evidence Volume.

(3) Portfolio Review Support Functions

The CSREES Office of the Administrator (Planning and Accountability) designed the portfolio review process and guides a systematic, standardized, transparent review process across all portfolios and programs of the agency. In order to obtain OMB approval for these panels, we have designed a structured process for rating each portfolio. The Office of the Administrator (P&A) provides facilitation of the effort to prepare documentation and to manage panels convened by the Administrator. Program staff (NPLs) and senior managers were asked to participate by:

- Recommending to the Administrator names of panelists of sufficient experience and breadth of view to allow them to assess large, complex portfolios of combined research, education, and extension work integrated to meet strategic objectives.
- Writing, in coordination with National Planning and Accountability Leaders (NPALs) who served as facilitators and with Inter-agency Personnel Agreements (IPAs) from partner universities, self-review papers (i.e., this document) that thoroughly addressed the key issues/problems/needs that the portfolio and its component problem areas addressed, the resources devoted (inputs), the activities (outputs), and results (outcomes), and the resulting relevance, quality, and performance of the portfolio.
- Preparing documentary evidence in coordination with NPAL facilitators to accompany and support the self review paper with evidence that best meets standards of evaluation science. The evidence and paper describe the accomplishments, needed work, and steps planned for the next five years until the next external review panel.
- Presenting a brief overview of the portfolio and address inquiries of panelists at the meeting hosted by the planning and accountability unit of the office of the administrator.
- Receiving and responding to the recommendations of the panel for ways the portfolio could best meet its objectives and goals, and thereby further the mission of the agency.
- Meeting annually between external panels to update the portfolio, address PREP recommendations, and review and rate the portfolio outcomes for annual submissions to OMB (in lieu of holding external panels every year).

The panel, hosted by the Office of the Administrator and staffed by P&A NPALs and the partner IPA who assisted NPLs in writing the self review paper, meets in Washington, D.C. for 2 ½ days. Support is provided in note taking, provision of further analyses or documentation, and the production of the draft panel report of recommendations. The panel reviews the draft report, revising and finalizing it on the final day of the meeting. The panel then also provides oral feedback to the Associate Administrator, Deputy Administrators, and NPLs as the last step of its meeting in Washington.

(4) Expert Panel Functions

During the review process, the external Portfolio Review Expert Panel is asked to:
(Read this self-review report)

- Peruse accompanying reference support evidentiary materials as desired when in Washington for the panel meeting.
- Request additional support information as panelists deem necessary.
- Hear a brief overview presentation on the portfolio by subject matter experts (Deputy Administrator and NPLs) on the first day of the panel meeting.
- Participate in a question-and-answer opportunity for clarification of issues during the overview presentations.
- Discuss the relevance, quality, and performance of the portfolio, based on the material presented, during the panel meeting.
- Rate the portfolio on the OMB criteria using a scoring tool that will be provided.
- Provide feedback to the CSREES Administrator and program managers on what achievements have been made, as well as recommendations for improvement in reaching portfolio goals.

C. How CSREES, in General, Meets the OMB Criteria of Relevance, Quality, and Performance

The main purpose of this self-review document is to prepare panelists for the portfolio review process in which experts will rate the relevance, quality, and performance of CSREES efforts to meet strategic objectives through complex, integrated research, education, and extension efforts. The following explanation provides insights into how the Agency excels in each dimension of the three OMB criteria by the general structure of its work. Section IV of this report provides a portfolio-specific discussion of these dimensions.

(1) Relevance

CSREES NPLs are the critical links to our partners and constituents (including researchers, educators, extension specialists, experiment stations, the processing and packaging industry, commodity organizations, consumer groups, advocacy organizations, advisory committees, review panels, national academies, scientific and professional societies, federal agencies, White House Office of Science and Technology Policy, and Congress). Feedback from these groups and individuals is obtained directly and indirectly for identifying and prioritizing the national needs to assure relevance of programs within each portfolio. (*See Evidentiary Materials*.)

Both formal and informal procedures are used to obtain stakeholder input. These may include stakeholder workshops, symposia, technical reviews, peer panel recommendation, white papers, CSREES departmental review reports, presidential directives, interagency, strategic plans for research and development, regulatory policies impacting food quality and safety and industry plans and priorities. In addition, every Request for Applications (RFA) specifically seeks stakeholder input as per requirements of the Agricultural Research, Extension, and Education Reform Act of 1998 (AREERA) (7 U.S.C. 7613(c)(2)). This section requires the Secretary to solicit and consider input on a current RFA from persons who conduct or use agricultural research, education and extension for use in formulating future RFAs for competitive programs. These processes and networks help the agency ensure the relevancy of programs relative to local, state, regional and national needs. Priorities are generated through aggregation of problems and issues identified at the local, state, and national level.

All the programs managed by CSREES use relevance and quality as criteria for pre-award evaluation of projects. Relevancy is established taking into consideration the industry and/or consumer needs and priorities. The quality is assessed based on the scientific merit, proposed procedure, and potential to succeed.

Criteria and indicators are used wherever available. According to the National Research Council (*Our Common Journey: A Transition toward Sustainability, 1999*), "Indicators are repeated observations of natural and social phenomena that represent systematic feedback. They generally provide quantitative measures of the economy, human well-being, and impacts of human activities on the natural world. The signals they produce sound alarms, define challenges, and measure progress . . . . Generally, indicators are most useful when obtained over many intervals of observation so that they illustrate trends and changes. Their calculation requires concerted efforts and financial investments by governments, firms, non-governmental organizations, and the scientific community."

The portfolios being reviewed are dynamic and change periodically to address emerging national needs consistent with cutting edge science. Program descriptions, program reports, and request for applications included in the Evidentiary Materials section of this document demonstrate the dynamic nature of the portfolios.

Scope
The scope of a portfolio is reflected in the funds invested, and the number of projects and programs involved. Most portfolio work encompasses the programs of state agricultural experiment stations (SAES), 1862, 1890, and 1994 land grant institutions, Hispanic-serving institutions, other cooperating institutions, including state and private colleges and university; and USDA intramural agencies. These programs are closely linked to and complement the teaching and extension activities of the land-grant and other institutions. At the university level, research programs also are integral to graduate education, through which scientists are prepared to address future scientific challenges. CSREES uses a unique partnership of federal and non-federal, private and public sector and non-government organizations (NGOs) partners to address national issues. Coordination, joint planning and priority setting are accomplished through various national and regional mechanisms to ensure the efficient use of resources.

CSREES portfolios usually employ a creative combination of funding mechanisms, including formula funds, the NRI, and special grants. Other Federal agencies and states may invest as well. This demonstrates that leveraging of funds and sharing of resources is critical to maximizing outcomes.

CSREES Science and Education Resources Development (SERD) is leading USDA's commitment to human capital development. It is important to note that the funds reported (except for SERD's education programs) in this document represent investments on research activities and do not include extension activities. The agency is currently addressing this issue, including modification of the CRIS database so that education and extension activities will be readily accessible in the next 5 years.

The summaries presented are based on federal and state research activity as documented in USDA CRIS, land-grant university plans of work, and the USDA Science and Education Impact database (see www.csrees.usda.gov/newsroom/impacts/impacts.html).

Focus on Critical Needs
CSREES peer review of formula-funded research proposals and competitive grant proposals and similar review of state Cooperative Extension plans of work and annual reports ensure that programs and activities supported by CSREES funds focus on critical scientific issues. National planning activities and listening sessions help to guide state and regional level research, education and extension programming to contribute to meeting national needs. The competitive review process especially encourages innovative ideas that are likely to open new research approaches to enhancing agricultural and natural resources management. A proven mechanism for stimulating new scientific research, the process increases the likelihood that investigations addressing important, relevant topics using well-designed and well-organized experimental plans will be funded. Each year, panels of scientific peers meet to evaluate and recommend proposals based on scientific merit, investigator qualifications, and relevance of the proposed research to the mission and goals of USDA.

For this report, priorities are based on USDA CSREES Strategic Plan. In addition, priorities and emerging issues are identified through the broad network of relationships that Deputy Administrators and National Program leaders have established. A number of themes are outlined in the PA descriptions (Book III) that illustrate where CSREES is contributing to timely, relevant research directed at solving critical problems of national significance.

Identification of Emerging Issues
Setting priorities is an important means of facilitating the scientific and technological advances needed to meet the challenges facing U.S. agriculture and natural resources management. Congress sets the budgetary framework by providing funds to CSREES. Members of Congress also make recommendations for the scientific and programmatic administration through appropriation language and through their questions and comments during Congressional hearings. Input into the priority-setting process is sought from a variety of customers and stakeholders. The Agricultural Research, Education, and Extension Reform Act of 1998 formally require that formula-funded projects reflect stakeholder priorities. The scientific

community provides direction through the competitive grant proposals it submits each year as well as through the proposal evaluation and funding recommendations of individual peer-review panels.

Participation by NPLs in review panels for competitive programs, federal interagency working groups, and stakeholder listening sessions are important mechanisms for CSREES to identify emerging issues. NPLs also attend professional and scientific meetings to remain current on scientific trends that should be reflected in CSREES programs and in the coordination of priority setting with other federal agencies. The Administrator and National Program Leaders have established close working relationships and networks with various stakeholder partners including research, education and extension scientists and educators at the universities and colleges, other federal agencies, county agents and educators, advocacy organizations, professional societies, advisory groups, environmental groups and Congress. Through such meetings, NPLs learn of stakeholders' current priorities, and solicit comments and suggestions on ways that CSREES can assist in meeting their needs. Through these interactions, emerging issues are identified.

Integration of CSREES Programs

Integration refers to the linkage of the several CSREES missions of research, education, and extension in programs and activities to produce products which reach a wide variety of audiences or stakeholders in appropriate formats. These products might otherwise be disjointed and more narrowly defined. Although CSREES is dedicated to integrated efforts in all its programming areas, there are some challenges to accomplishing this, caused chiefly by outside factors. For example, some legislative authorizations are so specifically defined that they preclude meaningful integration. Similarly, some CSREES stakeholders have interests which are similarly fixed on single purposes. Such situations require that NPLs must often take the initiative to stimulate and accomplish integration in otherwise focused program areas. While this has been somewhat problematic in the past, significant progress has been made. CSREES also has competitive grant programs that specifically require or encourage integrated programming. The NRI, for example, is now authorized to allocate up to 20 percent of its annual funding for integrated projects, and within it, certain programs are identified as been appropriate. Some programs can now allocate funds to projects that integrate research and education activities.

The long-term outcomes of the portfolio can best be achieved through strong research, education and extension programs that are integrated. While the portfolio presents a very complex system in terms of funding and integration of programs, there is a critical need to develop new models and delivery systems that are effective and performance-based. NPLs serve as an integral mechanism to direct, apply and adopt applied, research-based knowledge in innovative ways. They should continue and enhance their leadership in the delivery of research-based knowledge through extension, outreach and information dissemination thereby strengthening the capacity of public and private policy-makers who make decisions.

Multidisciplinary Balance / Interdisciplinary Integration

Both mission-linked research and fundamental research are supported by CSREES formula- and competitively-funded research. Mission-linked research targets specific problems, needs, or opportunities. Fundamental research involves the quest for new knowledge about important organisms, processes, systems, or products and opens new directions for mission-linked research. Mission-based and fundamental research is essential to the sustainability of agriculture. Review of formula-funded projects reveals that the vast majority typically combine both fundamental and basic approaches. Although single-investigator projects remain the norm, increasingly these types of research are taking multidisciplinary and multi-investigator formats. Additionally, CSREES competitive grant programs are encouraging multidisciplinary research. Moreover, CSREES requires that 20 percent of the research formula funding that it provides to states be devoted to multi-state activities, which at least indirectly promotes multidisciplinary approaches. In turn, the regional agriculture experiment station systems use the funds to support multi-state research projects and committees. At any given time, several such projects have objectives related to the portfolio of interest and CSREES NPLs serve as advisors to them.

From the extension perspective, multidisciplinary approaches, and involvement of end-users in the conduct of research experiments are well established practices in many states. This is especially true for multi-state research projects, where producers and other end-users are integrally involved in the projects. Additionally, some of the competitively funded programs require integration of research, education and extension in all funded projects. Specific examples of integrated projects and their outcomes are discussed in the PAs of the portfolio.

CSREES supports strong program and disciplinary linkages within the portfolio team, throughout the agency, and with other government agencies with similar mission responsibilities. A strong university-based research, education and extension system, linked to the various USDA agencies and federal departments, and the private sector, moves us toward an integrated, sustainable system of resource management.

(2) Quality

Significance of Findings and Outputs

At the Agency level, all federal funds are leveraged at least by a ratio of $2 of non-federal funds for every $1 of federal funding. This leveraging provides expanded fiscal resources to address programs that are partially funded by CSREES.

CSREES, through its partnership with universities, other federal and state agencies, and private organizations, is contributing to a bank of science-based knowledge through research, education and extension activities. Included in this report are examples of some of the thousands of CSREES-funded projects that are having significant positive impact on addressing portfolio issues.

Research activities are geared to the needs of CSREES' stakeholders and the science-based knowledge resulting from these activities is used by policy-decision makers and others, and the end result is the protection of the health and well-being of society.

Outputs and Outcomes

Outputs of CSREES-funded activities include but are not limited to publications, development of guidelines and guidebooks, training manuals, curricula and courses, trained scholars, new methodologies and techniques, models and management strategies for management of soil, air and water resources. These outputs then lead to short- medium- and long-term outcomes. CSREES-funded activities must demonstrate that they will result in measurable impacts, so that outcomes and impacts are integrally connected. Proposals submitted for funding are assessed for these criteria as a measure of quality. The result, when viewed nationally, is a diverse portfolio of programs with different goals and objectives, but which will eventually result in cleaner soil, air and water for all citizens. Several examples of outputs and outcomes are presented in this document and the quality of these outputs and outcomes are further illustrated in the examples of activities highlighted as success stories under the accomplishments.

Stakeholder Assessment

Formula funds (Hatch, Evans-Allen, McIntire-Stennis and Smith Lever) are required by the1998 Agricultural Research, Education and Extension Reform Act (AREERA) to obtain stakeholder input every year and describe the process used to identify individuals or groups as stakeholders. Also each institution needs to describe how these inputs relate to Plans of Work, priority setting, immediate needs and long-term goals, guidance on monitoring, and proposed research activities.

CSREES and ARS, the USDA in-house research component, conducts a number of stakeholder listening sessions, nation-wide, in order assess program effectiveness, for program development, and to identify new and emerging issues, and program directions. NPLs from both agencies participate in these listening sessions, thereby reducing redundancy of programs.

Alignment of Portfolio with Current Science

All funded projects complement the CSREES portfolio goals. The outcomes and accomplishments of funded projects could not be achieved without application of modern and advanced science methodologies and techniques.

Methodology and Use of Funded Projects

All proposals submitted to CSREES must undergo a rigorous review process at several levels. Competitively-funded projects are reviewed by an external peer panel of experts drawn from universities, other federal and state partners, and the private sector. Non-competitively funded proposals, including formula funds, are reviewed at the university level prior to submission to CSREES, where they are further reviewed by NPLs. NPLs ensure that the proposed projects are in keeping with the mission of the agency, fit the intent of the legislative acts, and have measurable potential outcomes and impacts. Proposals submitted for congressionally-directed funding are also reviewed by NPLs, who subsequently schedule site visits to monitor the progress of these projects. Similarly, NPLs serve as liaisons to all multi-state projects for reasons previously discussed.

(3) Performance

Assessment of the performance of the programs funded in this portfolio suggests that the programs are providing science-based knowledge and education to meet portfolio goals.

Portfolio Productivity

Each Problem Area described demonstrates various research, education and extension accomplishments. Assessing the productivity of competitively funded programs, including education, is relatively straightforward, in that project directors are required to submit annual and termination reports. In addition, NPLs routinely schedule site visits to assess progress of projects that receive congressionally-directed funds. The assessment is more difficult, however, with formula programs, particularly extension, in that states in the past have exercised wide latitude in what they report in their Plans of Work (POW) and annual reports. The new electronic web-based reporting system now under construction will require reporting plans and outcomes via the logic model. Because CSREES contributes a small percentage of the funds in some states, State annual POW reports varied from state to state, with some filing a detailed and comprehensive report regardless of funding source, to those that report on only those programs that were "touched" by CSREES funding. The result is that at the national level, there is a very mixed and incomplete picture of the results that emerge from CSREES-funded programs.

Portfolio Completeness

Programs in this portfolio meet their intended outcomes at the individual project level as well as at state and institution levels where guidelines and directions are provided to states through formula funds. Details are provided in the PA discussions that demonstrate that accomplishments are being achieved. Timely reviews and feedback from NPL-directed project reviews ensure that proposed objectives are being addressed so that proposed objectives are aligned with potential outcomes and impacts.

Portfolio Timeliness

Assessing the timeliness of the work in a portfolio is largely done by monitoring the submission of final reports or requests for renewal, extension, or budget carryover. These determinations are relatively easy to track for competitive grants and special grant projects that require submission of formal proposals, annual and termination reports. Assessing the timeliness of the work accomplished through formula programs, particularly extension programs, has inherent challenges. Research projects have discreet start and completion dates, but extension programs may have semi-discreet start and completion dates because of the nature of education, which is rarely "completed." For example, because there is continual turnover in the extension audiences, the "timeliness" criterion is harder to assess. What can be assessed, in place of timeliness, is extension program evolution. As issues change and new knowledge is gained, extension programs are continually evolving in order to incorporate new considerations. This is monitored, in part, through the state Annual Reports which are reviewed by NPLs.

Agency Guidance

The agency provides guidance in the conduct and assessment of programs through several mechanisms:

- Requests for Applications - Project Directors of funded projects are expected to fulfill the project objectives and to submit annual progress and termination reports, which are logged into the CRIS database. The requirements that must be fulfilled by the Project Director are clearly spelled out in the Terms and Conditions of the award document that is sent to the performing institution. NPLs, if needed, are also available to provide timely answers to the Project Directors on an individual basis. In this way, CSREES ensures that funding recipients clearly understand their obligations.
- NPL Management and Leadership - NPLs are responsible for portfolios of work within specific disciplines, funding sources and functions. NPLs interact with multi-state research committees, ad hoc program committees, strategic planning efforts and other venues with the university community. Part of this interaction involves conveying agency needs and expectations regarding the funding that is being provided. This is usually more relevant to formula-funded programs, as competitive grant recipients have formal obligations to complete project objectives for which they were funded.

Examples of the various forms of agency guidance are contained in the Evidentiary Materials.

Portfolio Accountability

The work accomplished in portfolios is monitored by NPLs who are either program directors for competitive grant programs, agency contacts for special grants, or state annual report reviewers. The CRIS system is an informational resource that allows NPLs to track the progress of research and, more recently, education programs. The CRIS database is accessed by NPLs to determine if projects were completed as funded, requests for extensions and budget carryovers are justified, and progress reports were submitted prior to approving requests for renewals. Extension formula-funded programs submitted as plan of work (POW) annual reports are evaluated on a state-by-state basis by a two-member NPL Review Team. These reports are evaluated for completeness, evidence of impacts, and stakeholder involvement. A written assessment is completed and returned to each institution. In the event that a report has deficiencies, the lead NPL communicates those deficiencies to the extension director, and awaits additional documentation before proceeding with the review. The review is completed upon receipt of a satisfactory report.

CSREES is in the process of designing new processes and tools, particularly monitoring and evaluation systems, and will train the agency's partners in their use. In an environment in which funding is becoming tighter, any activity that strengthen accountability and impacts will likely have greater funding support.

D. Current Trends and Opportunities

The land-grant university system was established by the Morrill Act of 1862 "to teach such branches of learning as are related to agriculture and the mechanic arts . . . in order to promote the liberal and practical education of the industrial classes in the several pursuits and professions in life." At that time, the scientific basis of agriculture was rudimentary and focused primarily on increasing agricultural productivity. Plant and animal breeding, nutrient management and mechanization of agriculture are significant milestones in the spectrum of scientific investment in agricultural productivity.

As agriculture matured and became more fully integrated into the social, political and economic structure of the nation, broader issues, including positive and negative environmental and economic externalities, access to and the distribution of the benefits of public investment in agriculture and rural communities, and the sustainability of the scientific workforce have emerged. Breakthroughs in fundamental science, including genomics, microbiology and nanotechnology have raised the bar for the application of science, technology, and practice in producing, processing, marketing and distributing food and fiber products. These sometimes produced additional questions regarding long term risks and benefits, ethics, and domestic and international consumer acceptance. In the post-9/11 environment, the aggregate safety and security of the food and fiber supply, terrorism aimed at food and fiber products, and protecting public health and well being become paramount.

In order for U.S. agriculture to compete in today's global market, a number of production, economic, and policy issues must be addressed by the research, education, and extension. Continued advances in biotechnology, precision farming, disease epidemiology, and animal and human nutrition will improve agricultural production efficiency and the quality of agricultural products. The complexity of public policy decisions, as influenced by divergent societal values, economic forces, changing demographics and natural resource sustainability, will be addressed by consensus-building forums. The development of new food and nonfood products such as fuel, paint, plastics, pharmaceuticals and nutraceuticals from agricultural or other bio-based materials will expand the market for agricultural commodities. Some have the potential to minimize our dependence on foreign oil. Better understanding of global markets and improved business and marketing practices can help firms be more successful. Domestic and international policy analysis will identify existing policies that are impediments to trade and development, and lead to alternatives.

E. "The Partnership," Stakeholders and Customers

Integral to the CSREES mission, and its ability to carry on that mission, is the notion of partnerships. CSREES is the federal partner in a vast network of thousands of scientists, educators, and extension staff and volunteers, who carry out its programs throughout the United States and its territories, and beyond. Most of these partners work at or through land-grant universities. This special relationship is known as "The Partnership". There are one or more land-grant institutions in each U.S. state and territory and in the District of Columbia. These partnerships demonstrate the linkages and interdependency between the federal and state components of a broad-based, national agricultural research, extension, and higher education system.

Starting in 1862, the federal government granted federally owned land (hence the name "land-grant") to each state for the development of a university that would serve the citizens of the state in the areas of research, education and extension. Other land-grant universities were designated in 1890 (historically black universities and land-grant colleges) and in 1994 (American Indian/Alaska Native tribal colleges). In 1996 USDA also began partnering with Hispanic-serving institutions to provide support for a growing Hispanic population in the US.

While nearly all universities have research and education as their core responsibilities, land-grant universities also have a federal government-mandated extension (outreach) responsibility. "Extension" is defined as "non-formal adult and youth education programs that translate and transfer research findings that can be applied to real-life situations." This means they are directed by law to offer to the public noncredit, tax-supported educational programs and information based on the results of university research. The role of the university system is critical to assure relevancy, quality, and performance for the programs administered and led by the agency. CSREES program leadership serves as both the catalyst and focal point for national research, extension and education programs dealing with agriculture, the environment, human health and well-being, and communities. The wide-ranging CSREES land-grant partnership includes:

- More than 130 colleges of agriculture
- 59 agriculture and natural resource experiment stations
- 57 cooperative extension services
- 65 McIntire-Stennis Cooperative Forestry Research institutions
- 20 historically black colleges and universities
- 27 colleges of veterinary medicine
- 42 schools and colleges of family and consumer sciences
- 33 Native American land-grant institutions
- 17 Alaskan native-serving and Hawaiian native-serving institutions
- More than 240 Hispanic-serving institutions

The scope of partner activities is broad. They include: all aspects of agriculture; natural resource conservation and environmental quality; plant and animal production, protection, and health; processing, distribution, safety, marketing, and utilization of food and agricultural products; forestry (including urban and agroforestry), fisheries, wildlife and range sciences; aquaculture; family and consumer sciences; human nutrition; rural, community, and economic development; sustainable agriculture; molecular biology; and biotechnology.

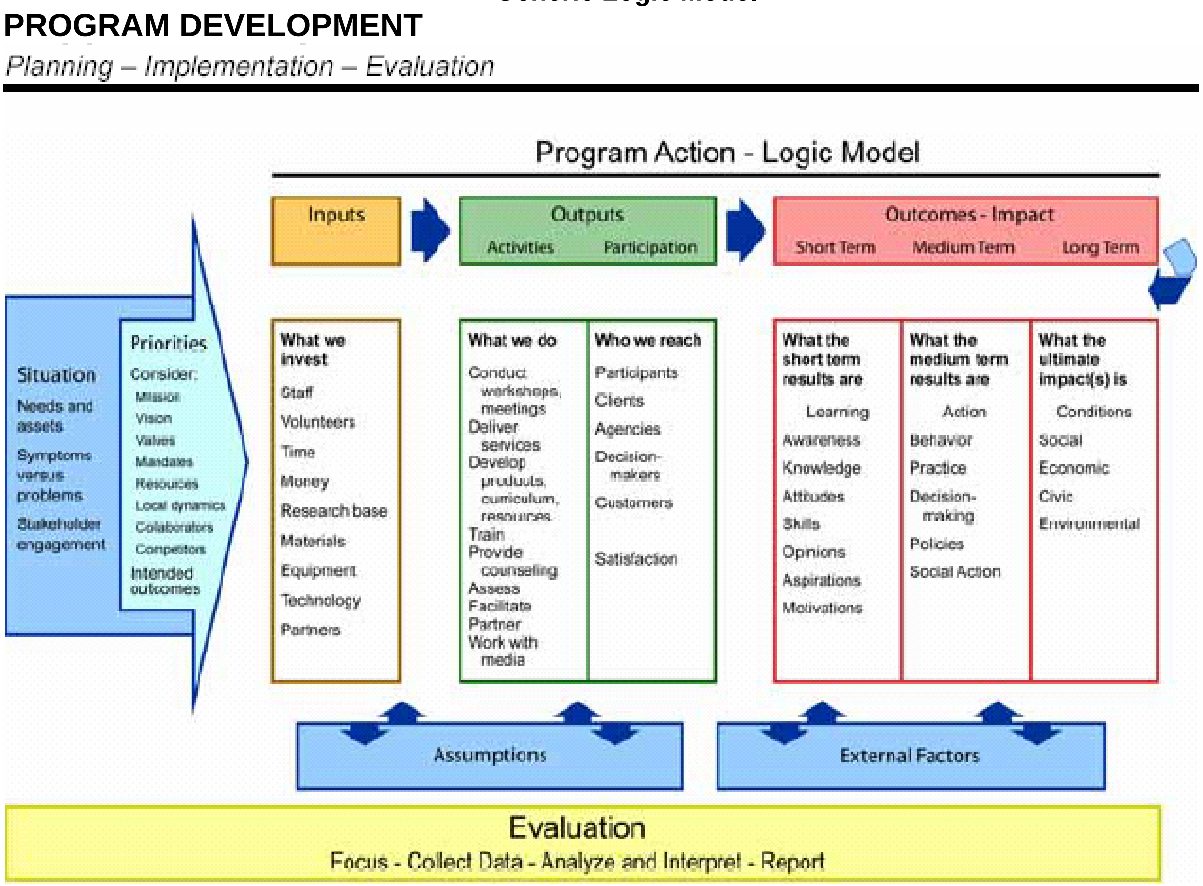
CSREES' ultimate customers are citizens. CSREES works with land-grant, other institutions and industry to create and transfer the know-how and the technology from the laboratory to farmers, ranchers, consumers, and agribusiness. The Cooperative Extension System (CES), through state and county extension offices, provides information to every county in the nation, offering extension education that links research, science and technology to people where they live and work. Topics range from community development, health care, food safety, water quality, sustainable agriculture, and the environment to programs for children, youth, and families.

The main extramural research and education partnership for CSREES exists with the Land Grant universities. Funding from CSREES supports research, extension, and education programs at these institutions. Where the funding is provided based on a formula-based allocation, CSREES does not dictate specific program goals and objectives, but relies on NPLs to convey the mission and goals and objectives of the Agency and relies on the original authorizing legislation to reflect that mission. This allows stakeholders at the state and local levels to determine their greatest research and extension needs, thereby solving national problems at the local and regional level. Where funding is provided through competitive grants announced via the Requests for Applications (RFAs) written by NPLs who focus work to meet Agency goals, institutions are required to pursue the program of work which they proposed and for which they received funding.

F. Portfolio Self-Review Document Organization

The portfolio is comprised of five books. Book I provides an introduction to the portfolio review process. Book II contains a portfolio overview that includes an organizational structure and a general description of the CSREES vision, mission, functions, and funding authorities. Book III is an analysis of the portfolio and PAs. This section contains a description of the overall portfolio and its component PAs. A conceptual ("logic") model common to program evaluation is used to illustrate the main components of the Agency's investments and work, the planned outcomes, and the logic of how the planned work is designed to affect the desired results in solving national problems, meeting national needs and achieving the mission of the Agency. A generic logic model is shown below. This section also provides data on performance measures identified via the logic model, results of evaluation studies, success stories and planned new directions for Agency efforts. The substantive descriptions of the portfolio and its components were prepared by CSREES National Program Leaders – topic area experts who manage programs or topic-related PA activities. Book IV describes cross-cutting issues in this portfolio.

Generic Logic Model[1]



The Government Accountability Office (GAO), the evaluation and oversight agency for Congress, promotes the use of logic models in good evaluation practice and has praised CSREES as a model in its use of logic models. The new Plan of Work/ Annual Report guidelines for planning and accountability submissions for formula funds via the new web-based electronic reporting system under development require the use of the logic model and provide an explanation, contained In the Box below.

Logic Model, Plan of Work/Annual Report Guidance

Program Logic Model: the conceptual tool for planning and evaluation which displays the sequence of actions that describe what the science-based program is and will do – how investments link to results. Included in this depiction of the program action are six core components:

1. **Identification of the national problem, need, or situation that needs to be addressed by the program.** The conceptual model will delineate the steps that are planned, based on past science and best theory, to achieve outcomes that will best solve the identified national problems and meet the identified needs. The medium term outcomes should reflect the actual program results, while the long term outcomes should reflect the larger societal influence.

2. **Assumptions:** the beliefs we have about the program, the people and processes involved, and the context and the way we think the program will work. These science-based assumptions are based on past evaluation science findings regarding the effects and functioning of the program or similar programs, program theory, stakeholder input, etc.

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[1] *From*: University of Wisconsin Cooperative Extension – Program Development and Evaluation, 2000.

3. **External Factors:** the environment in which the program exists includes a variety of external factors that interact with and influence the program action. Evaluation plans for the program should account for these factors, which are alternative explanations for the outcomes of the program other than the program itself. Strong causal conclusions about the efficacy of the program must eliminate these environmental factors as viable explanations for the observed outcomes of the program. These identify the factors for which the scientific evaluation design must control in order to make causal conclusions.

4. **Inputs:** resources, contributions, and investments that are provided for the program. This includes federal, state, and local spending, private donations, volunteer time, etc.

5. **Outputs:** activities, services, events, and products that are intended to lead to the program's outcomes in solving national problems by the causal chain of events depicted in the logic model. These activities and products are posited to reach the people who are targeted as participants or the audience or beneficiaries of the program. Output performance measures often include tallies, such as the number of persons targeted and reached (direct and indirect contacts), the number and type of grants awarded, etc.

   An understanding of the actual inputs and outputs posited in the logic model comprises the process evaluation for the program. It is important to stop and consider these data, as they tell us what the REAL program is—that is, what has actually been implemented. This tells us to what the eventual observed outcomes really relate. Often times what federal managers plan and describe in the logic model is **not** what is eventually implemented in the field, and it is important to note what the true "program" really is. The effects of the <u>planned program</u> may actually be unknown, because the planned program NEVER ACTUALLY OCCURRED. It is important to understand and properly report all of this.

   In addition, it is these PROCESS factors that managers actually control, and which they can manipulate to improve the program based on the evaluation feedback.

6. **Outcomes:** planned results or changes for individuals, groups, communities, organizations, or systems. These include short-, medium-, and long-term outcomes in the theorized chain of causal events that will lead to the planned solution of the identified national problems or meet national needs. These can be viewed as the public's return on its investment, i.e., the value-added to society in the benefits it reaps from the program. Examples include research findings, changes in knowledge, skill development, and behavior (such as the number of people adopting a new technology or using a new product), capacities or decision-making, and policy development. Impact in this model refers to the ultimate consequence or effects of the program (e.g., increased economic security, improved air quality). Impact refers to the ultimate, longer-term changes in social, economic, civic, or environmental conditions.

   This is also where the logic model loop is completed – the identified national problem should eventually be solved here. When we use the logic model, it should be clear to all involved in the program what it is about – what problems it intends to solve, how it is going to do it, how performance will be measured, and what ultimate outcomes and benefits we can expect. Evaluators can quickly assess what performance measures will be needed, and work with program managers to obtain the needed data.

   Another graphic is used to explain research investments-- the Honeycomb Research Focus, Accomplishments, and Needs Tables throughout Book III. For this portfolio, the (Figure 6.5, found on page 48) shows the relevant component PAs. The PA specific graphics for each PA depict the main areas of research identified by the scientific community that must be studied in order to address the identified this particular PA. The PA specific "honeycombs" (Figures 7.2, 8.2, 9.2, 10.2, 11.2, and 12.2) identifies the CSREES accomplishments and the needs (shown by each area of investigation) for each PA. The identified needs are usually translated into work supported by Land Grant universities to address these needs, supported by all the lines of funding from CSREES, as appropriate and as needed. Such tables can also be used to illustrate how CSREES teams with its federal agency partners in studying an area by adding in the names of other agencies targeted to specific parts of the honeycomb. Not only can such charts be used for planning and accountability purposes, they are also used by NPLs to explain CSREES' work and its needs for research, education and program delivery in specific areas to meet national objectives.

   Book IV contains a description of major crosscutting emphasis areas important to this portfolio. The goal for each crosscutting area description is to provide concise, comprehensive insights into these activities and provide some performance examples to enable the Panel to assess CSREES outcomes that bridge the portfolio. Book V is a concluding summarization of the ways we have tried to address relevance, quality and performance.

BOOK II:

PORTFOLIO OVERVIEW

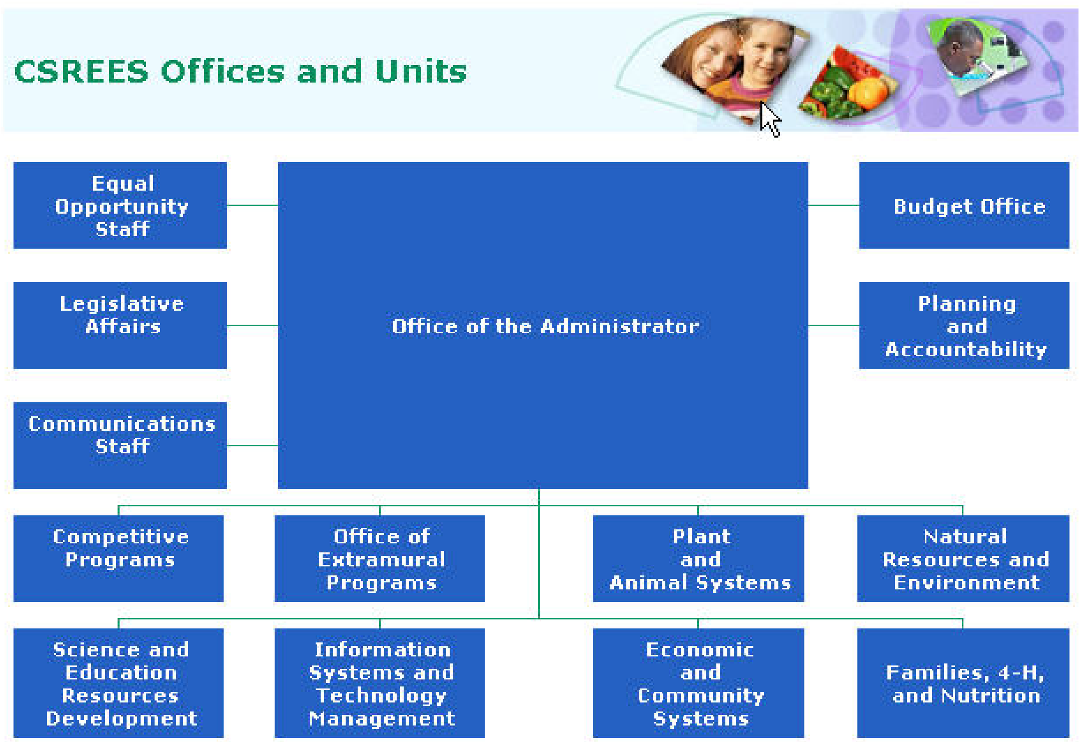
Section 1: Organizational Overview

1.1 USDA

The mission of the United States Department of Agriculture (USDA) is to provide leadership on food, agriculture, natural resources, and related issues based on sound public policy, the best available science, and efficient management. USDA's vision is to be recognized as a dynamic organization that is able to efficiently provide the integrated program delivery needed to lead a rapidly evolving food and agriculture system. Goal 3 of the USDA strategic plan is to enhance protection and safety of the nation's agriculture and food supply.

1.2 CSREES Organization and Mission

Figure 1.1
Organizational Structure of CSREES



The Cooperative State Research, Education and Extension Service (CSREES) is USDA's primary link with the Land-Grant University System and with other higher education institutions. CSREES invests public funds, as authorized and appropriated by the Congress, in basic, applied, and developmental research, extension, and teaching activities in food and fiber, agricultural, renewable natural resources, forestry, and the physical and social sciences. Through the distribution and management of formula funds, competitive grants and special grants, CSREES achieves its mission to advance knowledge for agriculture, the environment, human health and well being, and communities. Specifically, CSREES provides national program leadership to identify, develop and manage programs to support university-based and other institutional research, education, and extension, and provides fair, effective, and efficient administration of

Federal assistance implementing research, education and extension awards and agreements. See the draft CSREES Strategic Plan in the Evidentiary Material.

1.3 Vision, Mission and Functions

Mission: *Agriculture is a knowledge-based, global enterprise, sustained by the innovation of scientists and educators.*

Vision*: To advance knowledge for agriculture, the environment, human health and well being, and communities.*

Functions*: Program leadership to identify, develop, and manage programs to support university-based and other institutional research, education, and extension. Fair, effective, and efficient administration of Federal assistance implementing research, education, and extension awards and agreements.*

CSREES is one of four closely aligned service Agencies that make up the Research, Education, and Economics (REE) mission area of USDA. The other three agencies are the Agricultural Research Service (ARS), the Economics Research Service (ERS), and the National Agricultural Statistics Service (NASS). The USDA-REE mission area agencies provide federal leadership in creating and disseminating knowledge spanning the biological, physical, and social sciences related to agricultural research, economic analysis, statistics, extension, and higher education.

CSREES' unique mission is to advance knowledge for agriculture, the environment, human health and well-being, and communities by supporting research, education, and extension activities and programs with institutions and organizations beyond the federal government. Through CSREES, the USDA continues its long-term primary partnership with the Land-Grant University System and other partner organizations by helping to fund research, education, and extension activities at the state and local level. A major value added component CSREES brings to this partnership beyond funding is the national leadership to foster greater cooperation, coordination and priority setting across state lines through region-wide and national efforts. This national leadership brings together new partners and collaborators to address common problems and also provides a feed-back loop for accomplishments to the executive and legislative branches, demonstrating to each that the public investment in agricultural research, education and extension is addressing important issues and is making a difference to the folks back home.

CSREES provides the primary USDA extramural connection with the science and education activities in Land Grant institutions. This Agency is made up of eight separate units (Figure 1.1, found on page 16), each of which contributes complementary and individual roles in the distribution, broad oversight and quality control of equitable federal resource distribution for agricultural research, education and extension activities. CSREES is a small Agency with less than 350 staff. To distribute in a timely fashion, provide broad oversight and quality control of nearly a billion dollars of federal resources each year, each unit is staffed to enable it to accomplish their component of the agency's mission. Program leaders, program specialists, program and administrative assistants, secretaries, automation specialists and clerk-typists need to seamlessly engage within and across the agency's units.

1.4 Using Portfolios and Problem Areas to Address Issues

CSREES-sponsored research, education and extension work is funded from multiple authorizations and funding sources. To fully appreciate this integrated, mission-focused work, portfolios of topically-linked issues are aligned with the five USDA Strategic Goals, and 14 CSREES Strategic Objectives. Each objective has one or more portfolios composed of related Problem Areas (PA) that fully integrate research, education and extension, regardless of authorization or funding line. The portfolios, and their related PAs, demonstrate the complementary nature of research, education and extension that is integrated to solve national problems, and to ensure that the public investment is effective and efficient. This review format also allows for a more comprehensive application of the review criteria of relevance, quality and performance. A full description of the strategic goals, objectives, and portfolios, and the PA Classification for REE are included in the Evidentiary Material.

1.5 Roles of National Program Leaders

National Program Leaders (NPLs) serve as team leaders and facilitators of change for CSREES and for the Land-Grant System. This involves maintaining visible and respected leadership roles in and with professional societies, peers in their discipline(s), competitive grant programs, non-competitive programs, department and program reviews, other Federal agencies and partners and assigned multi-state committees and congressionally directed line items. An examination of the CSREES NPL's roles shows them fitting into four broad action categories, which are to:

- Develop networks and collaborate with partners and stakeholders to identify mission-relevant problems, opportunities and issues requiring Federal attention and support;
- Conceive, formulate, and direct programs and activities to respond to existing or emerging problems, opportunities and issues through the development and application of science-based knowledge;
- Lead, administer and manage programs and activities to develop and apply science and knowledge; and
- Evaluate and assess the relevance, quality and performance of these programs.

Table 1.1 (found on page 19) - Illustrates roles that NPLs play in a number of key funding categories for CSREES programs.

1.6 The National Program Leader and Program Management and Oversight

CSREES offers value-added services to funded recipients through program oversight and planning and also through post-award management. Leadership of these activities is part of the foundation responsibility of the Agency, providing positive impacts on all aspects of its portfolio a component of which is the plant protection portfolio. These activities involve services, which are intended to provide awardees receiving resources from CSREES to enhance their performance. Program oversight and planning involves activities such as leading team reviews of institutions, colleges, departments and programs. Post-award management involves a broad range of activities lead by CSREES staff; some examples include Principal Investigator (PI) workshops, program site-visits, project reviews and the development of accomplishment reporting systems for specific programs. These types of activities offer opportunities to enhance the performance of awardees and allow better documentation of accomplishments. The leadership of such activities comprises an appreciated and rewarding component of our national program leader's workload.

1.7 Program Oversight and Planning

CSREES places a high priority on participation and leadership in department and program reviews and considers the NPL leadership a core part of its service to the land-grant partnership. Many of the NPLs working with the plant protection portfolio provide team leadership for one or more Department Reviews each year. Initiation of a review involves an institutional request to CSREES to provide leadership for the process and to provide resources for a peer review of one or more departments. The term "review" as applied to this activity, does not fully reflect the scope and intent of this activity. What CSREES calls "Department Reviews" has evolved into a several-day facilitated process, which uses the collective knowledge and background of the peer team to work with faculty and staff to vision and plan their department's future. CSREES has developed a process, which involves a department developing a self-study description of where they are that is provided to the review team prior to arrival on campus. The peer team's site-visit involves discussions with faculty and staff on potential options to move the department's research, teaching and extension-outreach agenda forward to reflect the needs of their stakeholders to where they agree it should be heading in the next five to seven years. Before leaving campus, the peer team provides an exit interview with administration and faculty regarding their assessment of the current situation and the unit's plan for the future. A summary document that offers constructive critique and suggestions for the department to reach a realistic future vision is developed by the peer team and shared with the institution following the site review. CSREES program leaders also provide similar program planning activities, but less frequently than department reviews, at the institution, college and program levels. The following is a list of reviews led by NPLs, which included major components relating to the plant protection portfolio. Examples of the review summary documents are present in the supplemental evidentiary materials.

Table 1.1
National Program Leaders Activities in CSREES Program Categories

Program Category	Examples of Program Leadership
Formula Funding	
Formula Research*	National program planning & oversight, multi-state/multi-discipline coordination & facilitation, national priority setting, national symposia, project review
Formula (Smith Lever) Extension	National program planning & oversight, multi-state/multi-discipline coordination & facilitation, national priority setting, national symposia, plans of work review
Special Grants	
Special Grants - research	Overall programmatic oversight, grant management, national/regional coordination
Other Research	Overall programmatic oversight, grant management, national/regional coordination
Smith-Lever 3(d) Extension	Overall programmatic oversight, grant management, national/regional coordination
Other Extension	Overall programmatic oversight, grant management, national/regional coordination
Competitive Grants	
National Research Initiative	RFA development, panel management, national priority setting, national symposia
Integrated Activities (406)**	RFA development, panel management, national priority setting, national symposia, grant management
Higher Education	RFA development, panel management, national priority setting, national symposia, grant management

***** Includes Hatch Act, McIntire-Stennis Cooperative Forestry, Evans-Allen Program, and Animal Health and Disease Section 1433.
****** Includes water quality, food safety, and pest management programs.

Table 1.2 National Program Leaders with Responsibilities for Plant Protection-related Activities	
Name	**Discipline / Program / Issues**
Auburn, Jill	Ecology; sustainable agriculture, organic agriculture
Bewick, Tom	Horticulture; organic agriculture, invasive species, urban agriculture
Bolton, Herb	Entomology; invasive species
Cardwell, Kitty	Plant pathology, National Plant Diagnostic Network
Fitzner, Mike	Extension IPM; Regional IPM Centers; Plant breeding
Goldner, William	Small Business; Plant Production and Protection; Forests and Related Resources
Green, James	Horticulture, crop physiology
Hoffman, Bill	Plant bio-security, National Plant Diagnostic Network
Jerkins, Diana	Entomology, Managed ecosystems
Jones, Dan	Biochemistry & molecular biology; biotech.
Jones, Preston	Agronomy; precision agriculture
Johnson, Monte	Entomology; toxicology; PSEP; PMAP
Kaleikau, Ed	Plant Genomics
Kopp, Dennis	Entomology, Methyl Bromide Alternatives
Kotcon, James	Plant pathology; organic agriculture
Lichens-Park, Ann	Plant pathology, Biol. of plant microbe assn., microbial gene sequencing
Lin, Liang-Shiou	Plant genetic mechanisms, plant growth & development
McLean, Gail	Plant responses to the environment, plant biochemistry, bioinformatics
Menzel, Bruce	Wildlife ecology
Meyer, Rick	Entomology; CAR; critical issues
Nowierski, Bob	Bio-based IPM; applied ecology; RAMP, invasive species
Ortman, Eldon	Shared Faculty; IPM
Poth, Mark	Director, National Research Initiative
Parochetti, Jim	Weed science; IR-4
Purcell-Miramontes, Mary	Entomology, nematology, bio-based IPM
Sheely, Deb	Director, Competitive integrated programs
Thro, Ann Marie	Plant breeding; plant genetics; genomics

1.8 Current Trends and Opportunities

The Land-Grant University System was established by the Morrill Act of 1862 “to teach such branches of learning as are related to agriculture and the mechanic arts . . . in order to promote the liberal and practical education of the industrial classes in the several pursuits and profession in life.” At that time the scientific basis of agriculture was rudimentary, and focused primarily on increasing the productivity of lands and animals. Plant and animal breeding, nutrient management are significant milestones in the spectrum of scientific investment in agricultural productivity.

As agriculture matured and became more fully integrated into the social, political and economic structure of the Nation, broader issues, including positive and negative environmental and economic externalities, access to and the distribution of the benefits of public investment in agriculture and rural communities, and the sustainability of the scientific workforce have emerged. Breakthroughs in fundamental science, including genomics, microbiology and nanotechnology have raised the bar for the application of science, technology, and practice in producing, marketing and distributing food and fiber products. These sometimes produced additional questions regarding long term risks and benefits, ethics, and domestic and international consumer acceptance. In the post-9/11 environment, the aggregate safety and security of the food and fiber supply, terrorism aimed at food and fiber products, and protecting public health and well being have become paramount.

The increasingly global nature of contemporary agricultural products offers the world the benefit of a more varied food supply, but is accompanied by increased risks of food-borne disease and invasive pests. The information available from the sciences of plant and animal genomics, remote sensing, disease epidemiology, animal and human nutrition, and market and policy analysis have transformed agriculture into a high-tech, environmentally sustainable, and profitable industry that can address the world's accelerating food and fiber needs. Expanding the scientific base beyond the production sciences to also address human health, environmental sustainability, and community and economic development is crucial to increase distribution of food and fiber to growing international markets.

Adequate nutrition is needed to promote human health, maintain a healthy body weight, and to avoid the risk of chronic disease related to food consumption. State-of-the-art scientific techniques document optimal nutritional nutrition needs from pre-birth through old age. Technological advancements like sequencing of the human and other genomes, allow scientists to develop individual nutrient requirements as determined by age, environment, gender, genetics, lifestyle, and physiology.

1.9 Partners / Stakeholders / Customers

CSREES provides federally-mandated funding to support extramural research, education and extension programming throughout the United States and its territories.

CSREES' primary partners are public institutions of higher learning, particularly the 1862, 1890 (Historically Black) and 1994 (Tribal) land-grant colleges and universities, and the "non land-grant" public institutions whose missions include basic, applied and developmental research, extension, and teaching activities in food and fiber, agricultural, renewable natural resources, forestry, and physical and social sciences. The scope of partner activities is broad—all aspects of agriculture, including soil and water conservation and use; plant and animal production, protection, and health; processing, distribution, safety, marketing, and utilization of food and agricultural products; forestry, including urban forestry; aquaculture; home economics and family life, human nutrition; rural and community development; sustainable agriculture; molecular biology; and biotechnology.

CSREES solicits input on its programs from a broad and diverse stakeholder clientele. Our clientele includes individuals, businesses and organizations in the public and private sector. Examples of our stakeholder input process include the IR-4 industry committee, the regional integrated pest management centers advisory committee, the national plant diagnostic network infrastructure, the Sustainable Agricultural Research and Education Program (SARE) regional administrative councils and the National Research Initiative (NRI) sponsored stakeholder workshops. CSREES also solicits stakeholder input through the federal register regarding all competitive grant program requests for applications.

CSREES' ultimate customers are citizens. CSREES works with land-grant and other institutions and industry to create and transfer the know-how and the science-based technology from the laboratory to farmers, consumers, and agribusiness. The Cooperative Extension System provides information to every county in the Nation, offering education that links research, science, and technology to people where they live and work. Topics range from community economic development, health care, food safety, water quality, sustainable agriculture, and the environment to programs for children, youth, and families.

CSREES partners also include the land grant universities. CSREES provides service to these institutions through sponsored department and program reviews (Table 1.3 & 1.4, found on pages 23-24).

Table 1.3
CSREES Led Department Reviews Related to Plant Protection: 1999 - 2004

Entomology

- March 22 - 26, 1999. Comprehensive Review of the Department of Entomology, University of Wisconsin.
- April 11-14, 1999. Comprehensive Review of the Department of Entomology, Kansas State University.
- April 16-17, 2000. Comprehensive Review of the Department of Entomology, University of Georgia.
- May 15-18, 2000. Comprehensive Review of the Department of Entomology, Virginia Tech.
- June 12-16, 2000. Comprehensive Review of the Department of Plant Sciences, South Dakota State University.
- October 15-17, 2000. Review Department of Entomology and Applied Ecology, University of Delaware.
- October 22-25, 2001. Comprehensive Review of the Department of Entomology, North Carolina State University.
- February 26 – March 1, 2002. Comprehensive Review of the Department of Entomology, University of Arizona.
- May 6-8, 2002. Comprehensive Review of the Department of Entomology, Iowa State University.
- May 12-16, 2003. Comprehensive Review of the Department of Entomology and plant pathology, Auburn University.
- June 1-6, 2003. Comprehensive Review of the Department of Plant, Soil and Entomological Sciences, University of Idaho.
- October 17-21, 2004. Comprehensive Review of the Department of Entomology, Ohio State University.

Plant Pathology

- Department of Plant Pathology and Crop Physiology, Louisiana State University, Baton Rogue, LA March 26-30, 2000.
- North Dakota State Univ., Department of Plant Pathology, November 2001

Weed Science

- Univ. of Missouri, Plant Sciences Unit, October 2001
- Special Grant, Weed Control-North Dakota, with emphasis on the current three years of the active grant. October 30-31, 2002, at North Dakota State University

Horticulture

- North Carolina State University, Department of Horticultural Science, May 21-24, 2001
- Horticulture Program Component in the Department of Animal and Horticulture Science, University of Maine, Orono, ME, College of Natural Sciences, Forestry and Agriculture, June 11-14, 2001.
- Kansas State University, Department of Horticulture, Forestry and Recreational Resources, July 15-19, 2002
- Horticulture and Landscape Architecture, Purdue University, West Lafayette, IN March 2-6, 2003
- South Dakota State University, Department of Horticulture, Forestry, Landscape and Parks, April 1-4, 2003
- Auburn University, Horticulture Department, April 13-16, 2003
- Department of Horticulture, Virginia Tech, Blacksburg, VA September 15-18, 2003.
- Michigan State University, Horticulture Department, October 26-30, 2003
- University of Nebraska – Lincoln, Agronomy and Horticulture Department, November 16-20, 2003

Agronomy, Crops Science, Plant Sciences

- University of Illinois, Comprehensive Review of the Crop Sciences Department, March, 8-12, 1999
- University of Georgia, Comprehensive Review of the Crop and Soil Sciences Department, April, 26-40, 1999
- Plant and Soil Science and Botany/Agricultural Biochemistry Departments, University of Vermont, Burlington, VT. October 25-29, 1999.

- University of Wyoming, Comprehensive Review of the Plant Sciences Department, April, 2-5, 2001
- University of Florida, Comprehensive Review of the Agronomy Department, April, 9-14, 2000
- Michigan State University, Comprehensive Review of the Crop and Soil Sciences Department, September, 11-15, 2000
- University of Maine, Comprehensive Review of the Plant, Soil and Environmental Sciences Department, March, 12-15, 2001
- Utah State University, Comprehensive Review of the Plants, Soils and Biometerology Department, March, 25-29, 2002
- NC State University, Department of Plant Science, March 2002.
- New Mexico State University, Comprehensive Review of the Agronomy and Horticulture Department, April, 21-25, 2003

Table 1.4
CSREES Led Program Reviews – 1999 through 2004

- Colorado State Univ., Extension IPM Program, April 1999
- February 28-March 2, 2000. Comprehensive review of the Integrated Pest Management Program at the University of Oklahoma, Stillwater, OK
- March 25-29, 2001. Comprehensive Review of Statewide Entomology Programs, Louisiana State University.
- Cornell Univ., IPM Program, October 2001
- May 5-8, 2003. Comprehensive Review of the USDA, ARS Midwest Livestock Insects Research Unit, Lincoln, NE.
- Michigan State Univ. , Extension IPM Program, 2004

1.10 Post-Award Management of CSREES Funded Grants and Programs

An ongoing component of CSREES' resource stewardship involves Agency staff and NPLs providing post-award management to help grant and program recipients of agency resources document accomplishments and enhance performance. Grants and programs in the plant protection portfolio have high visibility and compose an important portion of CSREES post-award management activities. The intent of post-award management is to enhance the success of the Agency's grant and program activities. Due to the large number of CSREES annual awards and relatively few staff and NPLs that manage these grants as a part of their role and responsibility, only a relatively small portion of our funded grants and programs benefit from post-award management. Yet, where post-award management is provided, enhanced performance and quality of outcomes are apparent. Some examples of CSREES led post-award management activities are listed below and examples of are provided in the supplemental evidentiary materials.

Table 1.5 **Post Award Management Activities 1999 through 2003**
Site Visits for Congressionally Designated Line Items (CDLI) or National Support Research Projects (NRSP): • January 14, 1999. Site visit and review of the CDLI for the Vidalia Onion Special Research Grant-GA, University of Georgia, Athens, GA. • June 16, 2000. Site visit and review of the CDLI for the Agricultural Diversity Red River-MN/ND, University of Minnesota, Crookston, MN. • August 6, 2001. Site visit and review of the CDLI for the Wheat Stem Sawfly and Cereal Aphid Special Grant-MT, University of Idaho, Moscow, ID. • August 6, 2001. Site visit and review of the CDLI for the Sustainable Pest Management for Dryland Wheat-MT, University of Idaho, Moscow, ID. • December 12-13, 2002. Comprehensive Review of the National Research Support Project # 5 (National Virus – Tested Fruit Tree Project), Washington State University. • December 10, 2003. Comprehensive Review of the National Research Support Project # 1 (Research Planning using the Current Research Information System [CRIS]). Review via conference calls among reviewers.

Section 2:
Funding Authorities for CSREES Activities

2.1 Overview of Funding Types

CSREES programs increase and provide access to scientific knowledge; strengthen the capabilities of land-grant and other institutions in research, extension and higher education; increase access to and use of improved communication and network systems; and promote informed decision making by producers, families, communities, and other customers. CSREES supports research, education and extension at partner institutions mainly through four funding mechanisms: 1) formula funds, 2) competitive grants 3) special grants and 4) research and education activities.

(A) Formula Funds

CSREES provides funds for research and extension to land grant institutions (1862, 1890 and 1994 institutions) and schools of forestry and veterinary medicine through several formula grant authorities. The amount of funds provided to each institution is determined through a statutory formula which may include such things as the rural population or amount of farmed acreage in a state. Formula funds are a critical source for base support for agricultural programs at the land-grant institutions. Combined with matching funds from state and local governments, these funds form the foundation for activities ranging from animal and crop improvement, watershed management, 4-H programs and nutrition education. Decisions about how the funds are spent are determined on a local and regional basis. Institutions receiving Hatch and Smith-Lever formula funds and the 1890 Institutions receiving research and extension formula funds must submit plans of work describing the use of the funds and must document the process used to solicit stakeholder input used to set priorities for the use of Federal research and extension funds.

(B) Competitive Grants

Competitive programs enable CSREES to attract a large pool of applicants to work on agricultural issues of national interest, and to select the highest quality proposals submitted for funding. CSREES uses the competitive grant processes for fundamental or applied research, for extension, for higher education, and for programs which integrate research, education and extension functions. Grants are awarded through a rigorous peer-review process. Eligibility, administrative rules, and procedures may vary for each program depending authority derived from the Farm Bill or appropriation law. Special competitive programs are available that are tailored to increase participation of minority or small and midsized institutions in research, education or extension. Other competitive grants are more broadly open to all applicants or to specific types of applicant institutions. The number of competitive programs administered by CSREES has increased in recent fiscal years with the addition of the Integrated Research, Education and Extension Grant Programs.

(C) Special and Federal Administration Grants (Congressionally-directed projects)

Earmarked projects are those defined specifically by Congress to support a designated institution or set of institutions for particular topics in research, education or extension. Earmarks serve the purpose of directing funds to local or state issues that are of high specificity to the locality.

In this section each type of funding will be profiled along with the legislation that brought the funding into existence. It is important to note that while these funding allocations are listed under discrete headings (e.g. Research and Education Activities, Integrated Activities, Extension Activities, etc.) there are instances where the enabling legislation allows for a variety of program implementation scenarios. For example, under both Hatch and Smith-Lever there are multi-state projects that are similarly constructed to integrated efforts. The Sustainable Agriculture and

Education program also provides funding for projects that combine research, extension and sometimes also include formal education.

(D) Research and Education Activities
Research and Education programs administered by CSREES are USDA's principal connection to the university system of the U.S. for the purpose of conducting agricultural research and education programs. USDA participates with state and other cooperators to encourage and assist the state institutions in the conduct of agricultural research and education through the State Agricultural Experiment Stations (SAES) of the 50 states and the territories; by approved Schools of Forestry; the 1890 Land-Grant Institutions and Tuskegee University and West Virginia State College; Colleges of Veterinary Medicine; and other eligible institutions. Appropriations for research and education activities are authorized under the following Acts.

2.2 Formula Programs

(A) Hatch Act
The foundation of the Federal-State partnership in agricultural research is financed through formula Hatch funding and matching State revenue. Hatch Act was enabled 1887 and has been amended numerous time since then. The Hatch act allocates federal funds on a formula basis to the State Agricultural Experiment Stations of the 50 States, District of Columbia, Puerto Rico, Guam, Virgin Islands, Micronesia, American Samoa, and Northern Mariana Islands for research to promote a sound and prosperous agriculture and rural life. One hundred percent matching by state funds is required. Hatch funding supports sustained research activities in agricultural priority areas to address pre-commercial and/or non-funded technologies of public need. Hatch-funded research is complementary to Agricultural Research Service (ARS) National Research Programs and State-based research, addressing needs/ priorities through coordinated programs. The States are required to use no less than 25 percent of Hatch funds for multi-state research projects. These projects are supported through regional committees which address critical and emerging issues in agricultural research.

(B) McIntire-Stennis Cooperative Forestry Act
The Cooperative Forestry Research Act of October 10, 1962 established McIntire-Stennis funding. The Act authorizes funding of research in State institutions certified by a State representative designated by the governor of each State. The Act provides that appropriated funds be apportioned among States as determined by the Secretary after consultation with the legislatively mandated Forestry Research Advisory Council. The council consists of not fewer than 16 members representing Federal and State agencies concerned with developing and utilizing the Nation's forest resources, the forest industries, the forestry schools of the State-certified eligible institutions, SAES, and volunteer public groups concerned with forests and related natural resources. Determination of apportionments follows consideration of pertinent factors including areas of non-federal commercial forest land, volume of timber cut from growing stock, and the non-Federal dollars expended on forestry research in the State. The Act also provides that payments must be matched by funds made available and budgeted from non-Federal sources by the certified institutions for expenditure on forestry research. Three percent of funds appropriated under this Act are set-aside for Federal administration.

(C) Evans-Allen Program *(1890 Colleges, Tuskegee University, and West Virginia State College)*
The Evans-Allen program was established by the National Agricultural Research, Extension, and Teaching Policy Act of 1977, Section 1445. This program allocates funds on a formula basis for agricultural research at the 1890 Institutions, Tuskegee University and West Virginia State College. The agricultural research programs at the 1890 Land-Grant Colleges and Universities are designed to generate new knowledge which will assist rural underprivileged people and small farmers obtain a higher standard of living. Therefore, there is a high concentration of research effort in the areas of small farms, sustainable agriculture, rural economic development, human nutrition, rural health, and youth and elderly. The 2002 Farm Security and Rural Investment Act

requires a 100% match of federal dollars. The Secretary may waive the match above 50% if an institution is incapable of meeting that requirement.

(D) ***Animal Health and Disease Program***
The National Agricultural Research, Extension, and Teaching Policy Act of 1977, Section 1433 provides for support of livestock and poultry disease research in accredited schools or colleges of veterinary medicine or SAES that conduct animal health and disease research. These funds provide support for new research initiatives and enhance research capacity leading to improved animal health, reduced use of antibacterial drugs and improved safety of foods of animal origin. The funds are allocated on a formula basis in support of livestock and poultry disease research at accredited schools or colleges of veterinary medicine or State Agricultural Experiment Stations that conduct animal health disease research. Matching is required.

2.3 National Research Initiative Competitive Grants

Section 2(b), Act of August 4, 1965, 7 U.S.C. 450i(b), as amended, authorizes Competitive Research Grants for periods not to exceed five years to SAES, all colleges and universities, other research institutions and organizations, Federal agencies, private organizations or corporations, and individuals to further the programs of the Department. The NRI supports research, education, and extension grants that address key problems of national, regional, and multi-state importance in sustaining all components of agriculture (farming, ranching, forestry including urban and agro-forestry, aquaculture, rural communities, human nutrition, processing and others). Such integrated projects hold the greatest potential to produce and transfer knowledge directly to end users.

Providing this support requires that NRI advance fundamental sciences in support of agriculture and coordinate opportunities to build on these discoveries through new efforts in education and extension that deliver science-based knowledge to people, allowing them to make informed, practical decisions. Accordingly, the NRI supports fundamental research, mission-linked research, and integrated research, education, and extension projects. These programs build on a foundation of ongoing research addressing key issues of national and regional importance to agriculture, forestry, human nutrition and related sciences.

The authority to support integrated projects is contained in Section 733 of the General Provisions of the Consolidated Appropriations Act, 2004 (Pub. L. 108-199), which provided CSREES with the authority to use up to twenty percent of the amount made available in the Act for the NRI, to carry out a competitive grants program under the same terms and conditions as those provided in Section 401 of the Agricultural Research, Extension, and Education Reform Act of 1998 (AREERA) (7 U.S.C. 7621).

It should be noted that, within CSREES, integrated multi-functional projects are supported primarily through two competitive grants programs, the National Research Initiative (NRI) competitive grants program described in this section and the Integrated Research, Education, and Extension (from Section 406 of AREERA, described below under Integrated Activities) competitive grants program.

2.4 Special Grants

Section 2(c), Act of August 4, 1965, 7 U.S.C. 450i (c), as amended, authorizes Special Research Grants for periods not to exceed three years to SAES, all colleges and universities, other research institutions and organizations, federal agencies, private organizations or corporations, and individuals. Previously, grants were made available for the purpose of conducting research to facilitate or expand promising breakthroughs in areas of the food and agricultural sciences. However, AREERA expanded the purposes under this authority to include extension or education activities. Grants funded in this account are only for research projects. Special Research Grants are awarded on discretionary basis as well as through the use of competitive scientific peer and merit review processes. These grants, numbering in the hundreds, will not be discussed further in this document.

2.5 Other Research and Education Activities

(A) Critical Agricultural Materials
Authorizes a program of research, technology development, and technology transfer for the development of critical agricultural materials from native agricultural crops having strategic and industrial importance. Funding is currently directed to the University of Southern Mississippi.

(B) Aquaculture Centers
Authorizes the establishment of aquacultural research, development and demonstration centers in the United States for the performance of aquaculture research extension work and demonstration projects. Funding currently supports five regional aquaculture centers, as designated by Congress.

(C) Sustainable Agriculture Research and Education Program
Authorizes a program to facilitate and increase scientific investigation and education in order to reduce the use of chemical pesticides, fertilizers, and toxic natural materials in agricultural production; improve low-input farm management; take advantage of the experiences and expertise of farmers and ranchers through their direct participation and leadership in projects; and transfer reliable and timely information to farmers and ranchers. Grants are awarded on a regional basis by panels which include producers as well as scientific experts. *(see also SARE in Extension below)*

(D) Supplemental and Alternative Crops
Authorizes a research and pilot project program for the development of supplemental and alternative crops. The program has been directed to support the development of canola, hesperole and other natural products from desert plants.

(E) 1994 Institution Research Grants
The Equity in Educational Land-Grant Status Act of 1994, Public Law 103-382, as amended, authorizes a competitive grants program for the 30 institutions designated as 1994 institutions. Section 7201 of the Farm Security and Rural Investment Act of 2002 adds a new institution, increasing the number of recipients eligible to receive funding under this program to 31. The program allows scientists at the 1994 institutions to participate in agricultural research activities that address tribal, National, and multi-state priorities.

(F) Federal Administration *(direct appropriation)*
Authority for direct appropriations is provided in the annual Agriculture, Rural Development, Food and Drug Administration (FDA) and Related Agencies Appropriation Act. These funds are used to provide support services in connection with planning and coordination of all research and education programs administered by CSREES, including the REE Data Information System.

(G) Small Business Innovation Research Program
Authorizes the award of competitive grants to science-based small business firms for the support of research dealing with Forests and Related Resources,; Plant Production and Protection; Animal Production and Protection; Air, Water and Soils; Food Science and Nutrition; Rural and Community Development; Aquaculture; Industrial Applications; and marketing and trade. The program is funded through a statutory mandatory assessment of 2.5 percent on all USDA supported research.

(H) Community Food Projects
This program is funded through the Food Stamp Act and competitively awards grants to support the development of Community Food Projects with a one-time infusion of Federal dollars to make such projects self-sustaining or to support stand-alone technical and technical assistance activities. Community Food Projects are designed to meet the food needs of low-income people, increase the self-reliance of communities in providing for their own food need; and promote comprehensive responses to local food, farm and nutrition issues.

(I) Biotechnology Risk Assessment Research Competitive Grant Program
This program was authorized by the 1990 Farm Bill and funds research in support of biotechnology research and regulation related to environmental risk assessment. The program is funded through a 2 percent assessment on USDA-supported biotechnology research.

2.6 Higher Education

CSREES' Science and Education Resources Development (SERD) is leading USDA's commitment to human capital development. SERD's grant programs strengthen agricultural and science literacy in K-12 education, influence students' career choices toward agriculture, strengthen higher education in the food and agricultural sciences, prepare graduate students, and train master's and doctoral-level students as future scientists. SERD also provides national leadership for revitalizing curricula, recruiting and retaining new faculty, expanding faculty competencies, using new technologies to improve instruction delivery, attracting outside scholars, developing research and teaching capacity at minority-serving institutions, and increasing the diversity of the food and agricultural scientific work force. The following grant programs support our efforts.

(A) Graduate Fellowships Grants
The National Agricultural Research, Extension, and Teaching Policy Act of 1977, Section 1417(b)(6), Higher Education-Graduate Scholarships Grants are awarded on a competitive basis to colleges and universities to conduct graduate training programs to stimulate the development of food and agricultural scientific expertise in targeted national need areas. This program strengthens higher education in the food and agricultural sciences by producing graduates capable of fulfilling the Nation's requirements for professional and scientific expertise. Doctoral students are recruited and supported for three years of training in targeted specializations characterized by shortages of expertise.

(B) Institution Challenge Grants
Pursuant to Section 1417(b)(1), initiated in FY 1990, stimulates and enables colleges and universities to provide the quality of education necessary to produce baccalaureate or doctor of veterinary medicine graduates capable of strengthening the nation's food and agricultural professional work force. It is intended that projects supported under this program will 1) address a State, regional, national, or international educational need, 2) involve a creative or nontraditional approach toward addressing that need which can serve as a model to others, 3) encourage and facilitate better working relationships in the university science and education community, as well as between universities and the private sector, to enhance program quality and supplement available resources, and 4) result in benefits which will likely transcend the project duration and USDA support. U.S. colleges and universities that offer a baccalaureate or first professional degree in at least one discipline or area of the food and agricultural sciences may submit proposals. All Federal funds competitively awarded under this program must be matched by the universities on a dollar-for-dollar basis from non-federal sources.

(C) 1890 Institution Capacity Building Grants
Initiated in 1990, under 1417(b)(4), this program was established to build the institutional capacities of the 1890 historically Black Land-Grant colleges and Tuskegee University through cooperative linkages with Federal and non-Federal entities. This program is designed to strengthen institutional teaching and research capacities, through cooperative programs with

Federal and non-Federal entities, including curriculum, faculty, scientific instrumentation, instruction delivery systems, student experimental learning, student recruitment and retention, studies and experimentation, centralized research support systems, and technology delivery systems, to respond to identified State, regional, national, or international educational needs in the food and agricultural sciences, or rural economic, community, and business development. Matching is encouraged.

(D) Multicultural Scholars
Competitively awarded grants program open to colleges and universities for undergraduate multicultural four-year scholarships to meet national needs for training food and agricultural scientists and professionals. Multicultural eligibility is specifically defines as African-Americans, Hispanics, Asians or Pacific Islanders, and Native Americans or Alaskan Natives. Matching required.

(E) Hispanic-Serving Institutions Education Grants Program
The competitive Hispanic Education Partnership Grants Program, established under Section 1455(a), is intended to promote and strengthen the ability of Hispanic-Serving Institutions (HSI) to carry out higher education teaching programs in the food and agricultural sciences. (HSI designation requires an undergraduate Hispanic enrollment of at least 25 percent.) About 240 such institutions are eligible to compete. Funded projects will address one or more targeted need areas: curricula design and materials development; faculty preparation and enhancement for teaching; instruction delivery systems; scientific instrumentation for teaching; student experiential learning; and, student recruitment and retention.

(F) Tribal Colleges Education Equity Grants Program
The Equity in Educational Land-Grant Status Act of 1994, Public Law 103-382, as amended, launched in 1996 a formula-based effort to enhance educational opportunities for Native Americans by strengthening instructional programs in the food and agricultural sciences at the 31 tribally controlled colleges designated as the 1994 Land-Grant Institutions. Section 7202 of the Farm Security and Rural Investment Act of 2002 increases the authorized amount from $50,000 to $100,000. Funds may be used to support teaching programs in the food and agricultural sciences in the targeted need areas of curricula design and instructional materials development; faculty development and preparation for teaching; instruction delivery systems; student experimental learning; equipment and instrumentation for teaching, and student recruitment and retention. These institutions serve approximately 14,000 Native American students. Projects focus on undergraduate and graduate studies in the food and agricultural sciences.

(G) Tribal Colleges Endowment Fund
This program, authorized by Public Law 103-382 and launched in 1996, distributes interest earned by an endowment established for the 1994 Land-Grant Institutions (31 Tribally-controlled colleges) as authorized in the Equity in Education Land-Grant Status Act of 1994. The Endowment Fund Enhances education in agricultural sciences and related areas for Native Americans by building educational capacity at these institutions in the areas of curricula design and materials development, faculty development and preparation for teaching, instruction delivery systems, experiential learning, equipment and instrumentation for teaching, and student recruitment and retention. At the end of each fiscal year, the Secretary withdraws the earned interest income from the endowment fund for the fiscal year, and after subtracting administrative costs, CSREES distributes the adjusted income as follows: 60 percent of the adjusted income from these funds shall be distributed among the 1994 Land-Grant Institutions on a pro rata basis, the proportionate share being based on the Indian student count, and 40 percent of the adjusted income shall be distributed in equal shares to the 1994 Land-Grant Institutions.

(H) Secondary/2-Year Post Secondary
The National Agricultural Research, Extension, and Teaching Policy Act of 1977, Section 1417(j), as amended, established the Secondary and Two-year Postsecondary Agriculture Education Challenge Grants program is designed to promote and strengthen secondary education in

agribusiness and agri-science and to increase the number and/or diversity of young Americans pursuing college degrees in the food and agricultural sciences. The intent of the program is to encourage teachers to creatively incorporate elements of agri-science and agribusiness into secondary education programs. Matching required.

(I) Alaska Native-Serving and Native Hawaiian-Serving Institutions
Authorized by Section 759 of Public Law 106-78, this program was authorized to build educational capacity within the Native Alaskan and Native Hawaiian serving institutions. The intent of the legislation is to assist these institutions to carry out higher education teaching programs in the food and agricultural sciences.

2.7 Outreach and Assistance for Disadvantaged Farmers Activities Section 2501 Legislative Authority

Outreach and Technical Assistance for Socially Disadvantaged Farmers and Ranchers Program Section 2501 program authorization resides in the miscellaneous title of the Farm Bill (7 U.S.C. 2279). This program provides outreach and technical assistance to encourage and assist socially disadvantaged farmers and rancher to own and operate farms and ranches and to participate in agricultural programs. CSREES assumed the responsibility for the grant making aspects of this program beginning in FY 2003. Competitive grant awards are made for multiple year projects.

Section 3:
Integrated Activities

Competitive grant programs offering support for integrated research, education, and extension activities are uniquely positioned to effectively develop and implement solutions to important agricultural problems. They do this by funding applied research on specific problems and issues, and transferring the resulting knowledge to end users via classroom education or informal extension and outreach. Within CSREES, integrated multi-functional projects are supported primarily through two competitive grants programs, the Integrated Research, Education, and Extension (from Section 406 of AREERA, see below) competitive grants program, and the National Research Initiative (NRI) competitive grants program.

3.1 Section 406 Legislative Authority

The 406 program is authorized in Section 406 of the Agricultural Research, Extension, and Education Reform Act (AREERA) of 1998, Public Law 105-185. Colleges and universities (as defined by section 1404 of the National Agricultural Research, Extension, and Teaching Policy Act of 1977) as well as 1994 land-grant universities (via Section 7206 of the Farm Security and Rural Investment Act of 2002) are eligible to apply for these funds. The following seven programs are currently funded under this authority.

(A) Water Quality
The purpose of this program is to improve the quality of our Nation's surface water and groundwater resources through integrated research, education and extension activities. Food Safety

(B) Regional Integrated Pest Management (IPM) Centers
These Regional IPM centers are currently hosted at the University of California-Davis, the University of Illinois/Michigan State University, Penn State University/Cornell University and North Carolina State University. These four centers are the focal point for team building efforts, communication networks, and stakeholder participation within a given region to address a range of pest management issues confronting farmers and other pest managers.

(C) Crops at Risk from the Food Quality Protection Act Implementation
The goal of the program is to develop new multiple-tactic IPM strategies to assist in the transition period for cropping systems affected by the implementation of the Food Quality Protection Act (FQPA) of 1996 - Food Quality Protection Act Risk Management Program for Major Food Crop Systems.

(D) Food Quality Protection Act Risk Mitigation Program for Major Food Crop System
This program emphasizes development and implementation of new and innovative pest management systems designed to maintain the productivity and profitability of major acreage crops while meeting or exceeding environmental quality and human health standards as the Food Quality Protection Act of 1996 is implemented

(E) Methyl Bromide Transition Program
This program is designed to support the discovery and implementation of practical pest management alternatives for commodities affected by the methyl bromide phase-out.

(F) Organic Transition Program
This program supports the development and implementation of biologically based pest management practices that mitigate the ecological, agronomic and economic risks associated with a transition from conventional to organic agricultural production systems.

(G) Food Safety
The National Integrated Food Safety Initiative (NIFSI) is primarily a food safety program, but a portion of this program addresses processing technologies for reduction and elimination of food-borne pathogens and allergens. Under Integrated Authority (Section 406), CSREES administers competitive grants in food safety activities that integrate research, education, and extension in priority areas that are based on stakeholder input. The food science and technology component addresses the impact of alternative technologies on food safety.

3.2 Other Legislative Authorities

The following programs are authorized as Special Grants in Section 2(c), Act of August 4, 1965, 7 U.S.C. 450i (c), as amended, and Public Law 105-185.

(A) Critical and Emerging Pests and Diseases
This program supports the development of early prevention strategies to prevent, manage or eradicate new and emerging diseases, both plant and animal, which would prevent loss of revenue to growers and producers. These funds are provided under competitive awards.

(B) Pest Management Alternatives Program
The Pest Management Alternatives Program (PMAP) was established in fiscal year 1996 as the primary vehicle to respond to the environmental and regulatory issues confronting agriculture. The purpose of this program is to develop replacement tactics and technologies for pesticides under consideration for regulatory action by the Environmental Protection Agency (EPA) and for which effective alternatives are not available. As the FQPA is implemented, this program will become more critical as a support base for pest management technologies, and additional funds will be required to maintain a pipeline of alternatives. The program is structured to fund short-term projects aimed at adaptive research and implementation of tactics which have shown promise in previous testing. The focus of the program is primarily towards replacement of individual tactics in a pest management program on a single crop basis, and not towards entire crop or cropping system pest management issues. For example, this program might fund an implementation program aimed at replacing an organophosphate insecticide in potato with a new and safer insecticide.

(C) Regional Rural Development Centers
This program provides funds at four regional centers in Pennsylvania, Mississippi, Utah and Iowa. Programs are designed to improve the social and economic well-being of rural communities in their respective regions. These funds are distributed according to the extent of the problem that requires attention in each state.

The National Agricultural Research, Extension, and Teaching Policy Act of 1977, as amended (7 U.S.C. 3101 et seq.), provides authority for the following two programs.

(D) International Science and Education Grants Program
The International Science and Education (ISE) Grants Program supports research, extension, and teaching activities that will enhance the capabilities of American colleges and universities to conduct international collaborative research, extension and teaching. ISE projects are expected to enhance the international content of curricula; ensure that faculty work beyond the U.S. and bring lessons learned back home; promote international research partnerships; enhance the use and application of foreign technologies in the U.S.; and strengthen the role that colleges and universities play in maintaining U.S. competitiveness. This is a competitive program.

(E) Homeland Security Program
This program provides support for a unified network National Plant Diagnostic Network (NPDN) of public agricultural institutions to identify and respond to high risk biological pathogens in the food

and agricultural system. The network will be used to increase the ability to protect the nation from disease threats by identifying, containing, and minimizing disease threats.

3.3 Other Programs

(A) Community Food Projects

This program is funded through the Food Stamp Act and competitively awards grants to support the development of Community Food Projects with a one-time infusion of Federal dollars to make such projects self-sustaining or to support stand-alone technical and technical assistance activities. Community Food Projects are designed to meet the food needs of low-income people, increase the self-reliance of communities in providing for their own food need; and promote comprehensive responses to local food, farm and nutrition issues.

(B) Organic Research and Extension Initiative

The Farm Security and Rural Investment Act of 2002 established this program with $3 million per year for Fiscal Years 2004-2008 to fund organic farming and marketing research. These funds are disbursed through a competitive grants program. The purpose of the program is to fund research that will enhance organic producers' and processors' abilities to grow and market high-quality organic food, feed, and fiber. These funds are allocated for high-priority aspects of organic agricultural systems research, education, and extension. Priority concerns encompass biological, physical, and social sciences (including economics).

(C) Risk Management Education

The Risk Management Education (RME) Competitive Grants program was authorized in the Agricultural Risk Protection Act (ARPA), signed into law in August 2000. The legislation provides $5 million to CSREES which, in turn, competitively awards four regional RME centers located as follows: Northeast-University of Delaware; North-central-University of Nebraska-Lincoln; Southern-Texas A&M University, Stephanville, TX, and Western-Washington State University, Spokane, WA. The Digital Center for Risk Management Education at the University of Minnesota provides electronic and other support to the four regional RME centers and was also awarded a grant and provides a library of accomplishments and other risk management-related materials. The program competitively awards grants to addresses national, regional and local risk management issues to allow U.S. producers to have the knowledge, skills and tools needed to make informed risk management decisions for their operations.

Section 4:
Extension Activities

All universities engage in research and teaching, but the nation's more than 100 land-grant colleges and universities, have a third critical mission - extension. "Extension" means "reaching out," and along with teaching and research land-grant institutions "extend" their resources, solving public needs with college or university resources through non-formal, non-credit programs. These programs are largely administered through thousands of county and regional extension offices in nearly all of the Nation's 3,150 counties, which bring land-grant expertise to the most local of levels. And both the universities and their local offices are supported by CSREES, the federal partner in the Cooperative Extension System (CES). CSREES plays a key role in the land-grant extension mission by distributing annual Congressionally-appropriated formula funding to supplement state and county funds. CSREES affects how these formula funds are used through national program leadership to help identify timely national priorities and ways to address them.

4.1 Formula Programs

(A) Smith-Lever Formula 3(b) and (c)

Federal base program funds authorized under Smith-Lever Act 3(b) and (c) and allocated on a formula basis support Cooperative Extension programs at the 1862 Land-Grant Universities. Funds are allocated on a formula basis to support cooperative extension work in 50 States, Puerto Rico, Guam, Virgin Islands, Micronesia, American Samoa, and Northern Mariana Islands. The States are required to spend no less than 25 percent of Smith-Lever funds on multi-state or regional extension activities. One hundred percent non-federal match required for 1862 institutions, 50 percent match with potential waiver for territories. The District of Columbia receives extension funds through separate legislative authority.

(B) 1890 Institutions

The 1890 Extension program supports the educational base program as well as specific national initiatives at the 1890 Land-Grant Institutions and Tuskegee University. Funding for the Extension programs at these institutions primarily addresses the needs of small-scale and minority agricultural producers and other limited-resources audiences. The 2002 Farm Security and Rural Investment Act requires a 100 percent match of federal dollars. The Secretary may waive the match above 50 percent if an institution is incapable of meeting that requirement.

4.2 Smith-Lever 3(d) Programs

These targeted funds are allocated to the states to address special programs or concerns of regional and national importance and are primarily distributed according to the extent of the problem that requires attention in each state. The following extension programs are supported:

(A) Expanded Food and Nutrition Education Program

Expanded Food and Nutrition Education Program (EFNEP) is designed to assist limited resource audiences in acquiring the knowledge, skills, attitudes, and changed-behavior necessary for nutritionally sound diets, and to contribute to their personal development and the improvement of the total family diet and nutritional well-being.

(B) Pest Management

Integrated Pest Management (IPM) promotes minimized pesticide use, enhanced environmental stewardship, and sustainable systems. This program targets three areas: commercial agricultural producers, urban audiences (including parks and schools), and natural resources. The goals for the National IPM program (June 2, 2003) are to: 1) improve economic benefits related to the adoption of IPM practices; 2) reduce potential human health risks from pests and the use of IPM practices; and 3) minimize adverse environmental effects from pests and the use of IPM practices.

(C) Farm Safety
The primary purpose of this funding is to provide seed money to develop a farm safety programs that meets the states' most critical needs. CSREES participates in regional partnership development meetings and funds farm safety initiatives in U.S. states and territories.

(D) Children, Youth, and Families at Risk
Through an annual Congressional appropriation for the National Children, Youth and Families at Risk (CYFAR) Program, CSREES allocates funding to land-grant university extension services for community-based programs for at-risk children and their families. Since 1991, CYFAR has supported programs in more than 600 communities in all U.S. states and territories. State and local public and private organizations have contributed cash and in-kind resources that match or exceed the federal appropriation.

(E) Youth Farm Safety Education and Certification
The scope of this project is to develop and assess the effectiveness of a hazardous occupation certification program for youth employed in agriculture and determine the resources required for implementation of a national certification program.

(F) Sustainable Agriculture
Authorizes the Sustainable Agriculture Technology Development and Transfer Program, known as the Sustainable Agricultural Research and Education Program's (SARE's) Professional Development Program (PDP), which is designed to develop and conduct training and education activities for Extension, NRCS and other agricultural professionals, so that they are better prepared to work with farmers and the public on sustainable agriculture concepts and techniques. Funds are used for competitive grants awarded on a regional basis, and state and regional activities. (see SARE in Research and Education above)

(G) Extension Indian Reservation Program
The Extension Indian Reservation Program (EIRP) was authorized by the 1990 Farm Bill (P.L. 101-624). This measure directs the "Secretary of Agriculture, acting through the Extension Service, shall establish appropriate extension education programs on Indian Reservations and tribal jurisdictions." The legislation specified consultation with the Bureau of Indian Affairs, the Intertribal Agriculture Council, and the Southwest Indian Agriculture Association in establishing these extension programs.

4.3 Other Extension Programs

(A) Extension Services at the 1994 Institutions
The purpose of the Tribal Colleges Extension Program is to provide funding for the 1994 Land-Grant Institutions to conduct non-formal education and outreach activities that will improve the conditions in Native American communities. Through a competitive application process, awards are made in one or more of the following extension based program areas: Agriculture; Community Resources and Economic Development; Family Development and Resource Management; 4-H and Youth Development; Leadership and Volunteer Development; Natural Resources and Environmental Management; and Nutrition, Diet and Health.

(B) Renewable Resources Extension Act
The Renewable Resources Extension Act (RREA) provides funding for expanded natural resource education programs. Funds are distributed to all States for educations programs and provided for projects focused on addressing the Forestry Investment Plan of the President.

(C) Rural Health and Safety

The Rural Health and Safety Education Act of 1990 helps rural residents avoid the numerous obstacles to maintaining their health status. This program maintains the ongoing rural health projects in Mississippi and Louisiana that focus on training health care professionals in rural areas.

(D) 1890 Facilities (Section 1447) (Payments to 1890 Colleges, Tuskegee University, and West Virginia State College)

Public Law 95-113, as amended, provides support to the 1890 Land-Grant Colleges and Universities for fostering, developing, implementing and improving extension educational programs to benefit their clientele. In accordance with the Agricultural Research, Extension, and Education Reform Act of 1998, Public Law 105-185, eligible State institutions are required to submit a five-year Plan of Work to CSREES for approval before these formula funds are distributed.

(E) Federal Administration

- **Other**
  Provides a portion of the general operating funds from the federal staff, and national program planning, coordination, and program leadership for the extension work in partnership with the states and territories.

- **Ag in the Classroom**
  Agriculture in the Classroom is a grassroots program coordinated by the United States Department of Agriculture. Its goal is to help students gain a greater awareness of the role of agriculture in the economy and society, so that they may become citizens who support wise agricultural policies. The program is carried out in each state, according to state needs and interests, by individuals representing farm organizations, agribusiness, education and government.

(F) EPA Pass-through Funding

Pesticide Safety Education Program (PSEP)

This program provides pesticide safety, approved practice information, and education for farmers using restricted-use pesticides and for commercial applicators of pesticides. USDA-CSREES administers EPA pass-though funding to partially offset the costs of this program delivered at the local level. Funds are designated for all states.

Section 5:
Publicly-Funded Agricultural Research, Education and Extension: Tracking, Accountability and Relevance

The U.S. system of publicly-funded research, education, and extension in the areas of food, agriculture, and natural resources supports a diverse, complex knowledge base that is vital to food and fiber production, conservation of natural resources, and to the economic well being of the nation. The scientific expertise available through the federal and state research and education system constitutes a valuable national resource with the flexibility to respond quickly to changes in demand, threats to sustainability, and concerns about environmental quality. CSREES contributes a unique national perspective to the network of research, education, and extension partnerships maintained by the USDA and cooperating institutions. This vantage point is essential to the agency's regional and national coordination and tracking of public resources invested to address diverse research and outreach problems.

5.1 The Growing Need for Research, Education, and Extension

In recent years, the need for problem-solving research and extension activities in food, agriculture, and natural resources has expanded. Changes in this agenda were given impetus by the U.S. Congress when it reauthorized USDA programs under the Food, Agriculture, Conservation, and Trade Act of 1990. This legislation emphasized food and fiber needs, long term viability and competitiveness, improvement of the quality of rural life, the assurance of supply of safe food, and enhancement of the environment and natural resource base. The growing consumer interest in environmental and social issues, as well as the increased complexity of contemporary research problems, has necessitated an increase in multi- and interdisciplinary research, education, and extension work.

The evolving U. S. system of food, agricultural, and environmental research, education, and extension encompasses the programs of State Agricultural Experiment Stations (SAES); colleges and departments of forestry, natural resources, family and consumer sciences, and veterinary medicine; 1890 and 1994 land-grant institutions and Tuskegee University; other cooperative institutions, including state and private colleges and universities; and USDA agencies such as the Agricultural Research Service (ARS), Economic Research Service (ERS), Forest Service (FS), and Natural Resource Conservation Service (NRCS) and federal departments. Research and extension programs are closely linked to and complement the teaching activities of the land-grant institutions. Additionally, research programs are integral to graduate education, through which scientists are prepared to confront future research challenges.
See www.csrees.usda.gov/newsroom/impacts/04index_pdf.html for Science and Education Impacts.

The education partnership is the most recent addition (1977) to the federal-state partnership comprising research, extension, and education. CSREES teaching initiatives support human capital development through programs that strengthen agricultural and natural resource sciences literacy in K-12 education, improve higher education curricula, modernize institutional academic capacity, and increase the diversity and quality of future graduates to enter the scientific and professional workforce. CSREES assists the nation's schools, colleges, and universities to develop essential strategies to meet future academic challenges. These include expanding student recruitment, preparing graduates in areas of national need, maintaining curricular relevance through innovative degree programs and technologies, developing academic infrastructure, and endowing graduates with problem-solving, communication, and hands-on collaborative learning skills and experiences they'll need to lead scientific inquiry and meet the challenges of an ever-changing world.

5.2 Tracking CSREES and Land-Grant Activities with Databases

The research summaries utilized in this report are based on activities documented in the USDA's Current Research Information System (CRIS) and in part from annual reports of National Research Initiative (NRI) and Cooperative Forestry Research projects, state annual reports, impact statements, and information provided by the CSREES National Program Leaders (NPLs). CRIS information includes funded research that is either in progress or is recently completed, objectives and procedures of each project (AD-416), research problem area and other classifications (AD-417), annual financial and management data (AD-419), and annual progress including accomplishments (AD-421). The scope of CRIS content includes essentially all projects supported or conducted by the USDA and under the aegis of the SAES. Some projects documented in CRIS are conducted by non-federal partner institutions without support from USDA funding. However, CRIS does not include all university based research supported by sources other than the USDA. The focus of the portfolio analyses is on the projects supported or performed by CSREES. As the agricultural research base expands, including more institutions and scientists outside USDA and SAES in agricultural and related research, the management data in CRIS should be viewed as conservative estimates. This may be most significant in the research areas at the boundaries of agricultural research.

The CSREES portfolio review includes research, education, and extension programs categorized by Problem Areas (PA). Each CRIS project is categorized by Research Problem Areas (RPA) that equate directly to the PA addressed in this report. The PA provides a common basis for analyzing the targeted areas under review. CRIS has been an operational system since 1968 and provides a resource of fiscal data with a consistent basis since fiscal year 1970. CRIS data were designed to be informational and does not support accountability from the perspective of financial accounting, which is conducted and controlled through processes administered by the Funds Management Branch under the Office of Extramural Programs (OEP) in CSREES. However, the structure of CRIS information can be used in the broad sense for program accountability (a non-auditable informational based evaluation process). At present the information collected by CRIS on activities relevant to program accountability is essentially limited to research, and, more recently, education. Efforts are underway to capture award on CSREES programs in education and extension. Extensive planning is being pursued by CSREES to develop an appropriate framework that will document extension plan of work activities along with research and education to accommodate an integrated approach to CSREES portfolio analyses. Therefore, quantitative productivity data are not readily available for extension activities for this portfolio analysis.

More comprehensive CSREES accountability reporting is being pursued with maximum effort but will require several years to be completed. Implementation will most likely occur in phases drawing upon existing capabilities of CRIS, the Research, Education and Economics Information System (REEIS), Food and Agricultural Education Information System (FAEIS), and other established CSREES data and information systems. The integration of existing systems with expanded functionality and/or additional systems to address new segments of the process will provide more efficient collection and distribution of information. The integrated approach will reduce the effort and resource requirements for CSREES and all of the partnership while encompassing research, education and extension in a consistent approach allowing more effective program accountability.

5.3 How CSREES Assures Relevancy in its Programs

CSREES developed a comprehensive expert review process and scoring mechanism to quantitatively assess research and development relevance, quality and productivity based on a comprehensive coding system of explicit problem areas that define exclusive and non-duplicative portfolios. Each of the portfolios under review cut across a number of research, education and extension programs targeted to critical and emerging national needs, issues and priorities relevant to maintaining a sustainable agricultural sector of the economy.

Research, education and extension programs must demonstrate relevancy, therefore they are developed based on national needs consistent with USDA and agency strategic plans, the agency mission, and enabling legislation. Critical national needs and program priorities are identified and set using stakeholder inputs. CSREES NPL's are the critical links to our partners and constituents (including researchers, educators, extension specialists, experiment stations, the processing and packaging industry, commodity organizations, consumer groups, advocacy organizations, advisory committees, review panels, national academies, scientific and professional societies, federal agencies, White House Office of Science and Technology Policy, and Congress). Feedback from these groups and individuals is obtained directly and indirectly for identifying and prioritizing the national needs to assure relevancy of programs within each portfolio. (*See Evidentiary Material*)

Both formal and informal procedures are used to obtain stakeholder input. These may include stakeholder workshops, symposia, technical reviews, peer panel recommendation, white papers, CSREES departmental review reports, presidential directives, interagency, strategic plans for research and development, regulatory policies impacting food quality and safety and industry plans and priorities. In addition, every request for applications (RFA) specifically seeks stakeholder input as per requirements of the Agricultural Research, Extension, and Education Reform Act of 1998 (AREERA) (7 U.S.C. 7613(c)(2)). This section requires the Secretary to solicit and consider input on a current RFA from persons who conduct or use agricultural research, education and extension for use in formulating future RFAs for competitive programs. These processes and networks help the agency ensure the relevancy of programs relative to local, state, regional and national needs. Priorities are generated through aggregation of problems and issues identified at the local, state, and national level.

All the programs managed by CSREES use relevancy and quality as criteria for pre-award evaluation of projects. Relevancy is established taking into consideration the industry and/or consumer needs and priorities. The quality is assessed based on the scientific merit, proposed procedure, and potential to succeed.

Criteria and indicators are used wherever available. According to the National Research Council (*Our Common Journey: A Transition toward Sustainability, 1999*), "Indicators are repeated observations of natural and social phenomena that represent systematic feedback. They generally provide quantitative measures of the economy, human well-being, and impacts of human activities on the natural world. The signals they produce sound alarms, define challenges, and measure progress . . . . Generally, indicators are most useful when obtained over many intervals of observation so that they illustrate trends and changes. Their calculation requires concerted efforts and financial investments by governments, firms, non-governmental organizations, and the scientific community."

The portfolios being reviewed are dynamic and change periodically to address emerging national needs consistent with cutting edge science. Program descriptions, program reports, and request for applications included in the Evidentiary Materials section of this document demonstrate the dynamic nature of the portfolios.

BOOK III :

PORTFOLIO ANALYSIS

Section 6:
Plant Protection Overview

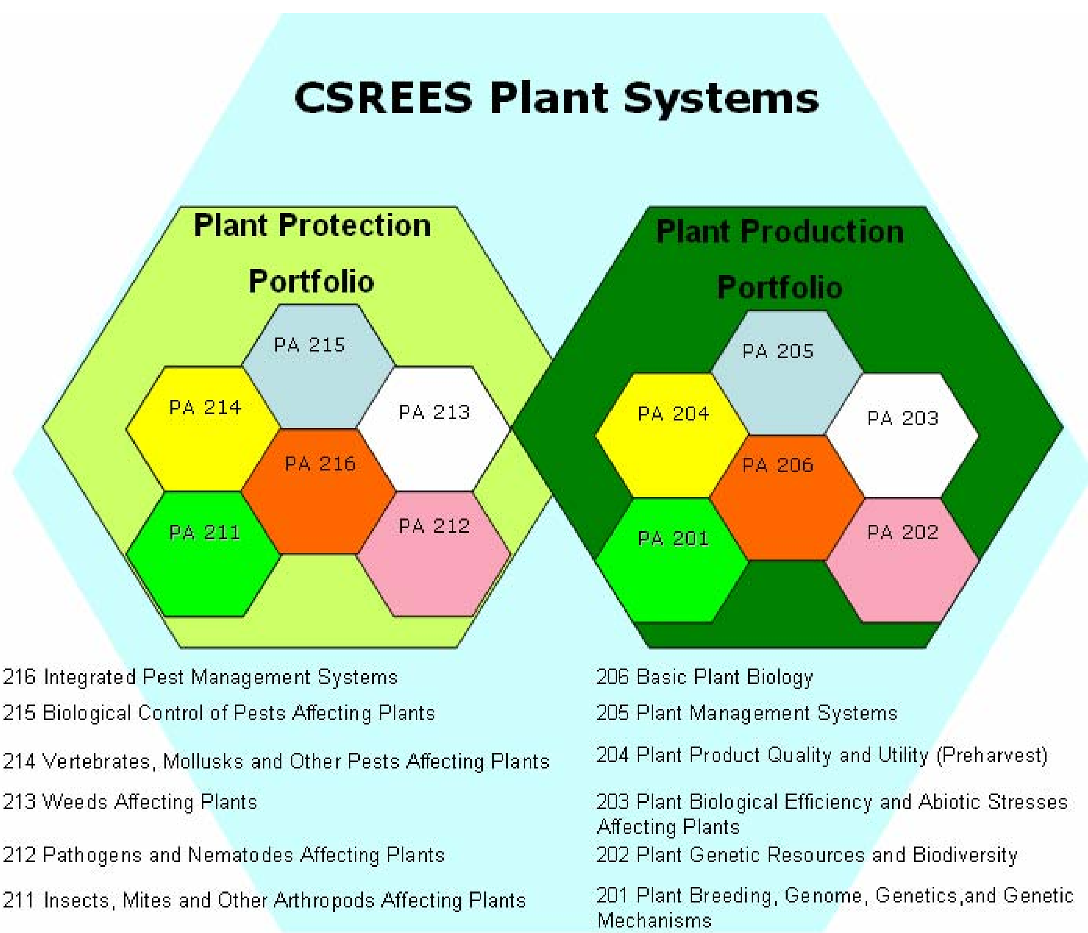
6.1 Plant Systems Portfolio Vision

A vibrant, globally competitive, technologically advanced, and consumer driven American plant agriculture industry that is based on and supported by high quality, innovative, and relevant research, extension and educational programs developed by USDA through partnerships with universities and the private sector as well as the in-house research programs of the Department.

6.2 Plant Systems Portfolio Mission

To provide strong research, extension, and educational program to promote the efficiency of plant protection systems that are economically competitive, environmentally sound, and socially acceptable, and produce high quality and safe products for the American consumer and international markets.

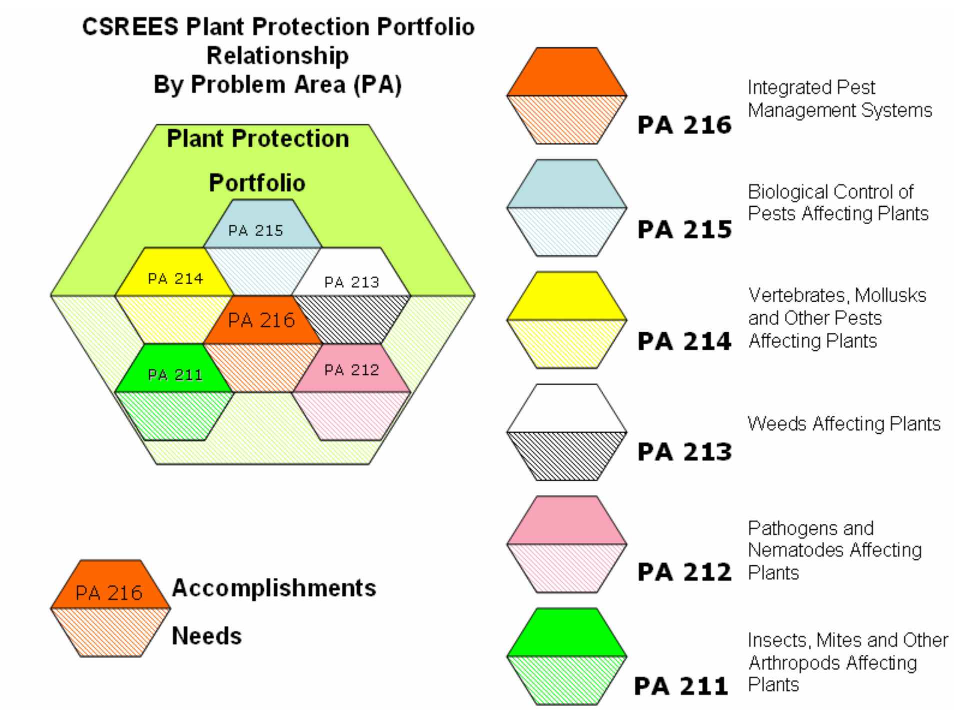
Figure 6.1
The CSREES Plant Systems Portfolio



6.3 Plant Protection Portfolio

The CSREES Plant Systems Portfolio (Figure 6.1, found on page 43) encompasses the Plant Protection Portfolio (Figure 6.2) as one major component along with the Plant Production portfolio**.** The CSREES Plant Production Portfolio has been defined as those research, extension, and education programs aligned with six problem areas (PAs) related to the efficiency of plant productions systems. The Plant Production Portfolio was the subject of an earlier portfolio review. The CSREES Plant Protection Portfolio includes new, emerging, and reemerging plant pests and diseases, plant agricultural security, biosecurity, and toxicology. In describing and reporting on the performance of the portfolio, it is important to recognize that an integrated systems approach is utilized in planning, developing, and implementing programs.

Figure 6.2
The Component PAs That Comprise The Plant Protection Portfolio



The CSREES National Program Leadership Team for Plant Systems recognizes that the protection and production components are closely linked and interdependent in terms of program development, implementation, and delivery. The Team also recognizes that these components are linked to other major programs areas such as product quality (post harvest), food safety, engineering, waste management, marketing, and economics.

The Plant Protection Portfolio is diverse in terms of commodities covered. The portfolio includes research and extension activities directed at plant protection systems. While broad goals and needs are similar across the various commodities, there are specific needs and priorities within these commodities that are addressed in the portfolio. Program goals and delivery systems also recognize the diversity of needs across and within these commodities in terms of size, concentration, regional differences, levels of integration, and external factors impacting these systems.

The Plant Protection Portfolio encourages multi-disciplinary approaches to address the needs of plant agriculture and the American consumer. The portfolio contains a balance of discipline-based components including all major grouping of pests affecting plants and the integration of these into pest management systems.

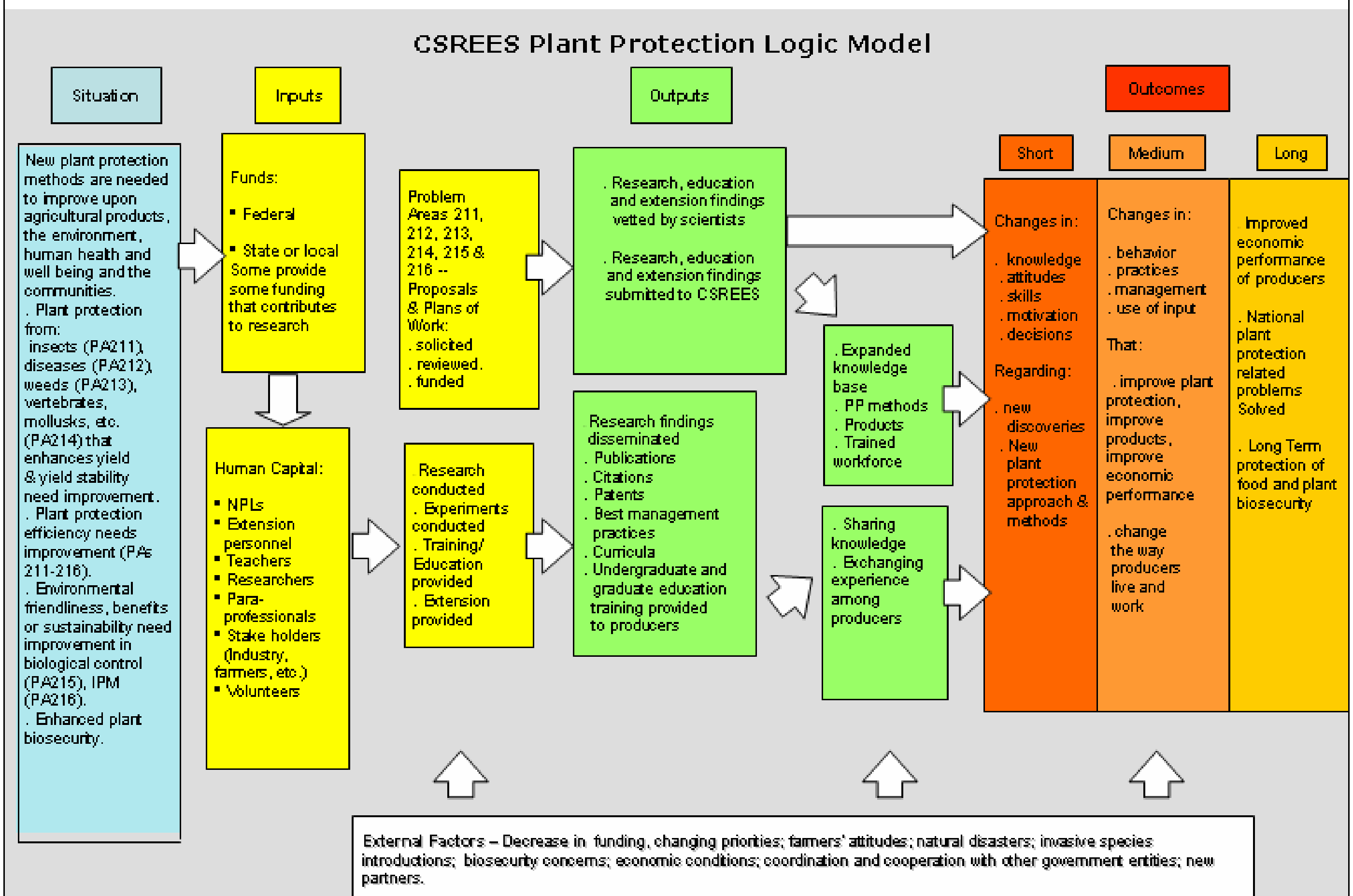
Program integration may occur at a commodity-based system level (e.g., rice or corn), as well as a biological/discipline system level (e.g., genetics). As much of the research is very applied in nature, the extension component is highly integrated and not always evident as a separate effort.

The Team recognizes that the long-terms goals of the programs within this portfolio can best be achieved through strong research, extension, and education programs that are clearly integrated. While the portfolio represents a very complex system in terms of functions and integration of these functions, there is a critical need to develop new models and delivery systems that are effective and performance based. Integrated program functions for the Plant Protection Portfolio include:

- Originate fundamental knowledge from basic research at the frontiers of the biological, physical, and social sciences relating to pest and disease management in plant agriculture.
- Produce, apply, and adopt applied research-based knowledge in innovative ways to address problems and issues in plant system.
- Provide developmental research and technology transfer to promote the commercialization and transfer of technologies and practices to potential users in a timely, cost-effective manner.
- Provide leadership in the delivery of research-based knowledge through extension, outreach, and information dissemination to strengthen the capacity of public and private decision makers impacting plant agriculture.
- Strengthen the capacity of institutions of higher education to develop the skills of the Nation's workforce in the food and agricultural sciences.
- Assure the quality, relevancy, and performance of programs supported through federal funding in plant agriculture.
- Optimize collaboration and cooperation across institutions and agencies in order to achieve broad strategic goals addressing the needs of agricultural producers, land managers and the American consumer.

The logic model shown in Figure 6.3 (found on page 46) illustrates the way in which the Plant Protection Portfolio responds to situations to achieve outcomes.

Figure 6.3



6.4 Portfolio Components Under Review

Plant protection, as defined in this portfolio, focuses on most of the key factors relating to insects, other arthropods, pathogens, vertebrates, mollusks, and weeds that may impact output from plant production and/or pest and disease management systems. This portfolio focuses on six (6) PAs. These include: insects, mites and other arthropods affecting plants (PA 211), pathogens and nematodes affecting plants (PA 212), Weeds affecting plants (PA 213), vertebrates, mollusks, and other pests affecting plants (PA 214), biological control of pests affecting plants (PA 215), and integrated pest management systems (PA 216).

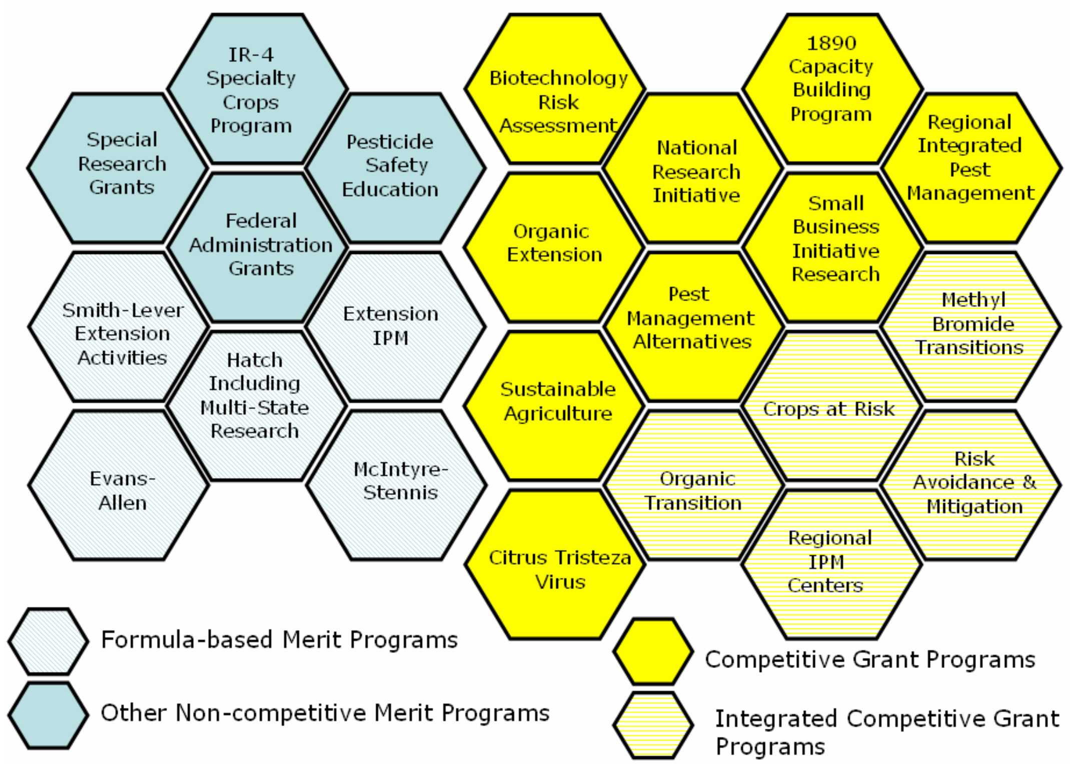
A number of other factors important to plant production were covered in a previous portfolio review (*Plant Production*) in 2004 and are not included in this report. However, it is obvious that issues such as pests, disease, climate, soils and genetics/genomics that affect the entire realm of plant production need to be considered in an integrated management system.

The scope of this review the scope is restricted to the specific issues covered under the six PAs (Figure 6.2, found on page 44). In many cases research and extension efforts are supported by one or more of the other PAs included in Plant Systems (see Figure 6.1, found on page 43). Therefore, the total CSREES resource allocation directed to Plant Protection is actually greater depicted in this portfolio.

The CSREES Plant Protection Portfolio is illustrated in Figure 6.4. Seventeen funded programs comprise the portfolio. The six PAs are embedded within and cut across the integrated structure as seen in the figure. Program activities in plant protection are funded across three major categories or processes and are managed by or with direction and support from CSREES National Program Leaders (NPLs) (see Table 1.2, found on page 20). Funding support is through *Competitive Grants, Integrated Competitive Grants* and *Merit Programs.* Considerable integration and cross cutting approaches take place through the 23 funded programs (Figure 6.4).

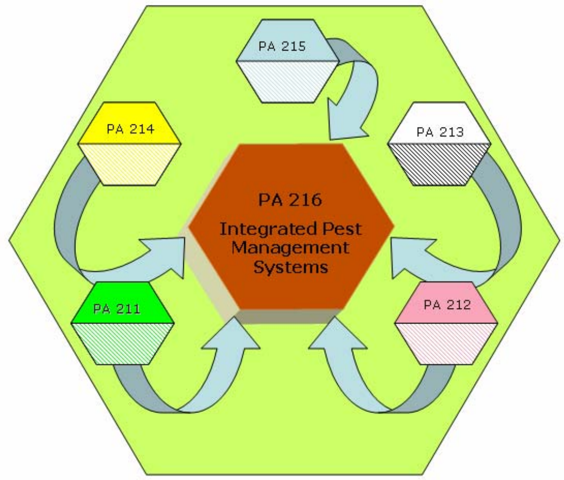
Figure 6.4

CSREES Plant Protection Portfolio (PAs 211-216) By Funded Program



The integration and impacts of the Plant Protection Portfolio are enhanced through the partnership and interaction with PA 216, Integrated Pest Management Systems (Figure 6.5, found on page 48). The PAs do not work in isolation but rather in a direct relationship to PA 216 in discovery and outreach. Recurring communication and feedback provide new program direction, alteration and ultimate impacts across the PAs.

Figure 6.5
Relationship of portfolio PAs to PA 216, Integrated Pest Management Systems



The sources of funding for State Agricultural Experiment Station (SAES) plant protection *research* from 1999-2003 are shown in Table 6.1 (found on page 49). Total investments in plant protection research rose approximately 18.3% in the four year period, from $341,132,000 to $403,596,000. A comparison of how the different funding sources for this portfolio changed between FY 1999 and 2003 is listed side by side in Table 6.3 (found on page 50).The funding contributed by CSREES during this same time period rose approximately 24.9% from $64,847,000 to $80,977,000. Table 6.2 (found on page 49) lists the percentage of total funding by source for the two time periods. CSREES percentage of total funding rose slightly from 1999 to 2003. Other USDA and Federal funds increased while state appropriations and industry grants declined.

Table 6.1
($ Thousands)

1999 Funding Sources for SAES Plant Protection Research									
	# of Projects	CSREES	Other USDA	Other Federal	State Appropriations	Self Generated	Industry Grants	Other Non-Fed	Total
211	1,205	16,286	3,204	6,987	41,328	2,414	6,932	4,389	81,554
212	1,603	21,215	4,615	7,111	60,863	3,006	13,414	8,376	118,602
213	608	8,393	939	1,036	19,274	1,796	5,232	2,714	39,386
214	36	356	56	56	1,189	69	69	55	1,854
215	784	9,536	2,688	3,340	28,195	1,338	6,280	2,332	53,709
216	833	9,061	2,195	1,565	23,509	1,062	5,257	3,382	46,027
$ Total	**5,069**	**64,847**	**13,697**	**20,095**	**174,358**	**9,685**	**37,184**	**21,248**	**341,132**
2003 Funding Sources for SAES Plant Protection Research									
	# of Projects	CSREES	Other USDA	Other Federal	State Appropriations	Self Generated	Industry Grants	Other Non-Fed	Total
211	1,207	19,777	4,748	9,964	42,418	2,235	7,055	5,829	92,029
212	1,728	25,597	8,914	19,141	71,682	4,373	17,138	10,071	156,919
213	697	10,053	1,396	2,180	21,600	2,284	4,613	3,895	46,015
214	37	643	196	481	732	205	45	53	2,359
215	799	9,908	2,626	4,692	22,358	1,426	3,291	1,960	46,264
216	962	14,999	3,766	3,528	26,463	1,981	5,917	3,360	60,010
$ Total	**5,430**	**80,977**	**21,646**	**39,986**	**185,253**	**12,504**	**38,059**	**25,168**	**403,596**

Table 6.2
PA in Crop Protection Comparisons for all CSREES Funding Sources 1999 vs 2003

PA	1999 Totals	% of Total	2003 Totals	% of Total	$ Difference 1999-2003	% Increase 1999-2003
211	$16,286,000	25.11%	$19,777,000	24.42%	$3,491,000	21.44%
212	$21,215,000	32.72%	$25,597,000	31.61%	$4,382,000	20.66%
213	$8,393,000	12.94%	$10,053,000	12.41%	$1,660,000	19.78%
214	$356,000	0.55%	$643,000	0.79%	$287,000	80.62%
215	$9,536,000	14.71%	$9,908,000	12.24%	$372,000	3.90%
216	$9,061,000	13.97%	$14,999,000	18.52%	$5,938,000	65.53%
Total of PA's 211-216	**$64,847,000**	**100.00%**	**$80,977,000**	**100.00%**	**$16,130,000**	**24.87%**
Combined Totals for: Hatch, McIntire -Stennis, Evan-Allen, An. Health, SRG, NRI, SBIR, & Other Grants						

Table 6.3 Funding Sources for SAES Plant Protection Research				
	1999		2003	
Source	$ Thousands	%	$ Thousands	%
CSREES	64,847	19%	80,977	20%
Other USDA	13,697	4%	21,646	5%
Other Federal	20,095	6%	39,986	10%
State Appropriations	174,358	51%	185,253	46%
Self Generated	9,685	3%	12,504	3%
Industry Grants	37,184	11%	38,059	9%
Other non-Federal	21,248	6%	25,168	6%
Total	341,114	100%	403,593	100%

The CSREES-administered funds for Plant Protection over the time period by Problem Area (PA) are illustrated in Figure 6.6. Changes in percentages of total funding by PA show that slight decreases in percentages of funding were incurred in three PAs: 211, 212, and 213. A moderate decrease was observed in PA 215, Biological Control of Pests Affecting Plants. A significant increase was observed in PA 216, Integrated Pest Management Systems. No significant change was incurred in PA 214. Actual dollars expended by SAES and CSREES by PA from 1999 to 2003 are provided in Table 6.4 (found on page 51).

Figure 6.6

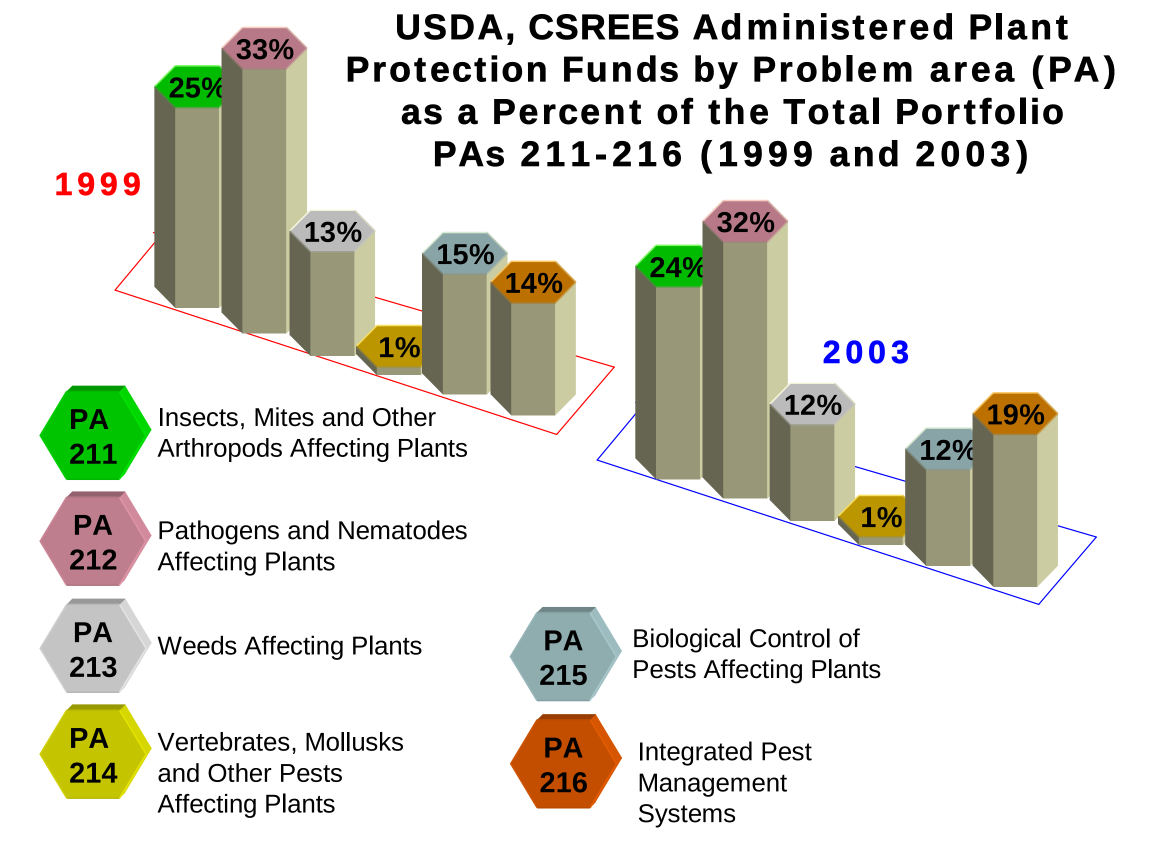


Table 6.4					
FY 1999 SAES and CSREES Plant Protection Funds by PA ($ Thousands)					
PA	**Title**	**SAES**	**%**	**CSREES**	**%**
211	Insects, Mites and Other Arthropods Affecting Plants	81,554	24%	16,286	25%
212	Pathogens and Nematodes Affecting Plants	118,602	35%	21,215	33%
213	Weeds Affecting Plants	39,386	12%	8,393	13%
214	Vertebrates, Mollusks, and Other Pests Affecting Plants	1,854	1%	356	1%
215	Biological Control of Pests Affecting Plants	53,709	16%	9,536	15%
216	Integrated Pest Management Systems	46,027	13%	9,061	14%
Total		**341,132**	**100%**	**64,847**	**100%**
FY 2003 SAES and CSREES Plant Protection Funds by PA ($Thousands)					
PA	**Title**	**SAES**	**%**	**CSREES**	**%**
211	Insects, Mites and Other Arthropods Affecting Plants	92,029	23%	19,777	24%
212	Pathogens and Nematodes Affecting Plants	156,919	39%	25,597	32%
213	Weeds Affecting Plants	46,015	11%	10,053	12%
214	Vertebrates, Mollusks, and Other Pests Affecting Plants	2,359	1%	643	12%
215	Biological Control of Pests Affecting Plants	46,264	11%	9,908	12%
216	Integrated Pest Management Systems	60,010	15%	14,999	19%
Total		**403,596**	**100%**	**$80,977**	**100%**

CSREES funding by *line item* is listed in Tables 6.4, 6.5 & 6.6. Line item funding increased from $64,847,000 in 1999 to $80,977,000 in 2003 an increase of 25.0%. The largest dollar increases were within SRG and Other Grant categories. Hatch support decreased by 5.5% over this time period. As a percentage of total funding Hatch support decreased from nearly 50% of the total CSREES funding in 1999 to slightly over only 1/3 of the total in 2003.

Table 6.6 (found on page 52) shows the change in CSREES funding for plant protection problem areas between 1999 and 2003 by funding line item. Funding for Extension-related areas of the Plant Protection portfolio are important to the overall mission of CSREES. Application of the science-based knowledge generated through the research enterprise happens because of the efforts of extension program delivery. Tracking the total investment in extension-related funding lines is not possible at this time. Some, but far from all, of the plant protection activities coming from Smith-Lever b and c formula funds can be tracked to reporting through AREERA-mandated Plan of Work accomplishments reports. Examples of accomplishments related to Plant protection are provided as illustrations of the scope of work of the portfolio. The PA system currently used as the portfolio reporting template will be used by CSREES in the near term future for tracking expenditures related to Extension programming. This will help to document and report efforts that relate to plant protection (as well as other areas in the complex set of CSREES programs). However, there are areas and lines of funding related to extension plant protection programming that can be documented. Table 6.7 (found on page 53) tracks the funding for Plant Protection related to the overarching area of integrated pest management and sustainable agriculture (PA 216, plus components of IPM related to other PAs and cross-cutting areas of the portfolio) from 1999 through 2003.

Table 6.5
($ Thousands)

1999 CSREES Funding by Line Item									
	# Projects	Hatch	McIntyre-Stennis	Evans-Allen	SRG	NRI	SBIR	Other Grants	CSREES
211	1,050	7,468	149	677	3,578	2,708	682	1,028	16,286
212	1,352	10,826	111	193	4,121	5,383	44	503	21,215
213	513	3,523	18	0	3,133	1,323	225	168	8,393
214	30	244	0	34	15	0	64	0	356
215	723	5,388	327	185	1,508	2,128	0	0	9,536
216	715	3,959	510	579	3,063	685	65	200	9,061
Total	**4,383**	**$31,408**	**$1,115**	**$1,668**	**$15,418**	**$12,227**	**$1,080**	**$1,899**	**$64,847**
2003 CSREES Funding by Line Item									
	# Projects	Hatch	McIntyre-Stennis	Evans-Allen	SRG	NRI	SBIR	Other Grants	CSREES
211	1,091	7,046	322	442	5,928	3,381	198	2,462	19,777
212	1,512	10,630	352	453	7,927	4,078	338	1,816	25,597
213	600	3,269	126	192	3,566	1,866	208	822	10,053
214	31	83	27	0	533	0	0	0	643
215	753	5,040	260	783	757	2,984	29	54	9,908
216	866	3,625	223	551	4,528	925	0	5,148	14,999
Total	**4,853**	**$29,693**	**$1,310**	**$2,421**	**$23,239**	**$13,234**	**$773**	**$10,302**	**$80,977**

Special Research Grants (SRG), National Research Initiative (NRI), Small Business Innovation Research (SBIR)

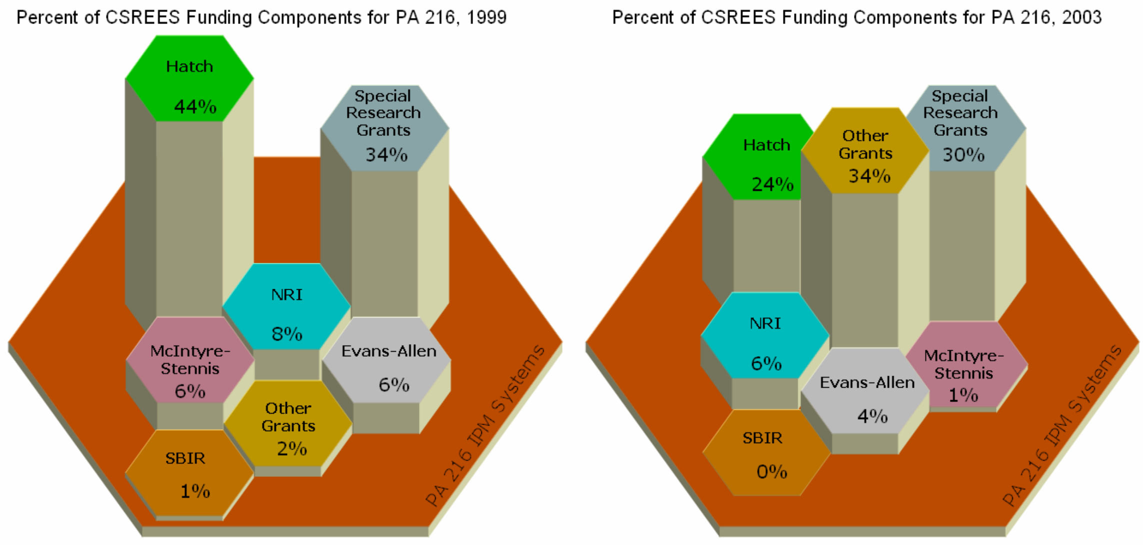
Table 6.6
CSREES Funding by Line Item Comparisons for 1999 & 2003
($ Thousands)

Line Item	1999	%	2003	%
Hatch	**$31,408**	**48%**	**$29,693**	**37%**
McIntyre-Stennis	**$1,115**	**2%**	**$1,310**	**2%**
Evans-Allen	**$1,668**	**3%**	**$2,421**	**3%**
SRG	**$15,418**	**24%**	**$23,239**	**29%**
NRI	**$12,227**	**19%**	**$13,234**	**16%**
SBIR	**$1,080**	**2%**	**$773**	**1%**
Other Grants	**$1,899**	**3%**	**$10,302**	**13%**
CSREES	**$64,847**	**100%**	**$80,977**	**100%**

Special Research Grants (SRG), National Research Initiative (NRI), Small Business Innovation Research (SBIR)

Funding sources for PA 216 have changed dramatically in two ways from 1999 to 2003 (Figure 6.7, found on page 53). Hatch dollars have decreased as a percentage of total CSREES funding from 44 to 24%. Other grants, however have increased from only 2% to 34% of total. This includes the 406 integrated competitive grants such as crops at risk, risk avoidance and mitigation program, methyl bromide transitions and organic transitions. NRI and Special research grants have decreased as a percentage of total.

Figure 6.7
Comparison of Funding Sources for PA 216 Integrated Pest Management Systems for Fiscal Years 1999 and 2003



National Research Initiative (NRI), Small Business Innovation Research (SBIR)

Extension funding (Table 6.7) to directly support Plant Protection from 1999 to 2003 shows a minimal increase of approximately only 1% in formula funding 3(b)&(c) used to support the basic infrastructure with Land Grant partners. In addition, Smith-Lever 3(d) funds decreased nearly 1% while Sustainable Agriculture (Professional Development) increased 46% from a base of $3,309,000.

Table 6.7
Extension Funding Lines Contributing to the Plant Protection Portfolio ($1000s)

Program	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003
Formula Programs:					
Smith-Lever 3(b)&(c) (part)	$276,548	$276,548	$275,940	$275,940	$279,390
Smith-Lever 3(d) Programs:					
Pest Management	10,783	10,783	10,759	10,759	10,689
Sustainable Agriculture (part)	3,309	3,309	3,792	4,750	4,843
Federal Administration Grants:					
Potato Pest Management (WI)	--	--	189	396	298
Urban Horticulture (WI)	--	--	--	200	788

A growing component of the portfolio is the Congressionally-designated line items (CDLI) related to the Pest Management activities administered by CSREES. Table 6.8 (found on page 54) lists CDLIs funded in FY 2005.

Table 6.8
Congressionally Designated Line Items (CDLI) Relating to the Pest Management Portfolio

Subject of Investigation	State	Appropriation
Aegilops cylindrica (jointed goatgrass)	WA	$340,976.00
Apple fire blight	MI, NY	$456,292.00
Armillaria root rot	MI	$142,156.00
Asparagus technology and production	WA	$248,525.00
Berry research	AK	$178,938.00
Chesapeake Bay agroecology	MD	$284,313.00
Citrus canker	FL	$447,345.00
Citrus tristeza	WA	$644,177.00
Cool season legume research	ID, WA	$536,814.00
Cranberry/Blueberry	MA	$153,091.00
Cranberry/Blueberry disease & breeding	NJ	$209,755.00
Crop pathogens	NC	$177,944.00
Diaprepes/root weevil	FL	$399,628.00
Ethnobotany research	AK	$268,407.00
Exotic pest diseases	CA	$1,789,380.00
Expert IPM Decision Support System	NC	$158,062.00
Floriculture	HI	$354,894.00
Grass seed cropping systems for sustainable agriculture	ID, OR, WA	$406,587.00
Greenhouse crop production	AK	$447,345.00
Hydroponic tomato production	OH	$178,938.00
Improved early detection of crop diseases	NC	$172,973.00
Improved fruit practices	MI	$211,743.00
Integrated production systems	OK	$206,773.00
Leopold Center hypoxia project	IA	$223,673.00
Lowbush blueberry research	ME	$235,602.00
Maple research	VT	$133,209.00
Meadow foam	OR	$262,442.00
National Center for Soybean Technology	MO	$894,690.00
Nematode resistance genetic engineering	NM	$130,227.00
Nursery, greenhouse, turf specialties	AL	$275,366.00
Oil resources from desert plants	NM	$200,808.00
Organic cropping	WA	$223,673.00
Peach tree short life	SC	$232,619.00
Perrenial wheat	WA	$133,209.00
Pest control alternatives	SC	$271,389.00
Phytophthora root rot	NM	$165,021.00
Pierce's disease	CA	$2,013,053.00
Rangeland ecosystems	NM	$284,313.00
Russian wheat aphid	CO	$284,313.00
Seed research	AK	$357,876.00
Seed technology	SD	$313,142.00
Small fruit research	ID, OR, WA	$354,894.00
Soybean cyst nematode	MO	$616,342.00
Soybean research	IL	$755,516.00
Sudden oak death	CA	$88,475.00
Sustainable agriculture	CA	$444,363.00
Sustainable agriculture	MI	$386,705.00
Sustainable agriculture & natural resources	PA	$133,209.00
Sustainable pest management for dryland wheat	MT	$401,616.00
Tri-state joint peanut research	AL	$532,838.00
Tropical and subtropical research/T STAR	FL, GU, HI, PR, VI	$8,946,900.00
Virtual plant database enhancement project	MO	$671,018.00
Viticulture consortium	CA, NY	$1,599,507.00
Weed control	ND	$386,705.00
Wheat sawfly research	MT	$449,333.00
Cotton research	TX	$2,236,725.00
Greenhouse nurseries	OH	$712,770.00
High value horticultural crops	VA	$447,345.00
Mariculture	NC	$320,100.00
Phytoremediation plant research	OH	$568,625.00
Sustainable agriculture development	OH	$178,938.00
Wetland plants	WV	$178,938.00
Nursery production	RI	$221,684.00
Potato pest management	WI	$357,876.00
Urban horticulture	WI	$783,351.00
Total		**$36,823,454.00**

6.5 Underlying Importance of Formula Funding

Plant protection programs, like most program areas supported under CSREES strategic goals are funded from a wide range of the funding authorizations and legislation described within this document. Major support for the plant protection portfolio comes from competitive programs, congressionally directed special grants and formula funding. Formula funds within this portfolio are authorized in large part by the Smith-Lever and Hatch acts. A smaller component of formula funding is authorized by the Evans-Allen and McIntyre-Stennis acts.

(A) Smith-Lever and Hatch Support and the Important Role of Formula Funding

Several recent studies have examined the role that formula funding has had on the productivity of American agriculture and the potential for continued productivity increases with continued formula-based support. These studies have been undertaken within the context of major changes that have occurred in U.S. agriculture at the national, regional and local levels and concurrent suggestions that the overarching goal of strengthening the agricultural enterprise would be better served through a shift to increased competitive funding at the expense of decreased formula support. These recent studies have been actively supported through funding from the Experiment Station Committee on Organization and Policy (ESCOP). A study by Wallace E. Huffman and Robert E. Evenson (C.F. Curtiss Distinguished Professor of Agriculture, Iowa State University and Professor of Economics, Yale University, respectively)[2] examined a proposal that formula funding of SAES research be reduced in the form of increased competitive grant funding. Their summary conclusion is that:

> "Overall, we conclude that the social rate of return to public agricultural research remains very high. However, with the increased transactions costs of federal competitive grant funds relative to federal formula funding and the focus on different sets of research issues, shifting federal funds from formula to competitive grants would lower the rate of increase in agricultural productivity and most likely lower the rate of return to public agricultural research. We conclude that a combination of funding sources---competitive funds, formula funds, state appropriations, and other funds---provide for more effective SAES programs rather that reliance on a single source. Federal formula funds give SAES directors flexibility and can be combined with state government appropriations to fund research on local problems or basic research needed to solve local agricultural research problems."

A second study by Mark W. Rosegrant and Sarah A. Cline (Division Director and Research Analyst, International Food Policy Research Institute [IFPRI])[3] examined the spillover and spill-in effects of formula funding on international agricultural production using the IFPRI International Model for Policy Analysis of Agricultural Commodities and Trade (IMPACT) to determine the effect of different levels of formula funding in the U.S. on international commodity production, demand and world trade prices, focusing on cereal and livestock commodities. These researchers examined two scenarios. The first was based on a reduction in the productivity of the SAES-USDA system affecting only U.S. agriculture and the second was based on the assumption that the shift in funding sources in the U.S. would affect the U.S. as well as other countries. The rational behind the second scenario was that applied science and graduate training would be affected by reduced funding and that this would affect other countries that rely on the U.S. both for training and informational programs. They conclude overall for both scenarios that:

> "The largest impact under both scenarios occurs for trade, with significant negative impacts for U.S. farmers. These effects are again larger for Scenario 1 than for Scenario 2, as Scenario 1 only affects the United States. U.S. Producers would experience reduction in exports under Scenario 1."
>
> And…

[2] Wallace E. Huffman and Robert E. Evenson. 2004. Agricultural Productivity, Demand for Experiment Station Resources and Impacts of Research on Productivity. 21 pp.

[3] Mark W. Rosegrant and Sarah A. Cline. 2004. The Impact of U.S. Formula Funding on Agricultural Productivity: A Counterfactual Study. International Food Policy Research Institute, Washington, D.C. 40 pp.

> "While the results of these two scenarios indicate that a shift in funding composition to include greater levels of competitive grant funding and reduced levels of federal formula funds may not have huge impacts on harvested area or production levels, others would be more significant. The estimated productivity shift expected from the change in funding composition would have had a significant impact on world trade, including large reductions in value of net exports for U.S. cereal and livestock producers."

(B) Smith-Lever Funding in the Plant Protection Portfolio

Smith-Lever dollars support essential Cooperative Extension System (CES) activities at all Land Grant Universities. Part of the dollars from Smith-Lever (b & c) legislative line funds are reported through the state Plans of Work (POW). Specific reporting requirements for POWs are described in the Agricultural Research, Education and Extension Reform Act (AREERA) of 1998 (see evidentiary materials). Components of these (b & c) funds are devoted to plant protection activities; however, under the current accounting system we are unable to track the dollars or make a valid estimate of the proportion of these funds at the state and local level that pertain to plant protection. CSREES, together with our partners, are currently developing a system for more accurate reporting and accounting for these dollars. This system, when operational will track Smith-Lever (b & c) dollars to the PAs included in this and all other goal-based portfolios. The Hatch and McIntyre-Stennis components of formula funding are currently tracked through the CRIS system described previously. Smith-Lever 3(d) line funds support extension IPM programs that are important for plant protection information delivery. These funds and two current Federal Administration grants are listed in Table 6.7 (found on page 53). In addition, part of the sustainable agriculture 3(d) line is devoted to plant protection, as indicated on this table.

(C) Hatch Multi-state Research and Why It Is Important

Introduction

The Federal Hatch Act of 1887 created a nationwide network of state agricultural experiment stations and today every state in the nation has an experiment station as part of the land-grant higher education system. This system links experiment station research to cooperative extension programs and college academic programs. The State Agricultural Experiment Stations (SAES) created under the Hatch Act were charged with conducting research and development projects on behalf of farmers. A number of subsequent acts, including the Adams Act of 1906, the Purnell Act of 1925, and the Bankhead-Jones Act of 1935, increased federal appropriations to SAES. In 1946, an amendment to the Hatch Act authorizing a Regional Research Fund (RRF) was signed. Base funding under the Hatch Act, administered by the USDA's CSREES, is apportioned to states based in part on a formula determined by the ratio of the states rural and farm population to the total rural and farm population of all the States as determined by the last census. The Agricultural Research, Extension, and Education Reform Act of 1998 (AREERA) amended the Hatch Act to identify the Multi-state Research Fund (MRF) (previously named the Regional Research Fund). The amendment specifies that: "Not less than 25 percent shall be allotted to the States for cooperative research employing multidisciplinary approaches in which a State agricultural experiment station, working with another State agricultural experiment station, the Agricultural Research Service, or a college or university, cooperates to solve problems that concern more than one state. The funds available under this paragraph, together with the funds available under subsection (b) for a similar purpose, shall be designated as the 'Multi-state Research Fund, State Agricultural Experiment Stations'."

Today the National Information Management and Support System (NIMSS), the database repository for all multi-state research activities, lists 168 active funded multi-state projects, 8 rapid response projects, 7 National research support projects and an additional 212 information exchange projects.

Mission of Multi-state Research

The mission of the multi-state research program is to enable research on high-priority topics among the State Agricultural Experiment Stations (SAES) in partnership with CSREES, other research institutions and agencies, and with the Cooperative Extension Service (CES). In this way, technological opportunities and complex problem solving activities which are beyond the scope of a single SAES, can be approached in a more efficient and comprehensive way.

Both the Hatch Act and the Smith-Lever Act were amended to require integrated research and extension activities. The amount to be expended was set at not less than 25 percent, or twice the states' FY 1997 expenditures for integrated activities. The Smith-Lever Act was also amended to require that each institution receiving funds under Sections 3(b) of that Act expend a portion of those funds for a multi-state program, beginning in FY 2000.

A primary consideration for establishment and continuation of a multi-state research activity is interdependence of the participants involved in the overall project. This concept of interdependence has been summarized in a brief essay by Tom Fretz that follows.

Building the Case for Increased Attention to Interdependence
Tom Fretz, Executive Director, Northeast Regional Association of Experiment Station Directors
June, 2004

Interdependence is defined by Webster as multiple dependencies, while being dependent is defined as being contingent on something or someone else for support or relying on the aid of another.

A goal of regional multistate research is to strengthen the collaborative nature of research between scientists, and disciplines in the state experiment station system (SAES). This was clearly the intent of Congress when regional research allocations were mandated at the level of 25% of the Hatch allocation. Furthermore, the specificity of the integrated accounts further encourages multistate, multidiscipline, multi-institutional research activity.

Specifically, the multistate research portfolio is designed to encourage and increase multistate collaborations on critical issues which have a national or regional priority, and in working collaboratively we can reduce duplication and further the areas of science while resolving issues and providing answers to important stakeholder driven questions in the regional or national interest. Given the current fiscal climate, increasing integrated multistate efforts to meet local, regional and national research goals is critical and will likely increase. Individual states can not continue to do all things, meet all needs, and are increasingly dependent on multistate, multidisciplinary approaches to research and outreach activity. Indeed many of the problems that today’s scientists face require this multistate, multidisciplinary approach. Within the framework of the above, it is clear that many regional research projects are not as interdependent as one would expect or anticipate.

It is clear that greater demonstration of the level of interdependence in impact and annual reports of project activities is required. Many regional research projects objectives are singularly acted upon by individual investigators and do not demonstrate the level of interdependence that is desired or anticipated at the time of the conception of the regional, multistate research project, nor do multistate research activities report a level of interdependence that would suggest that the activity could not be completed unless there is collaborative activity. While the sharing of research information and research protocols around single topical areas of research within the multistate research project activity is laudable, this in and of itself does not constitute interdependence. In many cases, the objectives and level of activity appear to be well-designed individual experiments conducted by individual investigators, but often without any interdependency or relationship with others investigators working on the project objective.

Regional multistate research should strive to achieve a level of interdependence within the orientation of the project activity. All projects should attempt to demonstrate this interdependence within each objective at the time of preparation of their annual report and when projects seek renew and revision. Without some level of prescribed interdependence, one has to question the continuing commitment of multistate research funding to the proscribed activity.

SAES Directors
SAES directors have primary responsibility for the multi-state research program in their respective states and for determining the most effective use of federal and non-federal funds in support of multi-state research. An Administrative Advisors **(**AA) is appointed for each multi-state research project, coordinating committee, information exchange group, and advisory committee. The AA is responsible for facilitating communication, making arrangements for peer reviews of proposals, applying the appropriate national and regional policies, assuring the quality of the governance of that activity, authorizing annual and other meetings, fulfilling the reporting requirements of the activity, and facilitating the conduct of an activity's business.

CSREES
The Secretary of Agriculture is responsible for the administration of the multi-state research program and has delegated this responsibility to the CSREES. In addition to promulgating rules and regulations for carrying out the program, CSREES is responsible for providing the leadership for the program at the national level and provides administrative oversight and authorization for the individual and collective, federally supported activities of the SAES. A national program leader (NPL) is assigned by the Administrator of CSREES as the Agency's representative to each multi-state research project, coordinating committee, or other activity for involvement beginning with the earliest stages of organization. CSREES representatives provide a national perspective to individual projects or other activities and to the regional associations by assisting in reviews of their multi-state research portfolios. CSREES representatives also assist in assuring that a multi-state research activity does not represent duplication of effort. In addition, CSREES representatives are responsible for providing communication from and to the federal partner and provide administrative reviews of projects or activity proposals. They also monitor, in conjunction with the AA, the progress and accomplishments of the project. The nature and extent of such involvement by representatives of CSREES greatly facilitates the process for review and approval of projects and other activities.

The Project Committee
The membership of a Multi-state Research Project is called the technical committee, and is made up of SAES scientists, an AA, CSREES representative, other public and private sector scientists, and as applicable, extension specialists and/or extension agents. This type of activity involves cooperative, jointly planned research employing multidisciplinary approaches in which a SAES, working with other SAES, the Agricultural Research Service (ARS), or a college or university, cooperates to solve problems that concern more than one state and usually more than one region.

6.6 Hatch Base-Funded Multi-state Pest Management Research

Pest Management related multi-state research and extension committees make up a significant component of the total multi-state research effort. Currently there are over 400 active multi-state committees. Multi-state research committees that currently address plant protection are listed in Table 6.9 (found on pages 59-60). Of these 67 directly relate to issues important for plant protection. Table 6.10 (found on page 60) provides a breakout of the number of pest management related projects and a dollar estimate for each region. Active committees occur all of the USDA regions. Additionally, scientist involved in these committees bridge all 4 regions. The net effect is that most multi-state committees are multi-regional or national in scope and in membership. Almost all of the critical issues involving pest management are addressed by these committees. In addition, through the establishment of rapid-response committees, new and emerging issues can be effectively addressed in a timely and coordinated fashion. Multi-state collaborations which address two of the major crop commodities are described below as examples of effective engagement of scientists to solve priority stakeholder issues related to this plant protection portfolio.

Table 6.9
Multi-state Projects Related to the Plant Protection Portfolio (PA 211-216)

Northeast Region	
NE-140	Biological Improvement of Chestnut and Management of the Chestnut Pathogens and Pests (PA 211 – 212, 215)
NE-171	Biologically Based IPM Systems for Management of Plant-Parasitic Nematodes (PA 212)
NE-503	Development of an Improved Management Program for the Internal Lepidoptera Pest Complex Attacking Apples in the Northeastern United States (PA 211, 215)
NE-1000	Improved Weed Control Through Residue Management and Crop Rotation (PA 213)
NE 1005	Management of Wildlife Damage in Suburban and Rural Landscapes; this committee is relevant to PA 214.
NE-1006	Eradication, Containment and/or Management of Plum Pox Disease (Sharka) (PA 212)
NE-1014	Development of New Potato Clones for Improved Pest Resistance, Marketability, and Sustainability in the East (PA 211 – 212)
NE-1015	Biological Improvement, Habitat Restoration, and Horticultural Development of Chestnut by Management of Populations, Pathogens, and Pests (PA 211 – 212)
NE-1019	Alternative management systems for plant-parasitic nematodes in horticultural and field crops (PA 212, 215)
NEREAP-003	The Northeast Regional Center for Integrated Pest Management (NE IPM) (PA 216)
North Central Region	
NC-125	Biological Control of Soil-and Residue-Borne Plant Pathogens (PA 212, 215)
NC-202	Characterizing Weed Population Variability for Improved Weed Management Decision Support Systems to Reduce Herbicide Use (PA 213)
NC-205	Ecology and Management of European Corn Borer and Other Stalk-Boring Lepidoptera (PA 211, 215)
NC-215	Persistence of *Heterodera glycines* and Other Regionally Important Nematodes (PA 212)
NC-226	Development of Pest Management Strategies for Forage Alfalfa Persistence (PA 211 – 212)
NC-227	Ergot: A New Disease of U.S. Grain Sorghum (PA 212)
NC-503	Host Plant Control Resistance to and Best Management Practices for Karnal Bunt of Wheat (PA 212)
NC-504	Soybean Rust: A New Pest of Soybean Production (PA 212)
NC 1005	Landscape Ecology of Whitetailed Deer in Agro-Forest Ecosystems: A Cooperative Approach to Support Management; this committee is relevant to PA 214.
NC-1015	Managing Karnal Bunt of Wheat (PA 212)
NCR-025	Diseases of Corn and Sorghum (PA 212)
NCR-046	Development, Optimization and Delivery of Management Strategies for Corn Rootworms (PA 211)
NCR-125	Biological Control of Arthropods and Weeds (PA 213, 215)
NCR-137	Soybean Diseases (PA 212)
NCR-184	Management of Small Grain Diseases (PA 212)
NCR-192	North Central Regional Turfgrass Research (PA 211-216)
NCR-193	Plant Health: Managing Insects and Diseases of Landscape Plants (PA 211–212, 215)
NCR-200	Management Strategies to Control Major Soybean Virus Diseases in the North Central Region (PA 212)
NCR-201	Integrated Pest Management (PA 216)
NCT-202	Soybean Rust (PA 212)
NCT-204	Biological Control of Plant Pathogens in the North Central Region (NC125) (PA 212, 215)
Southern Region	
DC-306	Improved Systems for Management of Economically-Important Arthropod Pests Attacking Pecan (PA 211, 215)
IEG-074	Southern Pine Beetle Working Group (PA 211)
S-293	Improved Pecan Insect and Mite Pest Management Systems (PA 211)
S-300	Mosquito and Agricultural Pest Management in Riceland Ecosystems PA 211– 212)
S-301	Development, Evaluation and Safety of Entomopathogens for Control of Arthropod Pests (PA 211, 215)
S-302	Biological Control of Soilborne Plant Pathogens for Sustainable Agriculture (PA 212, 215)
S-303	Biological Control of Arthropod Pests and Weeds (PA 211 – 213)
S-1001	Development of Plant Pathogens as Bioherbicides for Weed Control (PA 213, 215)
S-1010	Dynamic Soybean Pest Management for Evolving Agricultural Technologies and Cropping Systems (PA 211)

S-1011	Water Quality Methodology for Crop Protection Chemicals (PA 211 – 216)
S-1015	Host Resistance as the Cornerstone for Managing Plant-Parasitic Nematodes in Sustainable Agroecosystems (PA 212)
SERA-001	Southern Region Pesticide Impact Assessment Program (IEG-27) (PA 211 – 213)
SERA-003	Integrated Pest Management (PA 216)
SERA-007	Biology and Management of Peanut Insects and Other Arthropods(IEG-23) (PA 211)
SERA-012	Southern Forest Insect Work Conference (PA 211)
SERA-023	Cotton Insects (SERA-IEG-13) (PA 211)
SERA-033	Current Issues in Weed Biology, Weed/Crop Interactions, and Weed Management in the Southern Region (S-183) (PA 213)
S-temp824	Southern Region Information Exchange Group for IPM (PA 216)
S-temp1002	Discovery of Entomopathogens and Their Integration and Safety in Pest Management Systems (PA 211, 215)
Western Region	
W-150	Genetic Improvement of Beans (Phaseolus vulgaris L.) for Yield, Disease Resistance, and Food Value (PA 212)
W-187	Interactions Among Bark Beetles, Pathogens, and Conifers in North American Forests (PA 211 – 212)
W-189	Biorational Methods for Insect Pest Management (IPM): Bioorganic and Molecular Approaches (PA 211 – 216)
W-501	Management of Phytophthora ramorum in U.S. Nurseries (PA 212)
W-1185	Biological Control in Pest Management Systems of Plants (PA 215 - 216)
WCC-011	Western Regional Turfgrass Research (PA 211 – 216)
WCC-020	Virus and virus like diseases of fruit trees, small fruits and grapevines (PA 212)
WCC-043	Establishing Bio-Intensive Pest Management Programs for Western Orchard Systems (PA 211 – 216)
WCC-060	Science and Management of Pesticide Resistance (PA 211 – 213, 215)
WCC-066	Integrated Management of Russian Wheat Aphid and Other Cereal Aphids (PA 211, 215)
WCC-069	Coordination of Integrated Pest Management Research & Extension/Educational Programs for the Western United States & Pacific (PA 216)
WCC-077	Managing Invasive Weeds in Wheat (PA 213)
WCC-089	Potato Virus Disease Control (PA 212)
WCC 095	Vertebrate Pests of Agriculture, Forestry and Public Lands; (PA 214)
WCC-097	Research on Diseases of Cereals (PA 212)
WCC-old-077	Biology and Control of Winter Annual Grass Weeds in Winter Wheat (PA 213)
W-temp1241	Interactions among Bark Beetles, Pathogens, and Conifers in North American Forests (PA 211 – 212)

Table 6.10
Summary Information Relating to Multi-state Projects for 2003

Region	Total All Areas	Pest Management Related Projects	% Total Related to Pest Management	Total $ (thousands)
Northeastern	77	10	14%	25,057
North Central	136	21	31%	55,483
Southern	104	19	29%	51,903
Western	99	17	26%	46,534
Total	**416**	**67**	**100%**	**178,977**

6.7 Soybean and Corn Arthropod Pest Management Research and Extension—
A Case Study of the Accomplishments and Impacts of Hatch Act Multi-State Research

Below we present, as an example, of the impact value of multi-state committee activity write-ups on two dynamic groups of research scientists and extension educators. Multi-state research involving two of the most important U.S. agricultural commodities has had a strong and sustained impact on the development and practice of pest management used over the last four decades. Research and extension information developed by two multi-state committees has led both the development of the science and crop production practices used throughout corn and soybean growing areas within the U.S. These two committees have also been the training grounds for at least 2 generations of scientists. Notably both committees have had a strong and sustained record of publication and have leveraged additional resources through competitive grants, from USDA and other sources, from state and local support and from non-governmental sources such as private industry or commodity groups.

6.8 EXAMPLE 1: Case Study- S-1010 - Dynamic Soybean Pest Management for Evolving Agricultural Technologies and Cropping Systems

(A) Overview:

More soybeans are grown in the United States than anywhere else in the world. Today farmers in more than 30 states grow soybeans, making soybeans the second largest crop in cash sales and the number one value crop export. In 2002 74.31 million metric tons of soybeans with a crop value of $15,015 million were grown on 73.8 million acres. Soybean pest management is challenged by simultaneous occurrence of biotic (e.g., various insects) and abiotic (e.g., drought) stresses. With new understandings about the physiological basis for yield loss from different stressors, an opportunity now exists to develop better strategies to address combined stressors, which are what most soybean growers experience (Higley 1992)[4]. Additionally, the emergence of new soybean production practices, transgenic genotypes, and new insect pests requires research to determine how best to manage insects and other stressors in these systems (Boethel 2002)[5]. The potential impact on soybean profitability makes it essential that we begin addressing current and future problems now. Soybean growers have recently experienced increases in certain insect pest problems and the introduction of a new and potentially significant problem over the past few years. The first situation is the increase in population densities of the bean leaf beetle, *Cerotoma trifurcata*, and a corresponding rise in the incidence of bean pod mottle virus, a pathogen vectored by the beetle (Rice et al. 2000)[6]. This relationship between bean leaf beetle and bean pod mottle virus, previously more common in southern states, is a relative new occurrence in the central and northern United States. The second problem is the recent introduction of the soybean aphid, *Aphis glycines* (Marking 2001)[7]. Soybean growers now are facing widespread use of insecticide over potentially millions of acres of soybean in the upper Midwest and given the native range of this insect, soybeans throughout the United States are at risk of being invaded. In agriculture, we have seen tangible results from the landscape perspective including: area-wide management of such pests as boll weevil, Hessian fly, screwworm, and gypsy moth. Significant problems face producers and scouts in soybean in the future, and at least some of these problems could be addressed using remote sensing technologies. For instance, nutrient deficiencies, drought stress, insect damage, pathogen infestations, and delayed maturity are all significant problems over broad geographic areas. The solutions to pest management problems in soybeans require an area-wide view.

(B) History of Past Accomplishments:

Previous soybean entomological regional projects (S-74, S-157, S-219, S-255 and S-28, Table 6.8, found on page 54) have advanced both the underlying science and the practice of pest management in soybean production. Collaborative, multi-state research to address the arthropod pest complex attacking soybeans in the United States began formally with the establishment of a Southern region technical committee, S-74, in 1972. At that time, most of the soybean producing states conducted research and extension programs that addressed control of key pests within their own states. The formation of this committee enabled a group comprising scientists from most of the soybean growing states to plan, prioritize and address key problems faced by two or

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4 Higley, L. G. 1992. New understandings of soybean defoliation and their implications for pest management. pp. 56-66, In Pest Management in Soybean, L. G. Cropping, M. B. Green, and R. T. Rees, eds., Elsevier Applied Sci, New York, 367 pp.

5 Boethel, D. J. 2002. Integrated management of soybean insects. In Soybeans: Improvement, Production, and Uses. 3rd Edition. Amer. Soc. Agron. Madison, WI.

6 Rice, M. E., R. K. Krell, W. F. Lam, and L. P. Pedigo. 2000. New thresholds and strategies for management of bean leaf beetles in Iowa soybean, pp. 75-84, In Proceedings of the Integrated Crop Management Conf., Iowa State Univ. Ext. Serv.

7 Marking, S. 2001. Tiny Terrors. Soybean Digest 61:64-65.

more states. Even though the technical committee was administratively attached to the Southern region the membership included scientists from other regions where soybeans are grown.

In the first years of this collaborative research, five subcommittees were established with the following emphasis areas: 1. Host plant resistance; 2. Natural control agents; 3. Cultural and chemical control; 4. Ecological techniques; and 5. Pest management. During the term of this initial project significant advances were made in many areas of soybean arthropod research, an area that was in its infancy. Basic information relative to soybean pests was studied in detail. Emphasis was placed on predators, parasites and diseases of soybean pests, and significant information was developed on economic thresholds for various pests, host plant resistance and the effects of various cropping systems on soybean problems. An early suggestion from the Cooperative State Research Service (CSRS) Representative was to include an agricultural economist to interject the economics of soybean pests into the group thinking to give added direction, since it would be useful in determining the economic impact of pests in relation to pesticide usage. Each successive revision of the original research project was made to address the key issues and challenges of the day. A chronology of the regional research effort is given in Table 6.11. Each project was extremely productive in terms of publication in the scientific literature. Totals are provided in the Table of chronology; however, what is perhaps more important is that the knowledge was transferred into practice via the linkage to Cooperative Extension programs in each participating state. Pest control recommendations developed by each state quickly incorporated the control strategies developed through the research effort. Pest management in soybeans moved from reliance on “hard” pesticide usage to newer more environmentally friendly and target oriented pest management methods, first with the advent of organo-phosphorus and then with development of pyrethroids and other chemical groups. Resistant plant variety development obviated the need for some pesticide use. Timing of planting and pesticide applications made control more precise for specific target pests. Biological management methods were developed and put into practice. More recently, application methodologies were developed that required lower volumes of pesticides, more accurately placed. (GIS) and (GPS) technologies began development. A rapid response committee was formed in the North central region to address the invasive soybean aphid.

Table 6.11
A Chronology of the Multi-state Arthropod Soybean Pest Management Research Programs Leading to S-1010

S-74	Control Tactics and Management Strategies for Arthropod Pests of Soybeans July, 1969 – Terminated September 30, 1981 (515 PUBLICATIONS, published or in press)
S-157	Tactics for Management of Soybean Pest Complexes October, 1982 - Terminated September 30, 1987 (338 PUBLICATIONS, published or in press)
S-219	Arthropod Induced Stresses on Soybean: Evaluation and Management October 1987 – September 30, 1992 (358 PUBLICATIONS, published or in press)
S-255	Development of Sustainable IPM Strategies for Soybean Arthropod Pests October 1992 – September 30, 1997, (240 PUBLICATIONS, published or in press)
S-281	Dynamic Soybean Insect Management for Emerging Agricultural Technologies and Variable Environments October 1997 – September 30, 2002 (157 PUBLICATIONS, published or in press)
NC-502	Soybean Aphid: A New Pest of Soybean Production September 1, 2000 – September 30, 2002
S-1010	Dynamic Soybean Pest Management for Evolving Agricultural Technologies and Cropping Systems October 1, 2003 - present (28 PUBLICATIONS, published or in press to date)

(C) Current Funded Project:

Project goals: S-1010’s present goals are: 1) Characterize the dynamics and impact of evolving insect pests and optimize insect management as an integral element of developing cropping systems; 2) Define insect-vector ecology and virus-disease relationships and develop management strategies; 3) Biological control of the soybean aphid in North America; and 4) Apply geospatial and precision technologies to advance pest management in soybeans.

Progress toward project objectives: Participating scientists develop a proposal for a five year project with well defined goals to achieve during the life of the project. Each contributing scientist submits a Hatch proposal to work on specific objectives in the multi-state project. All contributing scientists meet annually to report on progress made toward the objectives and to plan for the coming year's work.

***Objective 1.* Characterize the dynamics and impact of evolving insect pests and optimize insect management as an integral element of developing cropping systems.**
Soybean pest management is challenged by simultaneous occurrence of biotic (e.g., various insects) and abiotic (e.g., drought) stresses. With new understandings about the physiological basis for yield loss from different stressors, we now have the opportunity to develop better strategies to address combined stressors. Additionally, the emergence of new soybean production practices, transgenic genotypes, and new insect pests requires research to determine how best to manage insects and other stressors in these new production systems. Pest arthropod populations were similar in conventional and Round-Up Ready systems of weed management. An early maturing variety of edible soybeans (Midori Giant) escaped damaging populations of stink bugs and caterpillars. Soybean aphid (SBA) was detected in Georgia for the second year in a row. Twenty-eight varieties of soybeans were screened for resistance to stink bugs and Lepidoptera pests. Varieties exhibited a large range of susceptibility to these pests. Fire ants in soybeans were controlled with Amdro and Lorsban; however, fewer spiders were collected in plots treated with these insecticides. Warrior, Scout, Capture, Demon and Orthene were effective against soybean looper. A preliminary threshold of 250 SBA/plant up to R4 was established. Planting date and plant age did not appear to have an impact on SBA density. SBA outbreaks occurred 1-2 weeks after outbreaks in more northern states; thus, SBA moves from north to south. SBA overwintered in northern Indiana. *Rhamnus cathartica, R. alnifolia*, and *R. lanceolata* were shown to be overwintering hosts of SBA. Several species of Rhamnaceae supported fall migrants (gynoparae), but only *R. cathartica* and *R. alnifolia* supported the egg-laying generation (oviparae) of SBA. In the field, initial colonies of SBA are patchy and consist of nymphs. Eventually, SBA colonize entire fields and achieve a more uniform distribution. A model of SBA population dynamics is being developed. Resistance to SBA is being investigated using a visual rating scale using KS 4202 as the sentry variety. Antibiosis tests revealed three varieties with significantly reduced aphid reproduction. *Dectes texanus* has shifted from sunflowers to soybeans. *D. texanus* on both hosts are conspecific, but sunflower is a better host than soybean. SBA gradually spread throughout the eastern half of NE in 2003. Most damaging populations were found in northeastern NE. This colonization pattern was similar to 2002 but more fields were treated in 2003 than 2002. Milder temperatures in 2003 may have accounted for higher populations in 2003. Two out of four studies showed about a 10 bu/acre yield increase in SBA-treated plots compared to untreated plots. Soybean defoliation reduced early-season crop tolerance to weeds. SBA was found on buckthorn in the fall of 2003 at Moorhead, MN on the MN/ND border. SBA was found in highest abundance on late reproductive stage soybeans in 2003. SBA initially colonized the edge of soybean fields near shelterbelts; populations gradually became uniformly distributed in the field. Recommendation: scout field borders near shelterbelts first in early July to detect initial colonization by aphids. In a greenhouse test, MN0302 and Dynagro 3072 generated high populations of SBA but exhibited low damage. SBA became established on thiamethoxam-treated (applied to seed) plots 3 weeks later than on untreated plots. ND participated in the common experimental protocol for refining the SBA economic threshold. Karate Z was applied at R2, R3, R4 and R5. Aphid infestation was not high enough to obtain meaningful data. In narrow row soybeans, skip row soybean planting is encouraged to avoid running over soybeans with spray equipment (treating for SBA). Heavy slug defoliation occurred soon after emergence when weather turned unseasonably cool. A $500,000 program funded by USDA-NCRS EQIP has been established in Ohio and will make monies available to growers to sample and treat for slugs. In Tennessee soybean cultivars were evaluated for resistance to *Dectes* stem borer; for early MGV cultivars, Delta King was most damaged; least damaged was FFR. For late MGV cultivars, *Dectes* damage was less than for early MGV cultivars. The pyrethroids, Asansa XL [0.05 lb (AI)/acre], Baythroid [0.03-0.044 lb (AI)/acre],Fury [0.05 lb (AI)/acre] and Karate Z [0.03 lb (AI)/acre] performed well against green stink bug.

Lorsban [l lb (AI)/acre] was least effective. Populations of stink bugs were compared on MG IV, V, VI and VII soybeans planted in mid-April and late May in Texas. Basically, stink bugs, primarily southern green stink bug, built-up to damaging levels on MG IV soybeans planted early. However, for the late May planting date, stink bug populations did not exceed threshold levels on MG V and VI and VII soybeans. Planting MG V or VI soybeans in May/June may avoid damaging stink bug populations and allow early harvest before cool, wet weather occurs. SBA was found in soybean fields in 10 counties in Virginia; however, populations did not approach damaging levels. Educational programs were conducted to alert clientele of this potentially devastating insect pest. Based on the Corn Earworm Advisory, corn earworm (CEW) problems on soybeans were predicted to be less in 2003 compared to 2002, and in fact, they were. About 60% of VA soybean acreage was treated for CEW in 2002; only 17% was treated in 2003. The % of soybean acres treated in August was well correlated with predictions based on a survey of field corn in July. Field-collected CEW moths from around the soybean-producing area of VA were subjected to varying rates of cypermethrin. No evidence of pyrethroid resistance was detected. However, field collected CEW moths reared from larvae collected around the soybean-producing area of VA did exhibit low levels of resistance. Growers were warned and encouraged to employ non-pyrethroid insecticides. Steward 1.25 SC at 4.6 and 6.7 oz/acre, Tracer 4SC at 2 oz/acre, Mustang Max at 2.8 and 4.0 oz/acre, Larvin at 10 oz/acre and Karate Z at 1.6 oz/acre provided at least 90% control of CEW. In field experiments conducted in Wisconsin, late-planted soybeans produced higher SBA populations than early planted soybeans. Results of experiments show that the economic threshold for SBA is 500/plant at R1. At R2/3, the threshold increases to 1000/plant. The best time to apply an insecticide for SBA is R/2. SBA was detected earlier on early- rather than late-planted soybeans. SBA tend to congregate in the uppermost nodes during June and early July after which their spatial distribution is less clumped. Adapted germplasm also was screened for SBA; populations ranged from 1000 to 2500 per plant which suggests that resistance to SBA can be incorporated into adapted germplasm.

Objective 2. **Define insect-vector ecology and virus-disease relationships and develop management strategies.**

Aphid-transmitted viruses were not detected in ND; however, soybean dwarf virus was detected in soybeans in five counties in WI in 2003. Alfalfa mosaic virus (AMV) and soybean mosaic virus (SMV) were the most prevalent viruses infecting soybeans in 2003. Soybean germplasm was evaluated for reaction to AMV, SMV and bean pod mottle virus; differences among varieties for yield and grain quality were evident. This information was given to breeders for use in their programs.

Objective 3. **Biological control of the soybean aphid in North America.**

The NC rapid response committee addressing the soybean aphid was incorporated into the new project. *Harmonia axyridis* is a common predator of SBA. Little parasitism occurs but fungal disease epidemics are common. Other predators are damselflies, flower flies and lacewing larvae. The major predator of SBA is *Orius insidiosus. O. insidiosus* populations were associated with thrips populations. Thrips may be sustaining *O. insidious* populations for later SBA predation. Hypothesis: *O. insidiosus* keep in check locally overwintering SBA but are unable to impact large migrant populations entering IN from the north. The predatory harvestman, *Phalangium opilio*, is a common predator of Corn earworm (CEW) eggs and also feeds on SBA. This predator only feeds at night. Also, CEW eggs are a better host diet than SBA. USDA/ARS Michigan: In cooperation with State Experiment Station scientists, the USDA PPQ Invasive Pests Management Laboratory in Niles, MI screened and evaluated exotic natural enemies of the SBA, modeled natural enemy impacts on SBA, conducted foreign exploration for SBA natural enemies and studied the interaction of predators and parasitoids on SBA biological control. Also, this facility reared the Wyoming strain of an established aphid parasitoid, *Aphelinus albipodus* (shipped 76,000 to MN and 447,000 to WI). In 2003, SBA was severe in southern WI. *A. albipodus* was released in 2002 and became established in 2003. Lady beetles are the most significant predator of SBA in WI. SBA natural enemy complex is diversifying following the recent introduction of this pest.

Objective 4. **Apply geospatial and precision technologies to advance pest management in soybeans.**
The drop cloth and light meter methods (measures light interception) of determining when to treat for defoliating insects gave similar results in Louisiana; both methods triggered an insecticide application within several days of one another. Results confirm that light measurements using hand-held light meters can accurately predict when insecticide application is warranted. Use of vegetation indices generated by remote sensing correlated well to light interception and leaf area index (LAI) measurements. Thus, remote sensing shows promise as an accurate method of determining when to apply insecticide. In Virginia varieties and planting dates were manipulated to achieve various LAIs of field-grown soybeans. Infrared images of these plots were taken from a fixed-wing aircraft at three different altitudes. NDVI (normalized difference vegetation index) values were calculated from the infrared images. Results show a significant linear relationship between LAI and NDVI.

(D) Project participation:
The following states are participating members of the current S-1010 project: AR, GA, IL, IN, IA, KS, KY, LA, MI, MN, MO, NE, ND, OH, TN, TX, VA, WI. The specific objectives being addressed by each state and the PA (RPA) they are addressing, the subject of investigation (SOI) and the field of science (FOS) and the time commitment are provided in a summary table in the Evidentiary Materials.

(E) Impacts:

1. Adoption of an economic threshold of 250-500 SBA per plant on 10% of the acreage in 6 mid-western states is estimated to result in savings of $225 annually in yield losses and reduced unnecessary insecticide application.
2. Progress was made towards determining the current distribution of SBA and predicting its future spread.
3. SBA overwintering relationships with buckthorn were elucidated and applied to predict future damaging populations of the pest.
4. Aggressive biological control programs involving native and exotic natural enemies of SBA are being conducted.
5. Planting of MGV and VI soybeans along the Texas Gulf Coast in mid-May and early June indicate that this method may avoid stink bug damage produce high yields, and allow harvesting before onset of inclement weather.
6. Impact 6 - Geospatial and remote sensing technology to estimate soybean defoliation revealed that vegetation indices generated by remote sensing correlated well with light interception and LAI measurements.

(F) Evidentiary Materials:

- S-1010 Project participants and their objectives.
- Publications Summary for 2002-2003: The committee members have listed 28 publications for the most recent year's annual report. A detailed listing of these publications is provided in the evidence.
- Termination reports for earlier committees are provided in the evidence.
- Leveraged research support for arthropod pest management in soybeans: Members of multi-state research committees, in general, receive research funding support from a variety of national, state and local sources, both public and private, in addition to the funding provided through the Hatch act multi-state research funds allocated by their Experiment Station. As an example, see the Table of leveraged support by S-1010 members from soybean commodity groups.
- Listing of students trained under S-74.
- Examples of annual reports.
- Key publications.

6.9 EXAMPLE 2: Multi-state Committee NC-205- Ecology and Management of European corn borer and Other Lepidopteran Pests of Corn

(A) Overview:

More than 80 million acres of field corn (*Zea mays* L.), worth over $20 billion, are annually grown for grain in the United States. European corn borer (ECB), Ostrinia nubilalis (Hübner), is the most damaging insect pest of corn throughout the United States and Canada. This pest alone, among several stalk boring pests, accounts for more than $1.85 billion in control costs and grain losses to corn growers each year. European corn borer also attacks many other important crops, such as, sorghum, small grains, cotton, potatoes, snap beans, peppers, and soybeans. A recent four-year study in Iowa indicated average losses near 13 bushels per acre in both first and second generations of European corn borer, for total losses of about 25 bushels per acre.

Despite consistent losses to European corn borer, many growers are reluctant to use current integrated pest management (IPM) methods for this pest. Historically, this reluctance stems from several factors:

- Larval damage is hidden,
- Heavy infestations are unpredictable,
- Scouting multiple times each summer takes time and requires skill,
- Insecticides are expensive and raise health or environmental concerns, and
- Benefits of European corn borer management are uncertain and vary from year to year and field to field.

One geographical exception, to the prevailing attitude of "benign neglect" toward European corn borer, occurs in the intensively managed irrigated corn of the high-plains states, such as Texas, western Kansas, eastern Colorado, and Nebraska. Irrigated corn with its higher yields is monitored closely for insect pests, such as European corn borer and the southwestern corn borer, and is treated frequently with insecticides. These farmers have a history of aggressive management of European corn borer.

(B) History of Past Committee Accomplishments:

The earliest coordinated multi-state activities involving the European corn borer can be traced back to the early1950s. During those years there was a growing recognition of the impact that the European corn borer through most Midwestern corn producing areas. At the same time the chlorinated hydrocarbon insecticide were being developed and much hope and early experimentation on corn borer management was with these new active ingredients and formulations. The recognized difficulty in managing the ECB was that there was but a narrow window of potential exposure to pesticides by the flying adult and the early instar larvae before the tunnel into the plant. Work in the 1950 involved in working on quantifying the level of yield loss due to the ECB, tillage practices that destroyed crop residue and over-wintering larvae, planting date variation to reduced crop damage and plant breeding for enhanced host plant resistance and for increased stalk strength. The most disheartening type of crop loss for growers due the ECB was late season boring near the base of the ear by second generation borers and the resulting ear drop prior to harvest. Through the 1960s and 70s, scientists working on the corn borer multi-state committee gradually developed and promoted integrated pest management practices and made substantial progress in understanding the life history of the European corn borer, seasonal field monitoring, following its seasonal movements, economic threshold development and refining pesticide management options and delivery systems. The activities of this committee reflect a natural progression of pest management tools and technologies from the 1950 into the 1990's. All of this was to change during the 1990s with the discoveries that led to the transgenic incorporation of Bt genes into the corn plant for Lepidoptera management. The 1996 commercial release of transgenic corn hybrids containing a gene from the bacterium *Bacillus thuringiensis* subsp. *kurstaki* (Bt) triggered a revolution in field corn insect pest management. This revolution began the trend to move field-corn pest management away from synthetic pesticides toward plant-based toxin delivery systems coupled with low dosage commercial seed treatments. The goals of this transition to a new pest management paradigm was to eliminate or greatly reduce the need to store, handle or apply toxic chemicals, eliminate the need for special insecticide application equipment, reduce management inputs and increase the effectiveness of pest control. Major seed technology companies viewed this as an opportunity to begin to develop new transgenic crops, which allow producers a new level and a greater assurance of pest protection. The scientists of NC-205 say these new technologies as the new direction of pest management, not only for corn and other major US crops, but also for many specialty crops.

A major regulatory challenge was presented to the agricultural scientific community, during the NC-205 meeting in Kansas City, Missouri in 1996, when the EPA announced that it would not allow the registration of any Bt-corn hybrid lines unless there was a farm-level enforceable science-based label statement that would reduce the potential of pest resistance to the Bt toxin. Prior to this time, an insect resistance management (IRM) program had not been a policy required for the registration of a pest management product or technology. Scientists in NC-205 recognized the potential of this new technology and accepted this challenge to prove the concept that resistance could be prevented by planting non-Bt corn interspersed in patterns with Bt-corn. Field-scale tests were needed to raise the refuge concept from a theoretical possibility to an experiment in-progress. NC-205 field crop scientists agreed to define a protocol for a series of large-field tests across the Midwest corn belt to evaluate the effect of refuges on gene flow in ECB populations. By the time these corn entomologists left their NC-205 meeting in Kansas City in 1996, two modeling scenarios were in place and Corn Belt-wide tests had been designed to bring data to the table by next year's meeting. During the late 1990's, research conducted by members of Nc-205 developed and refined predictive models that estimated the rates of resistance evolution and investigated the role of refuge structure in preventing or minimizing the development of resistance. These models suggested that a minimum refuge size of 20% is necessary to slow resistance development in the European corn borer. These research data were used by EPA to define a refuge requirement as part of the labeling of genetically modified corn containing the Bt gene that nearly eliminates stock-boring pests in field and sweet corn.

These technologies were so popular with the producer community that by 2003, about 29% of all corn hybrids planted in the Unites States contained a Bt gene. Stacked-gene hybrids were commercially released in 2004 that express two Bt genes, which prevent injury from both European corn borer and corn rootworm. Other genetically-enhanced hybrid types are expected to enter commercial markets within the next five years. As the level of adoption increases, particularly in the western Corn Belt, the potential for resistance evolution increases. The present IRM models were constructed based on the best information available. A number of assumptions, however, need further testing in order to move them from assumptions to quantified variables. Additional information is still needed on the economics of this new technology, how this technology will affect integrated pest management in corn and potential non-target impacts of Bt-corn toxins. Eliminating these information gaps forms the basis for several objectives that NC-205 has taken on as their challenge for the next five years.

(C) Current Funded Project:

Project Goals: NC-205's project present goals are: 1) Assess economic and sociological factors that influence the management of lepidopteran pests of corn; 2) Investigate ecological, evolutionary, genetic and behavioral factors that impact pest populations, including resistance management; 3) Conduct research to improve conservation biological control of lepidopteran pests of corn; 4) Assess impact of insect pest management strategies on non-target organisms; and 5) Conduct research and disseminate information related to sustainable management of lepidopteran pests.

Project Objectives: In order to accomplish these goals during the project's five-year life, NC-205 developed the following multi-state committee objectives. . Scientists from each state participating in NC-205 develop and submit a Hatch Project proposal working on one or more of the multi-state project objectives. Participating scientists annually report accomplishments on these objectives, the multi-state committee reviews annual progress on each goal and develops next years studies to further advance the project toward the multi-state 5-year project goals. The NC-205 project objectives are:

Objective 1. Assess economic and sociological factors that influence the management of lepidopteran pests of corn.
Economic analyses using surveys and bioeconomic models have identified economic, demographic, and societal factors affecting the adoption of Bt corn and implementation of resistance management requirements. Due to regional differences in corn lepidopteran pests, a regional evaluation approach has proved very effective. Economists and sociologists have conducted surveys of farmer attitudes concerning transgenic crops and the implementation of refuge requirements. These results are being used to develop more accurate models of farmer behavior to incorporate into existing insect resistance models developed by participating scientists in Minnesota, Wisconsin and Illinois. In addition, these results are being used to assess the effect of education efforts, crop insurance, and the new Compliance Assurance Program on the formation of farmer attitudes and implementation of refuge requirements. The goal of this objective is to develop a compliance program, which effectively ensures farmer compliance balancing producer costs and benefits of the program to the seed companies, growers, and society.

Objective 2. Investigate ecological, evolutionary, genetic and behavioral factors that impact pest populations, including resistance management.
Population models have been developed in Illinois and Minnesota to predict the potential evolution of resistance and to investigate alternative resistance management strategies. To address information gaps it was necessary for models to rely on assumptions and estimates regarding pest biology. Present research on these knowledge gaps is providing information improving the realism of these models. These biological models are being linked to the Best Economic Technology model to allow site-specific predictions of economic benefits and resistance management. NC-205 scientists in various states contribute to model development to “improve model parameters” by investigating adult European corn borer dispersal, egg deposition, voltism and voltine types, population dynamics, damage mapping, resistance-monitoring systems, the spread of resistance, the use of molecular markers, pheromone studies, and sensitivity to Bt toxins. The information generated from these population genetic structure studies are being incorporated into the population dynamics–population genetic models of Minnesota, Illinois, Iowa, and Pennsylvania to improve prediction of resistance development and potential spread of the European corn borer.

Objective 3. Conduct research to improve conservation biological control of lepidopteran pests of corn.
Scientists from Iowa, Delaware, Indiana, Kansas, Kentucky, Maryland, Minnesota, Nebraska, New York, Ohio, and Pennsylvania are evaluating the effect of Bt corn on insect pathogens that attack European corn borer (including *Nosema pyrausta*, a microsporidian pathogen, and *Beauvaria bassiana*, an endophytic fungal pathogen. Texas, Michigan, South Dakota, Missouri, Ohio and Minnesota have worked and surveyed to evaluate how the natural enemy communities use Bt cornfields in relation to the entire landscape, adjacent crops and pastures. Scientists at the University Minnesota and the University of Illinois are using regional data collected from previous multi-state collaborations to estimate the economic value of natural enemies of the European corn borer. Natural enemies will soon be added to their European corn borer simulation model to project their value in terms of pest population reduction, yield changes, and potential for economic gain. The projected effects of widespread adoption of Bt corn on natural enemies will be modeled to assess the cost/value of natural enemies in Bt corn.

Objective 4. Assess impact of insect pest management strategies on non-target organisms.
Field studies were conducted in Maryland and Iowa to develop protocols for non-target sampling, including plot size, replicate number, and sample timing in Bt corn. Data sets from industry

groups and NC-205 members will continue to be combined, which has made the protocols more statistically robust. These studies will provide improved methods to detect differences between Bt-crop production and alternative management practices. Cost–benefit analysis will continue to be conducted to evaluate the economic feasibility of Bt-sweet corn under various pest risk scenarios and technology costs.

Objective 5. Conduct research and disseminate information related to sustainable management of lepidopteran pests in corn.
NC-205 scientists from Minnesota, Iowa, Illinois, Kansas, Maryland, Michigan, and Ohio have conducted field evaluations to determine the efficacy, yield, and economic implications of European corn borer management, including Bt corn, scouting-based insecticide applications, and unprotected refuges. Various combinations of pest risks, pest complexes, and management outcomes have been and will continue to be investigated. Research data from NC-205 studies are being used to develop multiple media materials for use in Extension programming and grower educational activities. State newsletters, traditional extension materials, Web pages, scientific publications, adoption surveys, and position statements have been and will continue to be used to disseminate information to the agricultural and public sectors.

(D) NC-205 Participation by States:
The following states are members of NC-205 and have scientists that are contributing to the multi-state project: DE, IL, IN, IA, KS, KY, MD, MI, MN, MO, NC, ND, NE, NY, PA, TX, and WI. The type and magnitude of the each state's contribution to NC-205 is listed in the Evidentiary Materials. In addition, the contributions to research program areas (PAs), subject of investigation (SOI) and field of science (Field of Science) are also presented in tabular format in the Evidentiary Materials.

(E) NC-205 Accomplishments:
The following bulleted accomplishments have occurred because research and extension staff from many states worked cooperatively with EPA and agricultural industries to improve and better understand this new pest management technology.

- Because of NC-205, scientists from 18 land-grant universities and USDA/ARS labs have coordinated research activities addressing one or more of the objectives of NC-205. EPA considers the NC-205 committee as a highly qualified and unbiased source of science-based information on corn-pest management.
- Two complementary resistance development models were developed for the European corn borer, which provided the science-based foundation for EPA approving Section-3 labeling of Bt corn. .
- The science contributions by NC-205 allowed the development of a new multi-million dollar industry, economic benefits to producers and increased worker and environmental safety by drastically reducing of the use of high-risk insecticides in corn production.
- As part of their annual meeting from 1999-2003, NC-205 scheduled a one-day "Industry, Scientist and Regulatory Information Exchange Symposium". This engagement allowed the primary parties, interested in marketing and regulating genetically-modified corn to have an open and frank dialogue with scientists doing much of the research on corn-pest management.
- Between 1999 and 2003, scientists participating in NC-205 published 220 scientific articles relating to activities defined in this multi-state project. A complete listing of NC-205 publications, by year, is listed in the Evidentiary Materials.
- At least 125 graduate students were actively involved in the research projects contributing data to the NC-205 multi-state project and many of those students were co-authors on the 220 scientific publications.
- During the span of 1999-2003, at least 20 graduate students completed their Masters degree and at least 23 graduate students completed their PhD degree while working on one or more of the objectives of NC-205. This estimate is lower than the actual, since we have not been able to track the academic progress of all students.

- NC-205 publishes and updates North Central Regional Publication, NCR-327, *European Corn Borer: Biology and Management*, and NCR-602, *Bt Corn and the European Corn Borer: Long-Term Success Through Resistance Management*. These two publications have become standard primers on corn borer biology, life history, monitoring, management and resistance management. Iowa State University and the University of Minnesota distribute three to five thousand copies of each publication annually, which are purchased and dispensed by State Extension Services, grower organizations and private industry.
- NC-205 has developed new economic assessment tools, which help growers manage and understand the economic risk and value of Bt corn for European corn borer, aiding growers in deciding which management technology will serve their needs. The work of NC-205 scientists was instrumental for developing expertise used to design and assess resistance management policies for new transgenic crops active against insect pests other than European corn borer.
- NC-205 members have and continue to conduct surveys measuring farmer compliance and attitudes in the use of untreated refuges to manage the development of resistance to Bt in the European corn borer.
- NC-205 scientists provided the leadership in a consortium that addressed the monarch butterfly Bt corn pollen concern, which was one of the most controversial and polarizing issues to face agricultural scientists in recent memory. Their efforts led to the publication of five papers in the Proceedings of the National Academy of Sciences demonstrating that the impact of Bt corn on monarch populations is negligible.

(F) NC-205 Impacts:

The following are NC-205 impacts that have come about as a result of the cooperative engagements, interactions and science contributions that the committee members have had and made with Agricultural Industries, the breadth of the basic and applied scientific community and the regulatory community. The following represent a few impact of this committee's on plant protection and pest management of corn insects:

- The Federal and State Land-Grant University research and extension community, through NC-205, had been responsible for setting new standards of credibility, cooperation, responsiveness and engagement in providing unbiased scientific contributions which the unique needs of both the regulatory community and agricultural industry in regard to implementing (GMO) technology into field crop protection.
- The NC-205 publication of the Proceedings of the National Academy of Sciences resulted in the scientific community allowed the regulatory community to reassess and waylay undue fears of the impact of Bt corn pollen on monarch butterfly populations and non-target mortality.
- The credibility of the scientific research scientists and extension educators of NC-205 was greatly enhanced with EPA scientists because of the strength of the scientific discoveries made regarding ECB refuge development to delay resistance development and the Bt pollen impact on Monarch butterfly mortality.

(G) Evidentiary Materials:

- NCR-327, *European corn borer: Biology and Management*.
- NCR-602, *Bt Corn and the European corn borer: Long-Term Success Through Resistance Management*.
- Proceedings of the National Academy of Sciences – 5 papers by NC-205 Scientists on the impact of Bt corn pollen on monarch butterfly populations.
- Butterflies and Bt corn – Allowing Science to Guide Decisions.
- A list of publications relating to the objectives of NC-204, from 1999-2003.
- A list of the students working on NC-205 objectives that completed their graduate degree between 1999-2003.
- Type and magnitude of the each state's contribution to NC-205.
- Draft of the NC-205, 2005 multi-state project rewrite.

Section 7: Problem Area 211 Insects, Mites and Other Arthropods Affecting Plants

Relevance

7.1 Scope

This Problem Area (PA) focuses on plant yield and quality as affected by indigenous and exotic insects, mites, and other arthropods (including bees and other pollinators). This work includes basic and applied research, educational programs in the classroom at Bachelors, Masters and Doctoral levels and Extension program delivery covering a broad scope of delivery methods to a diverse audience. Research, education and extension topics supported within PA 211 include biosystematics/taxonomy, population dynamics, ecology, and behavior (including the impact of climate and other abiotic factors on pest biology and management), population and molecular genetics (e.g., physical linkage maps, gene expression, regulation, proteomics, mutagenesis and gene discovery). Also included are basic studies on mechanisms of host plant resistance, proceeding through a continuum of work from breeding (including genetic engineering) for host plant resistance to implementation of methods to circumvent resistance, to control methods or cultural practices to reduce infestations or effects. Evaluation of germplasm for genetic variation in resistance to pests was a component of the plant production portfolio (PA 202). Mission-oriented work from discovery to transfer of information on efficacy, product performance, application technology, and population management with conventional pesticides, biopesticides (e.g., growth regulators) and behavioral modifying chemicals (e.g., pheromones, semiochemicals) related to arthropod management is included here. Development of sampling protocols (including economic injury levels, action thresholds, and remote sensing and other automated sampling methodologies) and predictive models for single pests carried through to the implementation stage are important for plant protection. The development of the instrumentation for remote sensing and automated sampling may be considered in Problem area PA 404. Biosecurity measures to limit invasive insects, mites, and other arthropods in plant management systems are included here. The role of insects, mites, and other arthropods in disease transmission is included in the next PA in this portfolio (PA 212).

Beneficial arthropods that affect plants both directly and indirectly are also included in this problem area. Research, education and extension programs on topics such as nutrition, management, and productivity of bees and other pollinators are also considered here.

The integration of control tactics into systems for managing single pests or pest complexes and development of sampling protocols or predictive models for pest complexes are included under integrated pest management systems (PA 216).

When biological control is the focus of the work problem area, the section on PA 215 is appropriate. However, knowledge and materials from PA 211 are used in research in PA 215-216 to develop improved biological control methods and IPM systems.

Movement and dispersal resulting from airborne transport of pests is included in. PA 132 or 133.

Funding for this problem area within the portfolio comes from almost all of the programs illustrated in Figure 6.4 (found on page 47). Basic science underpinnings for research in this problem area receive funding from two major funding lines. These are the NRI competitive grant programs *Integrative Biology of Arthropods and Nematodes* and *Arthropod and Nematode Gateways to Genomics* and the formula-based Hatch Act research support, including Multi-state research funds. Applied integrated competitive programs such as Crops at Risk (CAR), Risk Avoidance and Mitigation Program (RAMP) and Organic Transitions Program also provide funding in this PA area. Additional funding at the state level complements and leverages this CSREES funding, as does support from other Federal programs such as (NSF). Mission-oriented research and extension support for this problem area comes from both competitive and base support lines of funding, as well as congressionally ear-marked funds and other special and federal administration grants. Virtually all of the funded programs shown in Figure 6.4 (found on page 47) are components of the total funding stream for this problem area. In addition, a large component of mission-oriented funding is leveraged from other non-governmental sources such as commodity or industry groups.

The logic model for PA 211 is illustrated in Figure 7.1 (found on page 73). Major accomplishments and needs summaries for PA 211 are provided in Figure 7.2 (found on page 74). Major subject area categories defined for PA 211 are shown at the bottom of Figure 7.2.

(A) Areas of work include but are not limited to:

- Population dynamics, ecology, and behavior.
- Biosystematics/taxonomy.
- Impact of climate and other abiotic factors on pest biology and behavior.
- Cultural practices to reduce infestations or effects.
- Mechanisms of host plant resistance.
- Breeding (including genetic engineering) for host plant resistance.
- Pest resistance to control methods or strategies.
- Efficacy, product performance, application technology, and population management with conventional pesticides and biopesticides (including pheromones and growth regulators).
- Development of sampling protocols (including economic injury levels, action thresholds, and remote sensing and other automated sampling methodologies) and predictive models for single pests.
- Population and molecular genetics (e.g., physical linkage maps, gene expression, regulation, proteomics, mutagenesis, gene discovery).
- Nutrition, management, and productivity of bees and other pollinators.
- Biosecurity measures to limit invasive insects, mites, and other arthropods in plant management systems.

(B) Exclude:

- Integration of control tactics into systems for managing single pests or pest complexes. (Use PA 216)
- Development of sampling protocols or predictive models for pest complexes. (Use PA 216)
- Biological control. (Use PA 215)
- Development of remote sensing instruments. (Use PA 404)
- Evaluation of germplasm for genetic variation in resistance to pests. (Use PA 202)
- Forest insects when work is not at the IPM systems level. (Use PA 121, 123, 124, or 125)
- The role of insects, mites, and other arthropods in disease transmission. (Use PA 212)
- Insect pests affecting humans. (Use PA 721 or 722)
- Movement and dispersal resulting from airborne transport of pests. (Use PA 132 or 133)

Figure 7.1

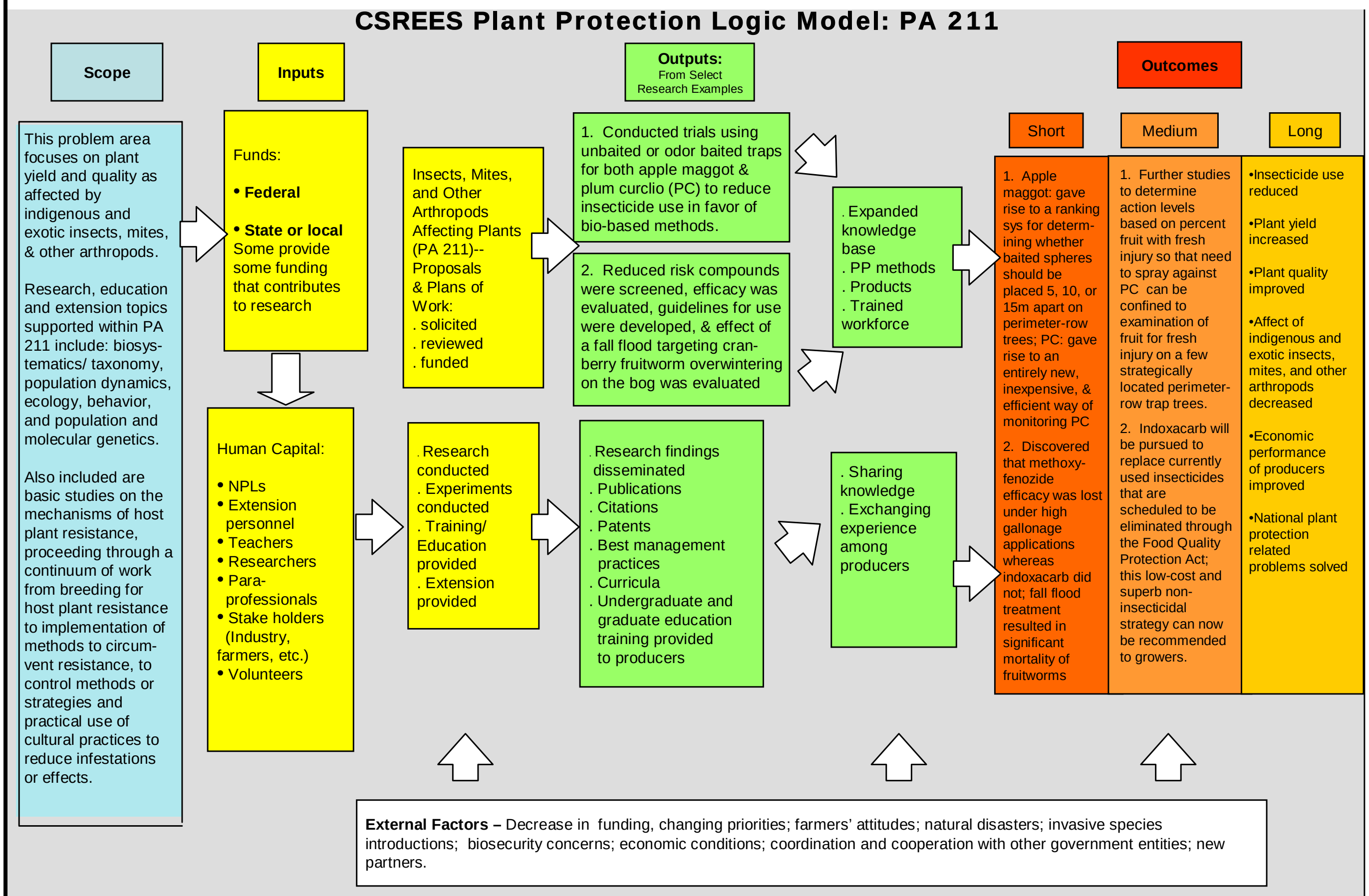

CSREES Plant Protection Logic Model: PA 211
Scope
Inputs
Outputs: From Select Research Examples
Outcomes
Short
Medium
Long
This problem area focuses on plant yield and quality as affected by indigenous and exotic insects, mites, & other arthropods.
Research, education and extension topics supported within PA 211 include: biosys-tematics/ taxonomy, population dynamics, ecology, behavior, and population and molecular genetics.
Also included are basic studies on the mechanisms of host plant resistance, proceeding through a continuum of work from breeding for host plant resistance to implementation of methods to circum-vent resistance, to control methods or strategies and practical use of cultural practices to reduce infestations or effects.
Funds:
• Federal
• State or local Some provide some funding that contributes to research
Human Capital:
• NPLs
• Extension personnel
• Teachers
• Researchers
• Para-professionals
• Stake holders (Industry, farmers, etc.)
• Volunteers
Insects, Mites, and Other Arthropods Affecting Plants (PA 211)-- Proposals & Plans of Work: . solicited . reviewed . funded
. Research conducted . Experiments conducted . Training/ Education provided . Extension provided
1. Conducted trials using unbaited or odor baited traps for both apple maggot & plum curclio (PC) to reduce insecticide use in favor of bio-based methods.
2. Reduced risk compounds were screened, efficacy was evaluated, guidelines for use were developed, & effect of a fall flood targeting cran-berry fruitworm overwintering on the bog was evaluated
. Research findings disseminated . Publications . Citations . Patents . Best management practices . Curricula . Undergraduate and graduate education training provided to producers
. Expanded knowledge base . PP methods . Products . Trained workforce
. Sharing knowledge . Exchanging experience among producers
1. Apple maggot: gave rise to a ranking sys for determ-ining whether baited spheres should be placed 5, 10, or 15m apart on perimeter-row trees; PC: gave rise to an entirely new, inexpensive, & efficient way of monitoring PC
2. Discovered that methoxy-fenozide efficacy was lost under high gallonage applications whereas indoxacarb did not; fall flood treatment resulted in significant mortality of fruitworms
1. Further studies to determine action levels based on percent fruit with fresh injury so that need to spray against PC can be confined to examination of fruit for fresh injury on a few strategically located perimeter-row trap trees.
2. Indoxacarb will be pursued to replace currently used insecticides that are scheduled to be eliminated through the Food Quality Protection Act; this low-cost and superb non-insecticidal strategy can now be recommended to growers.
•Insecticide use reduced
•Plant yield increased
•Plant quality improved
•Affect of indigenous and exotic insects, mites, and other arthropods decreased
•Economic performance of producers improved
•National plant protection related problems solved
External Factors – Decrease in funding, changing priorities; farmers' attitudes; natural disasters; invasive species introductions; biosecurity concerns; economic conditions; coordination and cooperation with other government entities; new partners.

Figure 7.2
Accomplishments and Needs Summary for PA 211

Accomplishments

Prevention
- Board on Agriculture (NRC) report on agricultural bioterrorism
- Training on ID of key pest groups (e.g., Homoptera)
- Development of resistant crop varieties
- Post-harvest resistant packaging

Biology and Ecology
- Global warming – documentation of range shifts of species
- Proactive biological control of weeds programs (e.g., leafy spurge)
- Use of buffer strips, trap crops
- Honey bee genome
- Bombyx mori genome
- New order – Mantophasmatodea
- Determination of host ranges for key pests
- disruption of mating by use of sterile insects or the chemicals insects use to find mates

Epidemiology
- West Nile transmission cycle
- Role of soybean aphid in virus transmission

Detection and Diagnosis
- National Plant Diagnostic Labs
- Detection and distribution of invasive species , e.g., Soybean aphid, pink hibiscus mealybug, Haanchen mealybug

Management
- BT resistance management
- Web-based tracking/reporting for key invasive species
- Web-based pest alerts, control guides
- Site- and Target-oriented management implemented for some species

Economics and Safety
- BT corn and monarchs
- Web-based pesticide safety education sites
- Economic thresholds established for key species
- Safer, less risky pesticides developed
- FQPA issues addressed

Needs

Prevention
- Urban pest management
- Human-insect interactions
- Promote characterization of ecological factors limiting spread of introduced, invasive species

Biology and Ecology
- Vector ecology and management
- Insect biodiversity and restoration
- Interface between urban and rural habitats
- Promote research on aerobiology in relation to insect movement
- knowledge of potential non-target effects on native ecosystems of introduced species
- Expand genomics and bioinformatics research with potential for insect manipulation
- Bioceutical and insecticeutical research and exploration
- Insects as protein/ fatty acid sources in food
- Mining insects for medically useful chemicals

Epidemiology
- Role of insects in transmission of food-borne pathogens
- Role of insects in the ecology of antibiotic resistance in microbes

Detection and Diagnosis
- Detection of invasive species at low populations
- More rapid and inexpensive detection tools
- More efficient use of remote sensing technology
- Insects as biosensors

Management
- Management strategies for new invasive species
- Augmentative biological control
- Greater emphasis on managing pests under organic production practices
- Research on conservation and use of exotic germplasm to manage introduced pests

Economics and Safety
- Greater emphasis on ecological assessment of transgenic crops
- Promote research on preservation/management of native and managed pollinators

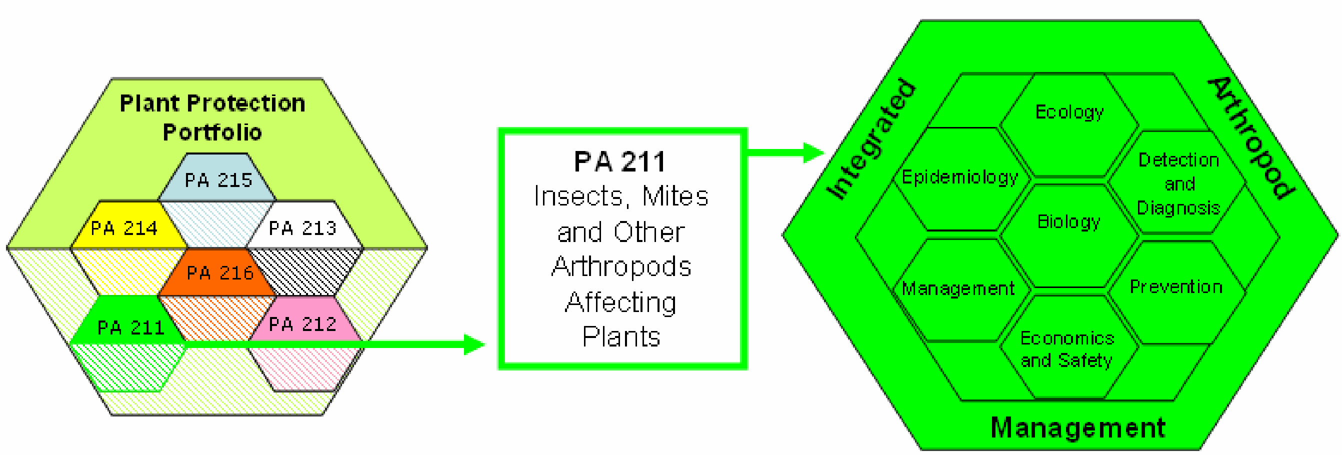
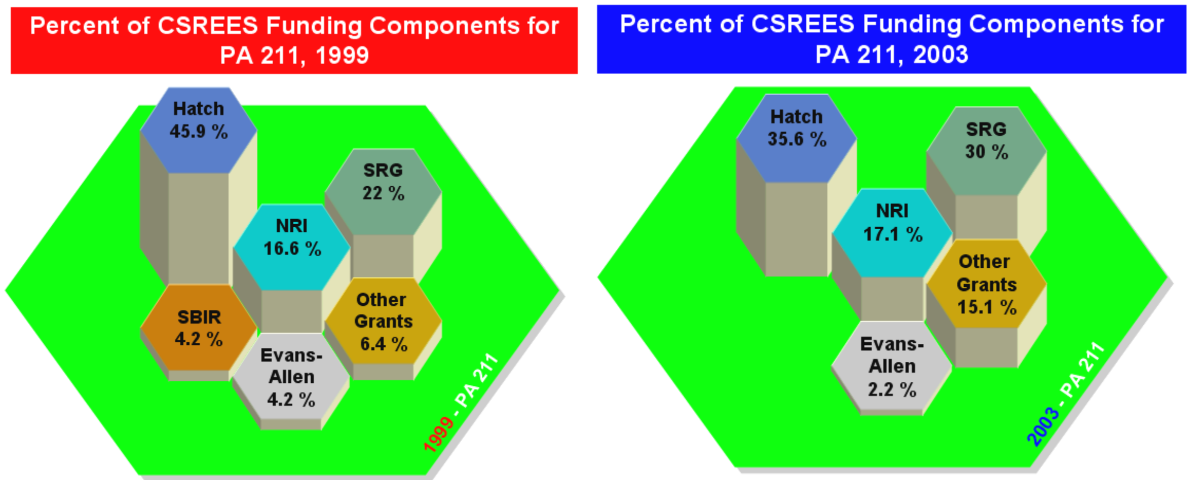


Figure 7.3



7.2 Focus on Critical Needs

The peer review process ensures that competitively-awarded CSREES projects focus on scientifically critical areas. The Agricultural Research Extension and Education Reform Act (AREERA) process requires that formula-funded projects reflect stakeholder priorities. The competitive review process encourages innovative ideas that are likely to open new research approaches to enhancing U.S. agriculture. A proven mechanism for stimulating new scientific research, the process increases the likelihood that investigations addressing important, relevant topics using well-designed and well-organized experimental plans will be funded. Each year, panels of scientific peers meet to evaluate and recommend proposal based on scientific merit, investigator qualifications, and relevance of the proposed research to US agriculture.

(A) Analysis of CRIS Data

Figure 7.3 shows a graphic comparison of funding percentages for PA 211 from 1999 & 2003. In 1999, CSREES invested a total of $16,286,000 in PA 211. Of this total, 45.9% came from Hatch funds, 4.2% from Evans-Allen funds and 22% from Special Research Grants (SRG). The National Research Initiative (NRI) invested $2,708,000 in arthropod-related programs dedicated to PA 211, which was 16.6% of the total CSREES investment. Together, these three non-competitive sources of funding accounted for 72.1% of all funds allocated by CSREES to PA 211, and combined with the NRI Program represented 88.7% of all the CSREES funds invested in plant protection. The breakdown of funding by commodity area is presented in Table 7.1 (found on page 76).

Table 7.1
Distribution of CSREES Investment in PA 211 for 1999

Description of SOI	Hatch	%	Evans -Allen	%	SRG	%	NRI	%	SBIR	%	Other Grants	%	CSREES	%
Invertebrates	1,340	28.9	0	0	996	21.4	1,810	39	278	6	220	4.7	4,644	100
Vegetables	1,085	44.2	59	2.4	810	33	139	5.7	0	0	363	14.8	2,456	100
Oilseed & Oil Crops	722	39	226	12.2	663	35.9	0	0	0	0	238	12.9	1,849	100
Grain Crops	985	56.7	204	11.7	233	13.4	204	11.7	0	0	112	6.4	1,737	100
Deciduous & Small Fruit	412	34.6	0	0	741	62.2	38	3.2	0	0	0	0	1,919	100
Fiber Crops	544	55.9	0	0	5	0.5	200	20.6	113	11.6	112	11.5	973	100
Weeds	0	0	103	100	0	0	0	0	0	0	0	0	103	100
Misc & New Crops	101	100	0	0	0	0	0	0	0	0	0	0	101	100
Top 6 SOI	5,088	39.6	489	3.8	3,448	26.8	2,391	18.6	391	3	$1,045	8.1	12,850	100
2 Small Focus Areas	101	49.5	103	50.5	0	0	0	0	0	0	0	0	204	100
25 Other SOI	2,279	70.5	85	2.6	130	4	317	9.8	291	9	0	0	3,232	100
Total	**$7,468**	**45.9**	**$677**	**4.2**	**$3,578**	**22**	**$2,708**	**16.6**	**$682**	**4.2**	**$1,045**	**6.4**	**$16,286**	**100**

In 2003, CSREES investment in PA 211 had increased to $19,177,000. Hatch funds accounted for 35.6% of the total and together with other non-competitive sources of funding for PA 211 accounted for 69% of the total. The increase in the other grants category for 2003 is due to the authorization and appropriations for 406 programs. The continued maturation of the CSREES Integrated Research, Education and Extension grant programs, such as the Risk Avoidance and Mitigation Program (RAMP), the Crops at Risk Program (CAR), the Methyl Bromide Transitions Program, and the Organic Transitions Program, accounted for some funds invested in PA 211. The National Research Initiative Program invested $3,381,000 in insect-related programs dedicated to PA 211 in 2003, which was 17.1% of the total CSREES investment. The CSREES investment in PA 211 in 2003 represented 24% of the total investment in all of plant protection. The breakdown of funding by commodity area is presented in Table 7.2.

Table 7.2
Distribution of CSREES Investment in PA 211 for 2003

Description of SOI	Hatch	%	Evans-Allen	%	SRG	%	NRI	%	Other Grants	%	CSREES	%
Invertebrates	1,858	33	0	0	1,262	22.4	2,262	40.1	256	4.5	5,638	100
Deciduous & Small Fruit	525	23.1	0	0	1,187	52.3	45	2	512	22.6	2,269	100
Vegetables	962	48.2	212	10.6	821	41.1	0	0	2	0.1	1,996	100
Grain Crops	777	49.8	0	0	309	19.8	0	0	474	30.4	1,561	100
Fiber Crops	455	34.4	0	0	53	4	355	26.9	459	34.7	1,322	100
Plants, General	338	29.5	0	0	551	48.1	100	8.7	156	13.6	1,145	100
Oilseed & Oil Crops	350	34	0	0	341	33.1	105	10.2	234	22.7	1,029	100
Tropical / Subtropical	106	20.8	0	0	403	79.2	0	0	0	0	509	100
Agricultural Supplies	75	27.2	0	0	156	56.5	0	0	45	16.3	276	100
Top 7 SOI	5,265	35.2	212	1.4	4,524	30.2	2867	19.2	2,093	14	14,960	100
2 Small Focus Areas	181	23.1	0	0	559	71.2	0	0	45	5.7	785	100
23 Other SOI	1,600	39.7	230	5.7	845	21	514	12.7	840	20.8	4,032	100
Total	**$7,046**	**35.6**	**$442**	**2.2**	**$5,928**	**30**	**$3,381**	**17.1**	**$2,978**	**15.1**	**$19,777**	**100**

7.3 Identification of Emerging Issues

Setting priorities is important to facilitate scientific and technological advances to meet the challenges facing US agriculture. Congress sets the budgetary framework by providing funds to CSREES. Members of Congress also make recommendations for the scientific and programmatic administration through appropriation language and through their questions and comments during Congressional hearings. Input into the priority-setting process is sought from a variety of customers and stakeholders. The scientific community provides input through the proposals it submits each year as well as through the proposal evaluation and funding recommendations of individual peer-review panels.

Review panels for competitive programs, Federal interagency working groups, stakeholder workshops, the National Research Council, participation in multi-state projects with (AES), Agricultural Research Service (ARS), and other researchers are examples of important mechanisms for CSREES to identify emerging issues for PA 211. National Program Leaders attend scientific and professional meetings to stay current on scientific trends that should be reflected in CSREES programs and in the coordination of priority setting with other federal agencies. NPLs also participate in meetings with representatives of key commodity groups and other user groups to discuss these stakeholders' current priorities, learn ways that CSREES can assist in meeting their needs, and solicit comments and suggestions.

7.4 Integration of CSREES Programs

Through linking multi-functional projects, multi-institutional activities that create links across funding sources, CSREES creates a mechanism for integrating its PA 211 activities in competitive grants, formula funds, and special grants activities that may otherwise be disjointed.

7.5 Multidisciplinary Balance / Interdisciplinary Integration

CSREES linking projects are multi-institutional and multi-disciplinary. Through these projects, CSREES is able to stimulate the integration of current scientific advances with national stakeholder needs for applied research. Both mission-linked research and fundamental research are supported by CSREES. Mission-linked research targets specific problems, needs, or opportunities. Fundamental research – the quest for new knowledge about agriculturally important organisms, processes, systems, or products – opens new directions for mission-linked research. Both mission-linked research and fundamental research are essential to the sustainability of agriculture. Most multi-state committee activities are multi-disciplinary and multi-functional.

<u>Quality</u>

7.6 Significance of Findings and Outputs

CSREES-funded projects focusing on arthropods affecting plants have resulted in many high-impact publications in well-regarded journals (see examples below). They have also supported graduate student and postdoctoral training in entomology and related disciplines.

7.7 Stakeholder Assessment

CSREES seeks stakeholder input with regard to portfolio composition, program direction and research priorities. Examples of activities soliciting stakeholder input are as follows:

(A) *Plants and Pest Biology stakeholder workshop,* Crystal City, VA, November 14, 2002 Provided a forum for stakeholders to review and contribute feedback on the agency's research priority issue areas that CSREES is considering multi year funding. The issue areas are: (1) Agricultural and Environmental Quality, (2) Agricultural Security, (3) Genomics and Food and Fiber Production, (4) Obesity, Human Nutrition and Food Security, (5) Food Safety, and (6) Rural and Community Development. Feedback from this workshop helped to focus CSREES portfolios including the Plant Protection portfolio.

(B) IR-4 uses an extensive stakeholder driven process to prioritize research to ensure that it is focusing on the most critical pest management needs of the specialty crop producers. The priority setting process engages representatives from state and federal agricultural scientific communities, state extension systems, commodity and growers groups, the crop protection industry, food processors, and state and federal regulators.

(C) Stakeholders are involved in every aspect of IPM, Sustainable Agricultural Research and Education Program (SARE) and NPDN Center management, planning and program delivery. The IPM Centers and regional SARE programs work to connect a diverse array of people who have an interest in pest management policy and implementation throughout the region. These include pest management users (farmers, nurserymen, park and turf managers, building superintendents, pest control operators, homeowners, gardeners, and others), consumer and environmental groups, governmental regulatory agencies, researchers, and educators. IPM Centers network these groups both through its internal organization (Advisory Committee, Stakeholder groups, State Project Leaders) and through development of electronic communications structures such as email lists, online bulletin boards, and web pages.

7.8 Alignment of Portfolio with Current Issues

Peer review of submitted proposals and NPL expertise assure that funded projects are aligned with the current state of science-based knowledge.

7.9 Methodology and Use of Funded Projects

This portfolio leads to solutions to National plant protection problems, improved economic performance for procedure and long term protection of the nation's food system, plant biosecurity and the environment.

Performance

7.10 Portfolio Productivity

Portfolio productivity is evidenced primarily by publications in well-regarded peer-reviewed journals (see Section 7.16 Examples of Research Accomplishments). Accomplishments described in annual CRIS reports, citations, and presentations at scientific and other professional meetings demonstrate productivity. Portfolio productivity in PA 211 is evidenced by commercially viable products and new discoveries.

7.11 Portfolio Completeness

Portfolio completeness is demonstrated through submitted annual progress reports (CRIS), termination reports and accomplishment reports. Some aspects of the portfolio in PA 211 are more complete than other aspects. Where possible, CSREES coordinates externally with other Federal agencies to address knowledge gaps. One example of such coordination is the partnership with the EPA and CSREES administration of the Pesticide Safety Education Program (PSEP). (See Section 7.16 for examples of projects funded by CSREES through this program).

7.12 Portfolio Timeliness

Portfolio timeliness of PA 211 is evidenced through annual performance reports (CRIS), termination reports, and accomplishments reports such as plan of work reports and science and education impacts. Peer review of competitive funding serves to ensure that funded projects are timely and take advantage of state-of-the-art methods.

7.13 Agency Guidance Relevant to Portfolio

Agency guidance to applicants is provided primarily in Requests for Applications (RFAs). Annual review and updating of RFA language is provided upon request for PA 211. Responses to congressional inquiries are provided as requested.

7.14 Portfolio Accountability

The agency solicits stakeholder input in determining the scope and priorities of its research, education and extension portfolio. Input is solicited in stakeholder workshops and other activities that solicit input from scientific communities (see Section 7.7 Stakeholder Assessment above). Accountability is provided through annual reports (CRIS), and accomplishment reports.

7.15 References and Evidentiary Materials

See file folders of evidentiary material, which includes publications, books, journal articles, websites, etc.

7.16 Examples of Research Accomplishments

(A) Bio-Based Methods of Reducing Insecticide Use Against Two Key Apple Pests in Massachusetts

Program/Project: For both apple maggot and plum curculio, the management approach involved trials using un-baited or odor-baited traps placed in blocks of apple trees in commercial orchards.

Impact: Results of research on plum curculio (PC) have given rise to an entirely new, inexpensive and efficient way of monitoring PC using perimeter-row trap trees baited with grandisoic acid and benzaldehyde. Once action levels based on percent fruit with fresh injury are determined through future studies, sampling to determine need to spray against PC can be confined to examination of fruit for fresh injury on a few strategically located perimeter-row trap trees. Results of research on Apple Maggot have given rise to a ranking system for determining whether spheres baited with a five-component blend of attractive odor should be placed 5, 10 or 15m apart on perimeter-row trees to achieve direct control. A combination of large trees, susceptible perimeter-row cultivars and woods as adjacent habitat would call for traps to be 5m apart, whereas a combination of small trees, tolerant perimeter-row cultivars and open field as adjacent habitat would call for traps to be 15 m apart.

(B) North Carolina- Sustains Cotton Production with Tansgenic Technology

Program/Project: Bollgard cottons that produce an internal insecticidal Bt toxin effective against caterpillar pests such as bollworms, *Helicoverpa zea*, have revolutionized insect management by ensuring against crop losses while minimizing the environmental impacts of insect control. Insect management achieved through this novel type of plant resistance is not only effective, but is much more convenient for the cotton farmer than conventional insecticides and often is more cost effective. If this technology is to be sustained, the evolution of resistance by insects must be delayed. One way to help delay the resistance development is to require that farmers plant refuges of conventional cotton. While the Environmental Protection Agency granted a five-year extension for the general Bollgard registration late in 2001, the 5% unsprayed refuge option will remain in effect only until the end of 2004, at which time it will be reviewed by EPA to determine whether or not this specific option will be continued. At that time, EPA may require changes in refuge size, structure and deployment. In an effort to determine if temporal and spatial production of *H. zea* from various crop hosts are effective for Bt resistance management, researchers at NC State University in 2002 measured bollworm production from various crop hosts. Larvae were monitored in commercial crop fields and side-by-side plantings.

Impact: The initial year of research confirmed that non-Bt crop hosts produce sufficient nonselected bollworm moths to substantially delay resistance evolution. There appears to be no rationale for requiring farmers to plant increased acreages of conventional cotton refuge. In fact, this research suggests that planting a conventional cotton refuge is unnecessary in regions of the cotton belt where large acreages of alternate crop hosts are grown. Elimination of the refuge requirement would relieve cotton producers from the burden imposed by an unnecessary regulatory requirement.

(C) From Science and Education Impacts

The place is bugged. One way to combat damaging imported pests is to import their natural predators. The insect quarantine facility at **Montana State** is one of a few high-security containment labs in the United States doing just that. Researchers have approved the release of more than 40 exotic insects to control invasive plants, including purple loosestrife, spotted knapweed, leafy spurge, St. John's wort, and musk thistle. **Connecticut** researchers introduced more than 250,000 beetles into 37 locations in the state to weaken purple loosestrife's hold. Saltcedar spreads rapidly along river banks, displacing native plants and trees, consuming precious water and impeding drainage in the western United States. **Nevada** led a multi-state effort that introduced a special Eurasian beetle to control the economically devastating brush. Researchers use their findings to launch a saltcedar biocontrol program slated for implementation in 14 western states in 2004.

Battle of the bugs. Let the good bugs take on the bad bugs. The soybean aphid cuts soybean yields by 10 percent to 15 percent, or $20 to $30 per acre. **Wisconsin** researchers have found that farmers battling soybean aphids can reduce yield losses by 50 percent using two forms of biocontrol: the Asia multicolored lady beetle and a parasitic wasp. A **California** entomologist identified a parasitic wasp that effectively controls a destructive eucalyptus parasite. Thanks to this wasp, chemical treatments costing $20,000 to $30,000 per acre are no longer necessary. **Washington State** scientists found a tiny wasp, native to the Northwest, that parasitizes the Eurasian cherry bark tortrix moth. This moth is a serious threat to the multimillion dollar ornamental landscape and fruit plant industries of Washington, Oregon, and British Columbia.

Fatal attraction. Researchers at **Colorado State** found that carbon dioxide given off by corn attracts western corn rootworm larvae. They developed a formulation of granules that produces the gas to lure the pests away from the corn. The technique also is proving effective in attracting and trapping termites.

You collect what? The entomology collection at **Montana State** with its 1.5 million specimens is a repository for the state's insect knowledge, helping scientists, land managers, producers and others identify pests and beneficial species. The collection provided information that helped resolve litigation. Development of a parking lot in Glacier National Park was halted because data from the collection helped identify the area as environmentally sensitive. Entomologists studied cultural practices that led to the emergence of a new wheat pest after information from the collection showed the insect was native to the state and not a migrating pest.

Stop the stem borer. ***Dectes*** stem borer can devastate a field of soybeans, damaging more than half the crop. Larvae weaken the plant stem and cause lodging; control is difficult. **Delaware** Extension evaluated cultural practices and found that varieties resistant to soybean cyst nematode have the greatest tolerance to ***Dectes*** stem borer. They also found that lodging decreased when soybeans were planted at a higher population. Depending on the growing season, growers could increase gross profits by $40 per acre using high-yielding SCN resistant varieties planted in 7.5-inch row spacings.

(D) Examples from the NRI Competitive Program

Genetics of Heliothine Resistance to Bacillus thuringiensis and Its Toxins (NC). Some insects have become virtually immune to most insecticides. This poses a major problem for society because it typically leads to farmers using mixtures of highly toxic compounds to combat these insects. Over the years some farmers have tried to protect their crops using a natural insecticide produced by the bacterium Bacillus thuringiensis. This insecticide, called Bt, is considered to be environmentally benign because it is toxic to a few important pest species, but has no effect on almost all other insects, or on any vertebrates. Recently, genetic engineers moved the genes for producing Bt insecticides from the bacterium into the chromosomes of crop plants. The Bt toxins are now produced by cotton and corn plants on more than 20 million acres of land. The toxin is produced from the seedling stage until harvest, so there is significant and constant selection for pest evolution of resistance to the Bt toxins. Such resistance could cause farmers to return to the use of less benign and more expensive insecticides. Dr. Fred Gould at North Carolina State University works with a number of strains of two major pest species that have become resistant to Bt based on selection with Bt in the laboratory. His team will determine which genes lead to Bt resistance and how these genes interact with each other to produce high levels of resistance. They will use molecular mapping techniques to localize these resistance genes. Once we understand how these genes operate, we will be better able to develop accurate ways to interfere with evolution of resistance in the field.
Dr. Gould said, “My research program has benefited dramatically from NRI financial support, and it has also benefited directly from the NRI peer-review process. Without the NRI, I would not have a research program.”

***Effects of a Novel Bacterium Associated with Parthenogenesis in Encarsia* (AZ).** The symbiotic bacterium *Wolbachia* has diverse reproductive effects on its insect hosts, including parthenogenesis (females producing daughters without mating) in species with haplodiploid genetic systems (in which females develop from diploid eggs and males from haploid eggs). The bacterium causes the chromosome complement of an incipient male egg to double and develop as a female. *Wolbachia* has been thought to be unique in its ability to cause parthenogenesis. *Wolbachia* and other symbiotic bacteria are likely to be an unacknowledged factor in many pest management programs. In addition to the potential liabilities of infection, these bacterial agents may also have tremendous potential as tools to manipulate populations in beneficial ways.
Dr. Martha Hunter at the University of Arizona, Tucson recently found a previously undescribed bacterium that is vertically transmitted, unrelated to Wolbachia, and appears to cause parthenogenetic reproduction in Encarsia, an economically important genus of parasitoid wasps that attacks whitefly and armored scale pests. Dr. Hunter proposes to determine the effects of this newly discovered bacterium in Encarsia spp. hosts. The understanding we gain in studying this new bacterium will broaden our general understanding of the means by which Wolbachia and other bacteria manipulate their hosts and will give insight into how to best use them to improve pest management.

Closterovirus and Insect Interactions (FL). Citrus Tristeza Virus (CTV) causes the most devastating virus disease of citrus, has destroyed entire citrus industries throughout the world and threatens those throughout the U.S. The efficient aphid vector (the brown citrus aphid) entered Florida in 1995 and is killing 20 percent of the Florida trees on the susceptible sour orange rootstock. The Texas and California industries are similarly threatened. Development of resistant trees is the most desirable option. However, approximately 20 years is required to produce virus-resistant trees for use in the field.

The interim management procedure is to genetically engineer mild strains that will interfere with superinfection by severe isolates, as proposed by Dr. William Dawson, University of Florida, Citrus Research and Education Center, Lake Alfred, FL.
One requirement for cross-protecting strains is that they must lack the ability to be transmitted by insects to other citrus varieties that might be susceptible to the cross-protecting virus. To engineer such isolates includes understanding virus and insect interactions. This requires that we understand how virions are assembled and what viral gene products are needed for aphid transmission. In this project, the investigator will examine the formation of virion complexes that are specifically acquired and transmitted by aphids and create mutants and hybrids to define viral genes required for aphid transmission. These studies may enable development of management strategies for CTV-induced diseases in a sustainable approach to retain a viable American citrus industry.

(E) Examples from Critical and Emerging Issues

Soybean aphid, *Aphis glycines*, a new invasive species on soybean.
Situation: The soybean aphid was first discovered in the US during the summer of 2000. In the first two growing seasons after discovery of the soybean aphid in the North Central states the CSREES Critical and Emerging Pests and Diseases program funded key seed grants that resulted in initiation of both research and extension activities to address management of the soybean aphid. These included:

- 2001 Proposal Number 2001-03151. Voegtlin, D.J.;Hogg, D.B.; Ragsdale, D.W.; O'Neil,R.J.; and DiFonzo, C.D. *Aphis glycines* –Overwintering distribution and spring migration from overwintering host. Amount: $27,938.
- 2001 Proposal Number 2001-03139. Perry, K.L. The soybean aphid and disease transmission. Amount: $32,927.
- 2002 Proposal Number 2002-06292. Voegtlin, D.J. Overwintering of *Aphis glycines* on *Rhamnus* spp. Amount: $27,960.
- 2002 Proposal Number 2002-06293. Isard, S.A. Soybean aphid internet reporting and mapping system. Amount: $15,000.

Outcomes and Impacts stemming from these seed grants:

- Establishment of an NC rapid response multi-state research committee addressing the soybean aphid in a coordinated manner. This committee involved Land Grant University scientists and key APHIS personnel and the commodity organizations with an interest in soybean production.
- Identified, demonstrated and tracked the movement and occurrence of soybean aphid and identified primary and secondary hosts for the species. A web based reporting and mapping system in now in place to track movement and population levels of the aphid.
- Established the potential of the soybean aphid as a transmitter of damaging soybean diseases. Soybean aphids are capable of transmitting several important viruses, including alfalfa mosaic, soybean mosaic and bean yellow mosaic. These viruses commonly occur together and form a complex.
- Development of a Pest Alert on the soybean aphid, now widely distributed through the USDA Regional IPM Centers. This Pest Alert has now been revised based on updated research information and is available on the web.
- Incorporation of research and extension activities related to the soybean aphid into a multi-state research committee addressing the full complex of pest species threatening soybean production throughout the U.S. (Hatch multi-state committee S-1010).
- Funding from Critical and Emerging Pests and Diseases, Hatch multi-state funding as well as funding from APHIS, the United Soybean Board and other state and local sources has resulted in development of the best currently available strategies for management of this invasive species.

Section 8: Problem Area 212
Pathogens and Nematodes Affecting Plants

Relevance

8.1 Scope

PA 212, plant pathogens and nematodes, is a highly relevant section of the CSREES portfolio as plant diseases are a significant drain on the agricultural and natural resource production and financial productivity in the country. PA 212 comprises approximately 1/3 of the Plant Protection Portfolio budget, having increased from $21.2 to $25.6 million between 1999 and 2003. The scope covers research, education, and extension concerning the health of crop, range and forest lands of the United States (approximately 1 billion acres), and agricultural bio-security. In general, the discipline focus covers prevention, biology and ecology of pathogens, detection and diagnosis technology, epidemiology, management, and economic sustainability and safety. Similarly, topical areas relative to agricultural bio-security and disaster recovery are detection, diagnosis, mitigation, control, and recovery. Of the 1,728 projects in 2003, about 82% of the PA 212 portfolio expenditure is primarily concentrated in large acreage and/or high value targets, viz (in order of descending priority) fruits and vegetables, grain crops, tree crops (including forests), oilseed and oil crops, ornamentals and turf, potato, fiber crops, and pasture and forage. The other 18% goes to miscellaneous crops and basic subject matter areas such as microbiology and microbial ecology.

The portfolio budget comes from various sectors. The largest contribution is via Hatch grants through which moneys go directly to Plant Pathology departments and Multi-State committees. This funding mechanism has undergone a 10% decrease in the past 5 years. The NRI competitive funding budget in this sector also decreased about 10% over the past 5 years, being replaced by an increase in congressionally mandated, topic and state-specific Special Research Grant dollars (see Figures 8.3).

This area focuses on yield and quality affected by indigenous and exotic bacteria, fungi, nematodes, viruses, and other pathogens.

The logic model for PA 212 is illustrated in Figure 8.1 (found on page 85). Major accomplishments and needs summaries for PA 212 are provided in Figure 8.2 (found on page 86). Major subject area categories defined for PA 212 are shown at the bottom of Figure 8.2.

(A) Areas of work include but are not limited to:

- Mechanisms of infection, reproduction, systemic spread, and pathogenesis.
- Epidemiology, ecology, and behavior.
- Biosystematics/taxonomy.
- Mechanisms of host plant resistance.
- Breeding (including genetic engineering) for host plant resistance.
- Cultural practices to reduce incidence, severity, or impacts.
- The role of insects, mites, and other arthropods in pathogen transmission.
- Efficacy, product performance, application technology, and population management with conventional pesticides and biopesticides (including pheromones and growth regulators).
- Pathogen resistance to control methods and strategies.

- Development of sampling protocols (including economic injury levels, action thresholds, and remote sensing and other automated sampling methodologies) and predictive models for pathogen or nematode species.
- Population and molecular genetics of nematodes (e.g., sequencing, proteomics, gene expression, regulation).
- Biosecurity measures to limit invasive pathogens and nematodes in plant management systems.

(B) Exclude:

- Integration of control tactics into systems for managing pathogen or nematode species complexes. (Use PA 216)
- Development of sampling protocols and predictive models for pathogen or nematode species complexes. (Use PA 216)
- Biological control. (Use PA 215)
- Development of remote sensing instruments. (Use PA 404)
- Evaluation of germplasm for genetic variation in resistance to pathogens or nematodes . (Use PA 202)
- Fundamental areas of plant genetics. (Use PA 201)
- Movement and dispersal resulting from airborne transport of pathogens or nematodes. (Use PA 132 or 133)

Figure 8.1

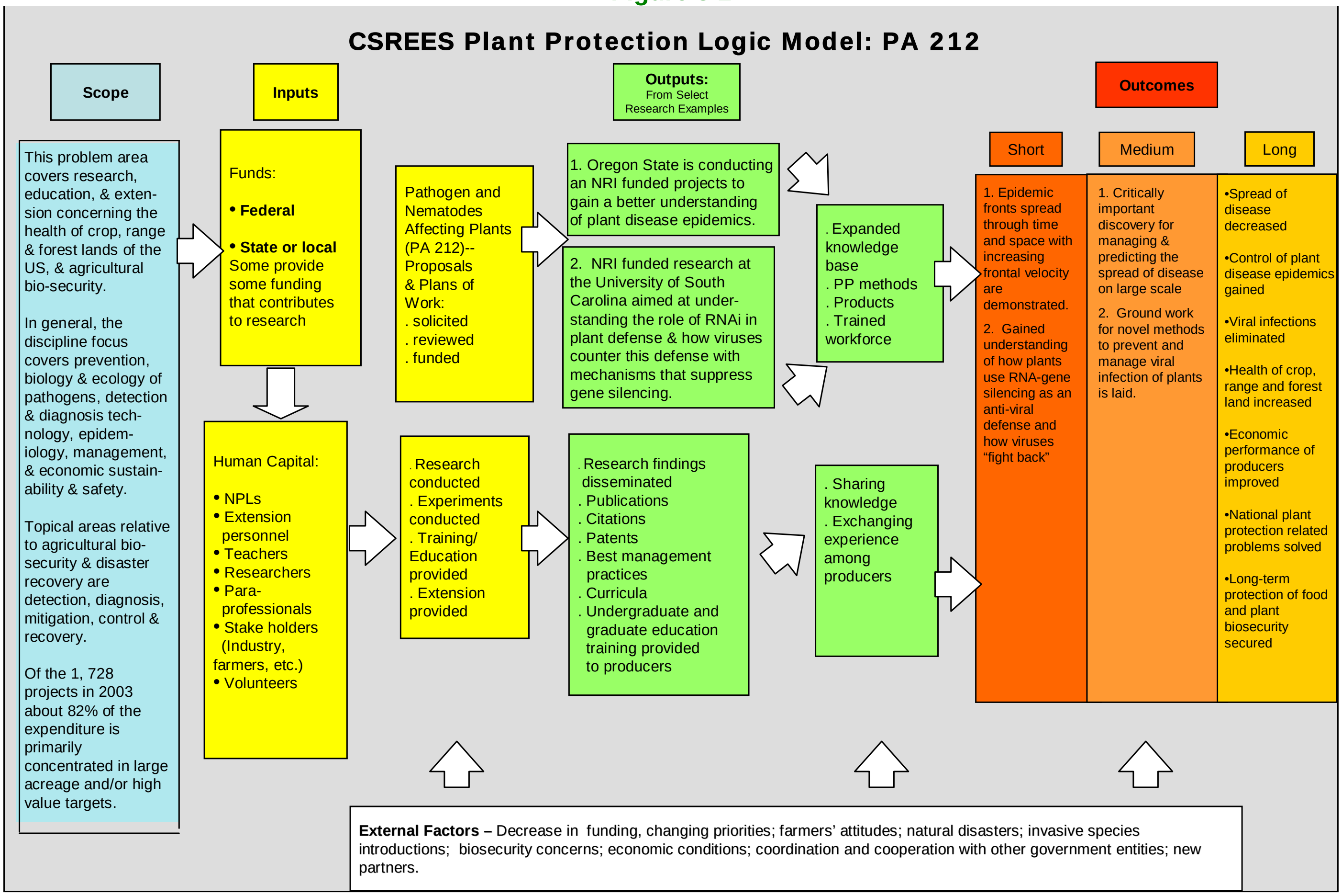

CSREES Plant Protection Logic Model: PA 212
Scope
Inputs
Outputs: From Select Research Examples
Outcomes
Short
Medium
Long
This problem area covers research, education, & extension concerning the health of crop, range & forest lands of the US, & agricultural bio-security.
In general, the discipline focus covers prevention, biology & ecology of pathogens, detection & diagnosis technology, epidemiology, management, & economic sustainability & safety.
Topical areas relative to agricultural bio-security & disaster recovery are detection, diagnosis, mitigation, control & recovery.
Of the 1, 728 projects in 2003 about 82% of the expenditure is primarily concentrated in large acreage and/or high value targets.
Funds:
• Federal
• State or local Some provide some funding that contributes to research
Human Capital:
• NPLs
• Extension personnel
• Teachers
• Researchers
• Para-professionals
• Stake holders (Industry, farmers, etc.)
• Volunteers
Pathogen and Nematodes Affecting Plants (PA 212)-- Proposals & Plans of Work: . solicited . reviewed . funded
. Research conducted . Experiments conducted . Training/ Education provided . Extension provided
1. Oregon State is conducting an NRI funded projects to gain a better understanding of plant disease epidemics.
2. NRI funded research at the University of South Carolina aimed at understanding the role of RNAi in plant defense & how viruses counter this defense with mechanisms that suppress gene silencing.
. Research findings disseminated . Publications . Citations . Patents . Best management practices . Curricula . Undergraduate and graduate education training provided to producers
. Expanded knowledge base . PP methods . Products . Trained workforce
. Sharing knowledge . Exchanging experience among producers
1. Epidemic fronts spread through time and space with increasing frontal velocity are demonstrated.
2. Gained understanding of how plants use RNA-gene silencing as an anti-viral defense and how viruses "fight back"
1. Critically important discovery for managing & predicting the spread of disease on large scale
2. Ground work for novel methods to prevent and manage viral infection of plants is laid.
•Spread of disease decreased
•Control of plant disease epidemics gained
•Viral infections eliminated
•Health of crop, range and forest land increased
•Economic performance of producers improved
•National plant protection related problems solved
•Long-term protection of food and plant biosecurity secured
External Factors – Decrease in funding, changing priorities; farmers' attitudes; natural disasters; invasive species introductions; biosecurity concerns; economic conditions; coordination and cooperation with other government entities; new partners.

Figure 8.2
Accomplishments and Needs Summary for PA 212

Accomplishments

Biology and Ecology
- Ability to identify some unculturable organisms
- Characterizing take-all suppressive soils
- Ecology of vectors
- Genomic sequencing
- Molecular communication between plants and microbes
- Programmed cell death

Epidemiology
- Understanding dynamics of spread
- Understanding mechanisms of spread
- Forecasting of disease based on knowledge of environmental parameters

Detection and Diagnosis
- Pathogen's genetic fingerprint used for rapid diagnosis
- Pathogenicity sequences identified
- Digital diagnosis / NPDN
- Seed propagation certification programs
- Quarantine programs
- Traditional detection methods

Prevention
- Disease free seed and stock for some diseases
- Breeding resistant plants
- Novel types of resistance genes
- Marker assisted selection

Management
- Biological control –e.g., A. radiobacter, Trichoderma, nematodes
- Chemical control (pathogen and/or vector)
- Cultural practices, IPM

Economics and Safety
- Disease loss estimates
- Trade embargoes – international and interstate
- Safer pesticides, reduced use through IPM

Needs

Biology and Ecology
- Functional genomics, proteomics, bioinformatics
- Non-host resistance
- Publicly accessible databases for genome-enabled biology

Epidemiology
- Influence of global change on pathogen spread and disease establishment
- Accurate determination of disease origin

Detection and Diagnosis
- Ability to detect individuals within a microbial population
- Rapid / high-throughput methods of detection (user friendly/economical)
- Genomic reclassification of microbial taxonomy
- Culture collection and characterization, and specific DNA probes for identification
- Other pathogens genetic fingerprint for rapid diagnosis
- Other pathogenicity sequences

Prevention
- Isolate resistance genes, create resistance genes
- Interfere with mechanisms of signaling, pathogen's virulence systems
- Durable resistance (understanding)

Management
- BC agents – establishment, mechanisms, compatibility
- Alternatives to methyl bromide
- Post-harvest disease
- Chemical induction of resistance
- Chemical resistance management

Economics and Safety
- Better understanding of impacts of diseases
- Development of sustainable production practices
- Development of trace-back

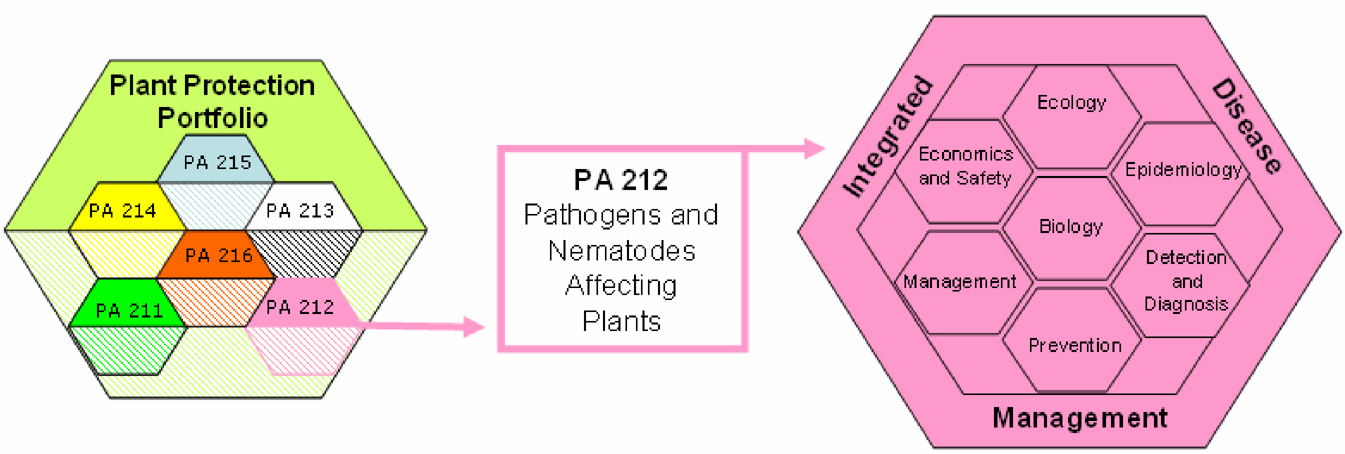
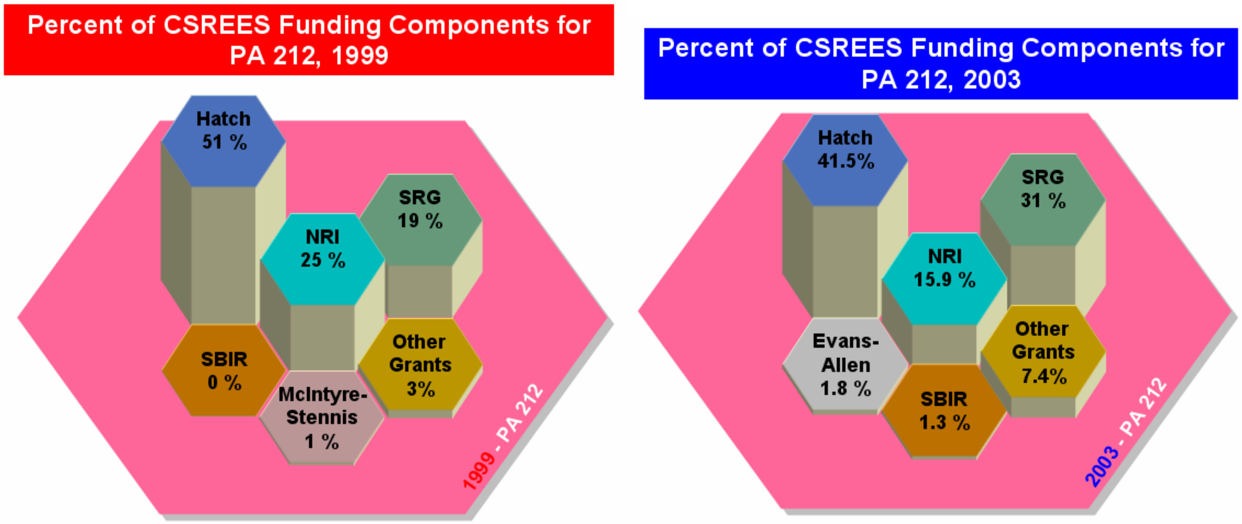


Figure 8.3



8.2 Focus on Critical Needs

Ability to focus on critical issues, topics, and needs of nation. Plant Pathology as a discipline requires flexibility to deal with significant crises while maintaining sustained support for basic, ground breaking research. PA 212 has been quite resilient in ability to deal with the changing scientific demands of the country. NRI projects on genomics, host-parasite interface, and plant bio-security are all cutting edge programs, responsive to needs considered high priority by the scientific community and client base.

(A) Analysis of CRIS Data:

Figure 8.3 shows a graphic comparison of funding percentages for PA 212 from 1999 & 2003. In 1999, CSREES invested a total of $21,215,000 in PA 212. Of this total, 51% came from Hatch funds, 0.5% from McIntire-Stennis funds, 19.4% from Special Research Grants (SRG). Together, these three non-competitive sources of funding accounted for 70.9% of all funds allocated to PA 212. The National Research Initiative (NRI) invested $5,383,000 in programs dedicated to PA 212, which equates to 25.4% of the total. These four funding sources therefore accounted for 96.3% of the CSREES funding invested in PA 212. The CSREES investment in PA 212 in 1999 represented 32.7% of the total funds invested in all of plant protection. The breakdown of funding by commodity area is presented in Table 8.1 (found on page 88) for 1999.

Table 8.1
Distribution of CSREES Investment in PA 212 for 1999

Description of SOI	Hatch	%	Mc-Stennis	%	SRG	%	NRI	%	SBIR	%	Other Grants	%	CSREES	%
Vegetables	1,954	45.8	0	0	1,009	23.7	1,126	26.4	0	0	175	4.1	4,264	100
Grain Crops	1,808	69.5	0	0	139	5.3	654	25.1	0	0	0	0	2,601	100
Microorganisms	854	34	1	0	59	2.3	1,408	56.1	22	1.9	167	6.6	2,512	100
Deciduous & Small Fruit	1,233	56.7	17	0.8	779	35.8	64	2.9	0	0	82	3.8	2,174	100
Plants, General	513	25.4	0	0	194	9.6	1,317	65.1	0	0	0	0	2,023	100
Oilseed & Oil Crops	971	76.2	0	0	55	4.3	100	7.8	0	0	150	11.8	1,275	100
Invertebrates	98	8.6	0	0	660	57.7	363	31.8	22	1.9	0	0	1,143	100
Tropical / Subtropical	426	40.2	0	0	630	59.4	0	0	0	0	4	0.4	1,061	100
Ornamentals & Turf	831	81.6	0	0	167	16.4	20	2	0	0	0	0	1,018	100
Pasture & Forage Crops	417	61.6	0	0	15	2.2	245	36.2	0	0	0	0	677	100
Top 9 SOI	8,688	48.1	18	0.1	3,692	20.4	5,052	28	44	0.2	578	3.2	18,071	100
1 Small Focus Areas	417	61.6	0	0	15	2.2	245	36.2	0	0	0	0	677	100
16 Other SOI	1,721	69.8	93	3.8	414	16.8	86	3.5	0	0	153	6.2	2,467	100
Total	**$10,826**	**51**	**$111**	**0.5**	**$4,121**	**19.4**	**$5,383**	**25.4**	**$44**	**0.2**	**$731**	**3.4**	**$21,215**	**100**

In 2003, CSREES investment in PA 212 increased to $25,597,000. Hatch funds accounted for 41.5% of the total and together with non-competitive sources of funding for PA 212 accounted for 74.3% of the total. NRI funding in this PA for 1999 was 15.9% of the total, while Small Business Innovation Research (SBIR) program funding was less than 2 %. The CSREES investment in PA 212 in 2003 represented 31.6% of the total investment in all of plant protection. The breakdown of funding by commodity area is presented in Table 8.2 (found on page 89) for 1999.

Table 8.2
Distribution of CSREES Investment in PA 212 for 2003

Description of SOI	Hatch	%	Evans Allen	%	SRG	%	NRI	%	SBIR	%	Other Grants	%	CSREES	%
Microorganisms	952	29	85	2.6	137	4.2	1,542	47	131	4	436	13.3	3,283	100
Oil Seed & Oil Crops	1,162	39.3	0	0	1,199	40.6	397	13.4	0	0	196	6.6	2,955	100
Vegetables	1,574	56.2	120	4.3	917	32.7	99	3.5	0	0	92	3.3	2,802	100
Grain Crops	1,692	60.7	0	0	329	11.8	721	25.9	14	.05	32	1.1	2,788	100
Plants, Gen.	782	32.1	0	0	815	33.4	769	31.5	0	0	72	3	2,438	100
Deciduous & Small Fruit	1,182	49.1	191	7.9	833	34.6	42	1.7	0	0	160	6.6	2,408	100
Invertebrates	230	15.3	0	0	777	51.6	235	15.6	193	12.8	71	4.7	1,507	100
Ornamentals & Turf	697	57.6	0	0	122	10.1	0	0	0	0	391	32.3	1,210	100
Citrus	93	7.8	0	0	1,095	92.2	0	0	0	0	0	0	1,188	1000
Tropical / Subtropical	397	34.8	0	0	743	65.2	0	0	0	0	0	0	1,140	1000
Potato	444	46.4	0	0	290	30.3	173	18.1	0	0	50	5.2	957	1000
Ag. Supplies	94	30.3	0	0	156	50.3	0	0	0	0	60	19.4	310	100
Animals, Gen.	0	0	0	0	279	100	0	0	0	0	0	0	279	100
Weeds	37	36.6	0	0	22	21.8	0	0	0	0	42	41.6	101	100
Top 11 SOI	9,205	40.6	396	1.7	7,257	32	3,978	17.5	338	1.5	1,500	6.6	22,676	100
3 Small Focus Areas	131	19	0	0	457	66.2	0	0	0	0	102	14.8	690	100
18 Other SOI	,1294	58	57	2.6	213	9.5	100	4.5	0	0	292	13.1	2,231	100
Total	**$10,630**	**41.5**	**$453**	**1.8**	**$7,927**	**31**	**$4,078**	**15.9**	**$338**	**1.3**	**$1,894**	**7.4**	**$25,597**	**100**

8.3 Identification of Emerging Issues

When a critical issue emerges, the Hatch Act gives the research, education and extension systems a very effective tool to coordinate and plan research. Identification of emerging issues often comes from the agriculture industry and disciplinary experts in the Land Grant University community. These experts are members of Multi-State Committees such as NCR137 or WCC097 (Table 8.3) which are groups with specific expertise in plant diseases. Emergency committees such as NC503 and 504 are established when a critical issue is just breaking to coordinate and organize research and response.

Table 8.3
Multi-State Committees

Project Number:	Name:
NC129:	Mycotoxins in Cereal Grains
NC215:	Persistence of Heterodera glycines and Other Regionally Important Nematodes
NC227:	Ergot: A New Disease of U.S. Grain Sorghum
NC1015:	Managing Karnal Bunt of Wheat (previously NC503)
SERA008:	Fescue Endophyte Research and Extension (IEG-37)
NCA014:	Plant Pathology
NCR137:	Soybean Diseases
NC504:	Soybean Rust: A New Pest of Soybean Production
WCC020:	Virus and virus like diseases of fruit trees, small fruits, and grapevines
WCC097:	Research on Diseases of Cereals
WCC089:	Potato Virus Disease Control
NCR184:	Management of Small Grain Disease
NCR025:	Diseases of Corn and Sorghum
NCR173:	Biochemistry and Genetics of Plant-Fungal Interactions

The CSREES NPL, Plant Pathology participates in these committees, and thus brings the latest information on what is happening in the field to the planning process. To be able to deal with emerging issues, a competitive funding line, Critical and Emerging issues, allows quick dispersal of funds to researchers to start urgent REE on new and critical problems. In PA 212, since 1999 there have been seed grants concerning Karnal Bunt, Soybean Rust, and Potato Leaf Blite.

8.4 Integration of CSREES Programs

PA 212 has part or all of 3 of REE integrated competitive projects: Methyl Bromide Transitions; Citrus Tristeza Virus; and plant bio-security. Additionally, the National Plant Diagnostic Network is fully integrating university diagnosticians, extension faculty, the regulatory community, and agricultural industry in creating a responsive, interconnected web of technology, knowledge and communications for homeland security.

8.5 Multidisciplinary Balance / Interdisciplinary Integration

Within the field of plant pathology there is a broad range of expertise. The PA 212 portfolio spans that expertise and includes prevention, detection, epidemiology, diagnostics, control (management & mitigation), genomics, host/parasite dynamics, extension/education, etc. Also, within the field there are specialists in different classes of pathogens, and the CSREES portfolio has a blend of projects in virology, nematology, bacteriology, mycology, and mycotoxicology, etc. The programmatic range is from very basic systems level research to extensive e-training and outreach. PA 212 has a good blend of conservative research with the expectation of near-term application, and riskier innovative projects that might have significant pay-off if they work.

Quality

8.6 Significance of Outputs and Findings

CSREES-funded projects focusing on pathogens and nematodes affecting plants have resulted in many high-impact publications in well-regarded journals (see examples Section 8.16). They have also supported graduate student and postdoctoral training in plant pathology and related disciplines.

8.7 Stakeholder Assessment

The Council for Agricultural Science and Technology has said that “through genetic alteration of crops and animals, it now is possible, and will become ever more commonplace, to increase food and fiber production and improve food nutritional properties while limiting environmental stress. Increased agricultural production will be accomplished primarily through increased yields of plants and animal efficiencies, and through decreased losses due to pests and postharvest spoilage.” CSREES seeks stakeholder input with regard to portfolio composition, program direction and research priorities. Examples of activities soliciting stakeholder input are as follows:

(A) *Plants and Pest Biology stakeholder workshop,* Crystal City, VA, November 14, 2002 Provided a forum for stakeholders to review and contribute feedback on the agency’s research priority issue areas that CSREES is considering multi year funding. The issue areas are: (1) Agricultural and Environmental Quality, (2) Agricultural Security, (3) Genomics and Food and Fiber Production, (4) Obesity, Human Nutrition and Food Security, (5) Food Safety, and (6) Rural and Community Development. Feedback from this workshop helped to focus CSREES portfolios including the Plant Protection portfolio.

(B) IR-4 uses an extensive stakeholder driven process to prioritize research to ensure that it is focusing on the most critical pest management needs of the specialty crop producers. The priority setting process engages representatives from state and federal agricultural scientific communities, state extension systems, commodity and growers groups, the crop protection industry, food processors, and state and federal regulators.

(C) Stakeholders are involved in every aspect of IPM, Sustainable Agricultural Research and Education Program (SARE) and NPDN Center management, planning and program delivery. The IPM Centers work to connect a diverse array of people who have an interest in pest management policy and implementation throughout the region. These include pest management users (farmers, nurserymen, park and turf managers, building superintendents, pest control operators, homeowners, gardeners, and others), consumer and environmental groups, governmental regulatory agencies, researchers, and educators. IPM Centers network these groups both through its internal organization (Advisory Committee, Stakeholder groups, State Project Leaders) and through development of electronic communications structures such as email lists, online bulletin boards, and web pages.

(D) *CSREES Partnering with the American Phytopathological Society (APS) for Planning and Accountability*
In an attempt to better document progress that has been enabled by competitive funding related to plant pathology and to identify research, education and extension program activities that will address critical regional and national issues and exploit emerging scientific opportunities, CSREES and APS planned some joint activities in conjunction with the APS 2004 Annual Meeting in Anaheim, California from July 31 to August 4, 2004. Specifically, APS conducted a survey, designed cooperatively with CSREES, to solicit broad input with regard to significant accomplishments and opportunities in the field of plant health. The survey solicited a total of 128 responses. Survey results were compiled by an APS Committee led by a CSREES NPL and members of the APS Public Policy Board. Survey results were presented at a workshop on August 2, 2004 where they were discussed and further commented on by workshop attendees.

8.8 Alignment of Portfolio with Current Issues

Peer review of submitted proposals and NPL expertise assure that funded projects are aligned with the current state of science-based knowledge.

8.9 Methodology and Use of Funded Projects

This portfolio leads to solutions to National plant protection problems, improved economic performance for procedure and long term protection of the nation's food system, plant biosecurity and the environment.

8.10 Portfolio Productivity

Portfolio productivity is evidenced primarily by publications in well-regarded peer-reviewed journals (see Section 8.16 Examples of Research Accomplishments). Accomplishments described in annual CRIS reports, citations, and presentations at scientific and other professional meetings demonstrate productivity. Portfolio productivity in PA 212 is evidenced by commercially viable products and new discoveries.

8.11 Portfolio Completeness

Portfolio completeness is demonstrated through submitted annual progress reports (CRIS), termination reports and accomplishment reports. Some aspects of the portfolio in PA212 are more complete than other aspects. Where possible, CSREES coordinates externally with other Federal agencies to address knowledge gaps. One example of such coordination is the partnership with the National Science Foundation (NSF) to administer the NSF/CSREES Microbial Genome Sequencing Program. (see Section 8.16 for examples of projects funded by CSREES through this program).

8.12 Portfolio Timeliness

Portfolio timeliness of PA 212 is evidenced through annual performance reports (CRIS), termination reports, and accomplishments reports. Peer review of competitive funding serves to ensure that funded projects are timely and take advantage of state-of-the-art methods.

8.13 Agency Guidance

Agency guidance to applicants is provided primarily in Requests for Applications (RFAs). Annual review and updating of RFA language is provided upon request for PA 212. Responses to congressional inquiries are provided as requested.

8.14 Portfolio Accountability

The agency solicits stakeholder input in determining the scope and priorities of its research, education and extension portfolio. Input is solicited in stakeholder workshops and other activities that solicit input from scientific communities (see Section 8.7 Stakeholder Assessment above). Accountability is provided through annual reports (CRIS), and accomplishment reports.

8.15 References and Evidentiary Material

See file folders of evidentiary material, which includes publications, books, journal articles, websites, etc.

8.16 Examples of Research Accomplishments

(A) Identifying Novel Types of Resistance Genes

Many plant disease resistance genes have been idenfied and characterized in projects supported by CSREES funding. Examples include NRI-funded projects at Kansas State University entitled *"Nonhost Resistance Mechanisms in Arabidopsis"* (0186414) and *"General Resistance Mediated by Arabidopsis NHO Genes and Pseudomonas Virulence"* (0189522) which identified the *Arabidopsis NHO1* gene (encoding a glycerol kinase) as being important for resistance to nonhost bacterial and fungal plant pathogens. Lu, M., Tang, X., and Zhou, J.-M. (2001) Arabidopsis NHO1 is required for general resistance against Pseudomonas bacteria. Plant Cell, 13, 437-447; L. Kang et al., (2003) Interplay of the *Arabidopsis* nonhost resistance gene *NHO1* with bacterial virulence, PNAS, 100:3519-3524.

(B) Breeding Resistant Plants

Development of disease resistant crop varieties has been a very important and productive CSREES-supported activity. Development of resistant varieties is one of the most economical and least environmentally damaging methods of controlling crop losses due to disease. CSREES-supported projects have assisted the release of varieties of numerous crops that were resistant to specific diseases. Examples of such projects include the Hatch project entitled *"Breeding Pierce's Disease Resistant Table and Raisin Grapes"* at the University of California at Davis (0194292) and the Hatch project entitled *"Soybean germplasm evaluation for resistance to soybean nematodes and pathogens of importance in Arkansas"* at the University of Arkansas (0193234).

(C) Understanding Molecular Mechanisms of Microbe-microbe Signaling and Effects of Such Signaling on Plants

Bacteria use signaling molecules released into the environment as a form of "communication." Bacteria are able to measure the concentration of these signaling molecules as a measure of their own population density. The term used to describe this process is "quorum sensing." NRI –funded work at the University of Connecticut shows that for *Pantoea stewartii* subsp. s*tewartii*, a bacterial pathogen of sweet corn and maize, the extracelluar polysaccharide (EPS) stewartian is a major virulence factor. Production of EPS is controlled by bacterial signaling mechanisms (quorum sensing) in a density dependent manner (0193308). NRI-funded researchers at the Ohio State University have shown that plants respond to the presence of bacterial quorum sensing signal molecules with changes in their own gene expression (0196135). Anthropomorphically-speaking, plants are "listening" to bacterial conversations. U. Mathesius et al. (2003) Extensive and Specific Responses of a eukaryote to bacterial quorum sensing signals. PNAS 100:1444-1449.

(D) Determining the Genome Sequence of Important Plant Pathogens

A pathogen's genome sequence identifies the order of bases in its genetic complement and provides a framework for understanding how the pathogen functions. CSREES supports research and education activities on microbial genomics to better understand how pathogens live and how they can be manipulated for the benefit of U.S. agriculture. NRI funded projects have produced genome sequences for numerous agriculturally important fungal plant pathogens, including *Fusarium graminearum*, the causal agent of wheat and barley head blight (0199492), *Aspergillus flavus*, which causes seed deterioration and contaminates seed with the carcinogen aflatoxin (0198676), *Alternaria brassicicola*, a necrotrophic fungal pathogen causing black spot disease of virtually all cultivated cruciferous plants (0201201), and *Sclerotinia sclerotiorum*, which causes disease on a wide variety of broadleaf crop plants including dry beans, sunflowers, soybeans and canola (0200882). An NRI-funded award, which was made in collaboration with the National Science Foundation and the Department of Energy, resulted in the genome sequence of two "fungus-like" organisms or stramenopiles. These are *Phytophthora sojae*, an economically important pathogen of soybean, and its relative *Phytophthora ramorum*, the cause of Sudden Oak Death, which threatens oak woodlands, and a wide variety of other plants, including fruits, vegetables, ornamentals and forest trees (0199139).

NRI-funded awards have also resulted in sequenced genomes for gram-negative bacterial plant pathogens such as *Erwinia chrysanthemi*, which causes post-harvest soft-rot disease (0190107), *Erwinia amylovora*, the causal agent of fire blight (0199280) and *Pantoea stewartii subsp. Stewartii* which causes Stewart's wilt and leaf blight of sweet corn and maize (0198694), *Clavibacter michiganensis* subsp. *sepedonicus* which causes bacterial ring rot of potato and the gram-positive bacterial plant pathogen, *Streptomyces scabies* which causes potato scab (0198761). NRI has also supported genomic sequencing of plant pathogenic phytoplasmas (0193619) and Barley Yellow Dwarf and Cereal Yellow Dwarf Viruses (0198883).

(E) Understanding Disease Spread

A better understanding of pathogen dispersal and disease spread will help plant pathologists defend crops from global threats to plant health related to emerging diseases and bioterrorism. Two NRI funded projects are contributing to a better understanding of plant disease epidemics. One project at Oregon State University showed that, contrary to standard dogma, epidemic fronts spread through time and space with increasing frontal velocity (0187409). This discovery could be critically important for managing and predicting the spread of disease on large (continental) scales. Another project funded at the New York Agricultural Experiment Station in Geneva is doing a retrospective analysis of high-resolution weather data for post-detection modeling of anomalous disease outbreaks such as might occur in a bioterrorist attack on agricultural crops (0199558).

(F) Understanding Host Resistance to Viral Infection – RNA Interference

Prior to the development of genetic engineering technologies, few management options existed for those wishing to defend plants from viral infection. The discovery that transgenic plants expressing viral genes could make plants resistant to viral infection opened up new management options.

Research supported by USDA's competitive programs unit, originally known as the Competitive Research Grants Office (CRGO), led to the observation by Lindbo et al that some transgenic plants, expressing viral coat protein mRNA which had been modified to prevent production of coat protein, became more resistant to infection than transgenic plants expressing wild-type coat protein. J. A. Lindbo and W. G. Dougherty (1992) Untranslatable Transcripts of the Tobacco Etch Virus Coat Protein Gene Sequence Can Interfere with Tobacco Etch Virus Replication in Transgenic Plants and Protoplasts. Virology 189: 725-733. USDA/Cooperative State Research Service competitive funding supported further research which demonstrated that plants have a surveillance system that specifically degrades viral DNA. This was the first observation of the biological phenomenon now known as "posttranscriptional gene silencing" or "RNA interference" (RNAi). J. A. Lindbo et al. (1993) Induction of a Highly Specific Antiviral State in Transgenic Plants: Implications for Regulation of Gene Expression and Virus Resistance. The Plant Cell, 5: 1749-1759.

More recently, it has been discovered that plants and animals defend themselves from viral infection by means of RNA-directed gene silencing which limits the accumulation and movement of viruses. The NRI continues to support research aimed at understanding the role of RNAi in plant defense and how viruses counter this defense with mechanisms that suppress gene silencing. NRI- funded research at the University of South Carolina showed that viral sequences suppress the establishment of both transgene-induced and virus-induced posttranscriptional gene silencing. R. Anandalakshmi et al. (1998) A viral suppressor of gene silencing in plants. PNAS 95: 13079-13084. Understanding how plants use RNA-gene silencing as an anti-viral defense and how viruses "fight back" should lay the ground work for novel methods to prevent and manage viral (and other types of microbial) infection of plants.

Researchers studying RNAi are now discovering that it has much broader roles in plant and animal physiology than those involved in anti-viral defense. Rather an RNA-directed regulatory system plays a critical role in controlling development. NRI-funded researchers at the University of California, Riverside that a turnip yellow mosaic virus virulence factor suppresses antiviral gene silencing but promotes RNA-mediated gene silencing involved in the control of development. J. Chen et al. (2004) Viral Virulence Protein Suppresses RNA Silencing-Mediated Defense but Upregulates the Role of MicroRNA in Host Gene Expression. The Plant Cell 16: 1302-1313. NRI-funded research at Oregon State University is examining how antiviral RNA silencing is integrated within the larger RNA-directed regulatory system in plants (0201994).

Research activity on RNAi is an extremely rapidly expanding field. It is now being examined as a potential tool for genome-wide studies in all types of organisms and as a tool for drug discovery and disease therapy. G. J. Hannon and J. Rossi (2004) Unlocking the Potential of the Human Genome with RNA Interference. Nature 431: 371-378.

Section 9: Problem Area 213 Weeds Affecting Plants

Relevance

9.1 Scope

This area focuses on economic losses affected by competition from indigenous and exotic weeds, including aquatic weeds and parasitic plants, as measured by several factors including yield and quality in crop production and natural areas (such as forest [excluding urban forestry and agroforestry], aquatic, rangeland).

PA 213, Weeds Affecting Plants, includes both fundamental and applied work. Areas of work include the basics of taxonomy and biosystematics to population dynamics and ecology. Abiotic factors and weed seed studies are included in a systems approach. Breeding, genetic engineering and cultural practices are areas of study. Efficacy and adoption of technologies related to conventional and biopesticides are a focus. Pest resistance, remote sensing and predictive modeling are also included in PA 213. Biosecurity and invasive weeds in management systems are a part of the portfolio.

This PA does not focus on single component issues but supports integrated efforts with other PAs. Work is excluded in PA 213 on single weed species management tactics, and biological control (see PA 215). Breeding for biological efficiency is excluded as well as vegetative studies in urban and agroforestry environments. The development of remote sensing technologies, sampling protocols, and fundamental plant genetics are excluded. Wildlife/weed interactions, impacts of weeds on human health and airborne transport of weeds are covered by other PAs.

This area focuses on yield and quality affected by competition from indigenous and exotic weeds, including aquatic weeds and parasitic plants.

The logic model for PA 213 is illustrated in Figure 9.1 (found on page 96). Major accomplishments and needs summaries for PA 213 are provided in Figure 9.2 (found on page 97). Major subject area categories defined for PA 213 are shown at the bottom of Figure 9.2.

(A) Areas of work include but are not limited to:

- Population dynamics and ecology.
- Biosystematics/taxonomy.
- Effects of abiotic factors such as temperature, water, or nutrients.
- Weed seed studies, including dormancy, survival, and depredation.
- Cultural practices (including solar sterilization) to reduce weed populations or effects.
- Breeding (including genetic engineering) for crop-weed management.
- Efficacy, product performance, application technology, and population management with conventional pesticides and biopesticides (including growth regulators).
- Pest resistance to weed control methods and strategies.
- Development of sampling protocols (including economic injury levels and remote sensing and other automated sampling methodologies) and predictive models for weeds.
- Biosecurity measures to limit invasive weeds in plant management systems.

(B) Exclude:

- Integration of control tactics into systems for managing single weed species or weed complexes. (Use PA 216)
- Biological control. (Use PA 215)
- Breeding (including genetic engineering) for biological efficiency. (Use PA 203)
- Control of competing vegetation in urban forestry and agroforestry. (Use PA 124 or 125)
- Protection of wildlife and natural resources from aquatic weeds. (Use PA 135)
- Development of sampling protocols and predictive models for weed complexes. (Use PA 216)
- Development of remote sensing instruments. (Use PA 404)
- Toxic effects of weeds on animals. (Use PA 314)
- Effects of weeds on human health, including allergies and toxicity. (Use PA 723)
- Fundamental areas of plant genetics. (Use PA 201)
- Movement and dispersal resulting from airborne transport of weeds. (Use PA 132 or 133)

Figure 9.1

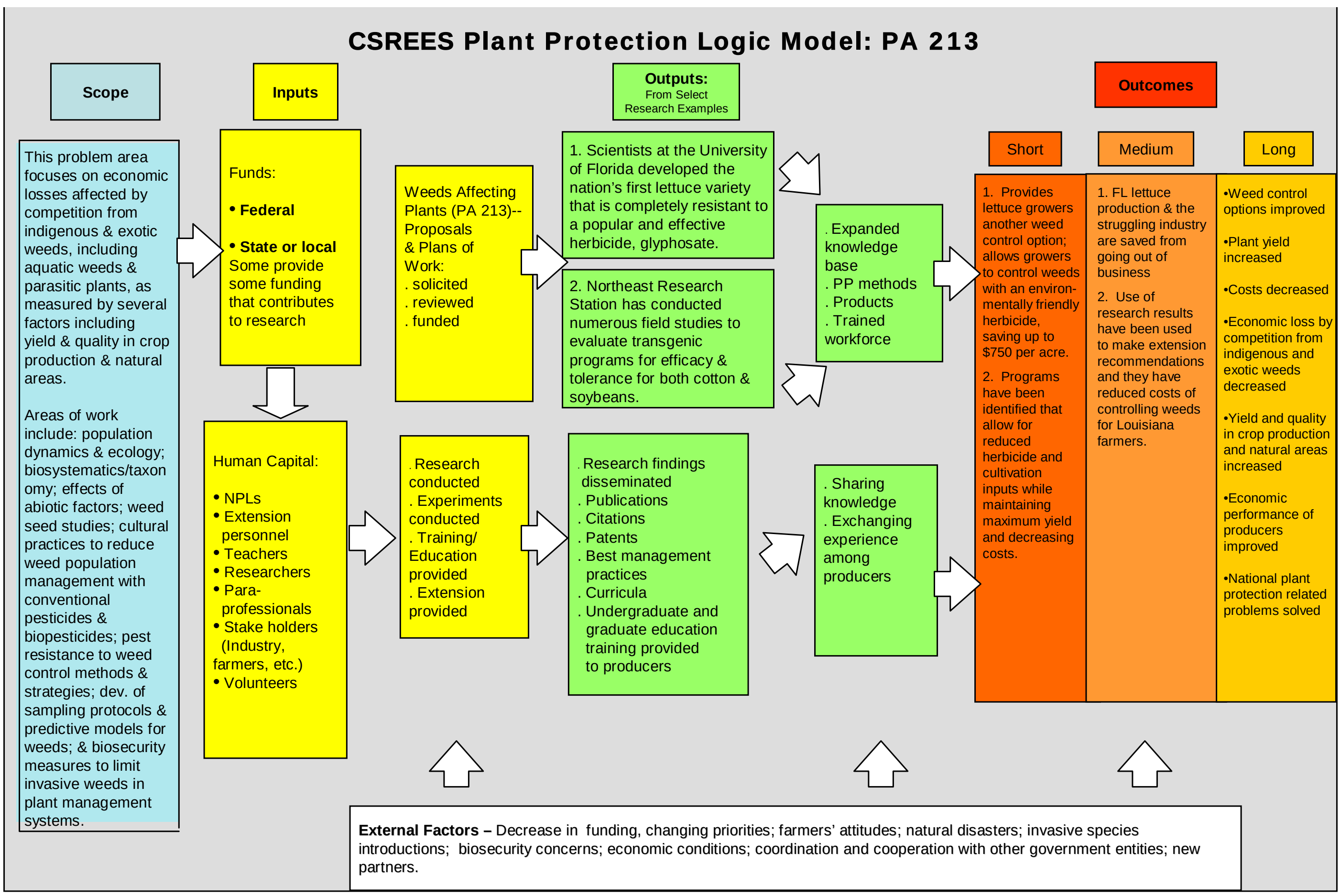


Figure 9.2
Accomplishments and Needs Summary for PA 213

Accomplishments

Prevention
- Major development of weed management systems including herbicides to prevent crop losses due weed competition; 58% of pesticide dollars spent on herbicides.
- Development and adaption of resistant crop varieties.

Biology and Ecology
- Development of expert decision systems using computer and web based modules to select best herbicide use.
- Research on single and multiple weed species competition with crops.
- Discovering genetics relationships in resistant weeds (jointed goat grass).
- Photosynthesis pathway discovery and eluciation using triazine resistant weeds.

Epidemiology
- Development of methods to identify potential weedy species.
- Horseweed resistance to glyphosate discovered in soybeans.
- Weed seed bank studies and greater understanding of seed longevity and future management.

Detection and Diagnosis
- Contributions made to the FICMNEW Early Detection and Rapid Response strategy.
- National Plant Diagnostic Labs.
- Extension program that use research information such as the Fire Model for Invasive weeds in Utah and the Invasive Plant Atlas of New England (NRI funded).

Management
- Development of multistate weed management programs using herbicides in an integrated systems (leafy spurge)
- Development of allelopathic cover crops for weed control.
- Invasive weed management in crop and non-crop land.
- Input into IR-4 program to register need herbicides and biocontrol agents.
- Extension provides herbicide and weed management systems without industry bias.
- Research, Extension and Education needs are highly coordinated in the Land Grant system due to limited number of weed scientists.

Economics and Safety
- Introduction of reduced risk herbicides and using IPM resulting in greater environmental safety.
- Environmental impacts less and crop production costs are lower due to herbicide use in no-till/conservation tillage (herbicide resistant crops [glyphosate]).

Needs

Prevention
- Funding for the FICMNEW Early Detection and Rapid Response strategy for Extension and Research.
- Research on weed seed bank and weed seed dormancy.

Biology and Ecology
- Research on genetic factors in resistant weeds.
- Continue research and extension on expert decision systems.
- Greater emphasis on the invasive species, such as cogongrass, aquatic weeds, tamarisk.

Epidemiology
- Continue research on resistant weed biology.
- Continued multistate research and extension on specific troublesome weeds.

Detection and Diagnosis
- Support for herbarium and plant systematics to used for weed identification and for higher education.

Management
- More support for aquatic weed management.
- IR-4 support for reduced risk herbicides.
- Needs of the Green Industry and non-crop land weed management systems.
- Continued support of research and extension on herbicide field studies
- Continued support for graduate student education.

Economics and Safety
- Better data on the benefits of conservation tillage and the use of herbicides in that system.
- Development of sustainable production practices.
- Continued education of consultants, crop producers, extension agents on appropriate, rate specific, best weed management practices.

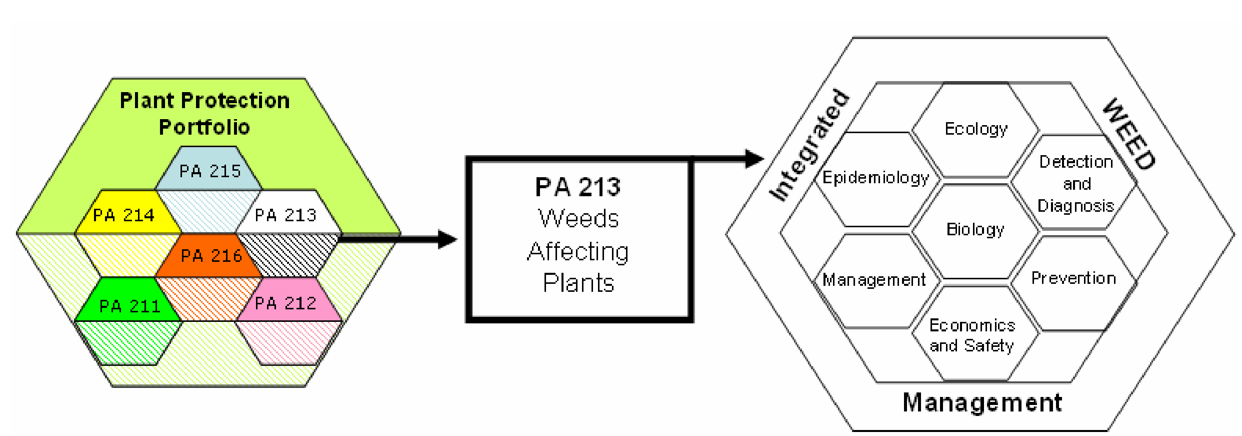
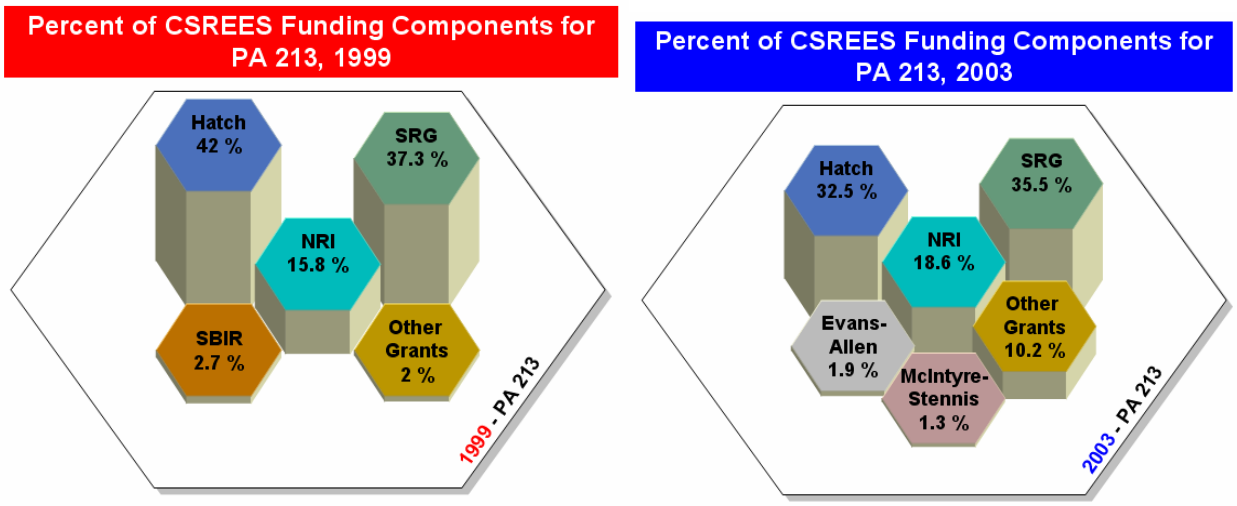


Figure 9.3



9.2 Focus on Critical Needs

The globalization of trade has put pressure on the agricultural sector of the U.S. economy as U.S. markets are opened for the importation of foreign agricultural products. In order to remain competitive in this global market place, where foreign producers generally have access to a greatly less expensive labor force, U.S. producers must maintain the production of high quality plant products at the same time they reduce costs. Programs dedicated to PA 213 are a major means that CSREES has to assist growers in this effort. Over the years from 1999 to 2003, the overall budget of CSREES remained relatively stable. At the same time, the CSREES investment in PA 213 increased 8.1% (21% when adjusted for inflation). The Agricultural Research, Education and Economics Reform Act of 1998 (AREERA), shifted previously formula based funds to competitively awarded funds. At the same time, funding for PA 213 shifted from about 15.8% of funding coming from NRI competitive sources to 18.6% of funding coming from NRI competitive sources. This demonstrates the ability of the CSREES-land grant university partnership to respond to critical needs in the grower community by shifting the allocation of resources to areas of critical need. A modest increase in PA 213 indicates that there continues to be a need to address the weed control issues in crop and non-crop areas.

(A) Analysis of CRIS Data:

Figure 9.3 shows a graphic comparison of funding percentages for PA 213 from 1999 & 2003. In1999, CSREES invested a total of $8,393,000 in PA 213. Of this total, 42% came from Hatch funds, 37.3% from Special Research Grants (SRG). Together, these two non-competitive sources of funding accounted for 79.3% of all funds allocated to PA 213. The National Research Initiative (NRI) invested $1,323,000 in programs dedicated to PA 213, which equates to 15.8% of the total. These four funding sources therefore accounted for 95.1% of the CSREES funding invested in PA 213. The CSREES investment in PA 213 in 1999 represented 13% of the total funds invested in all of plant protection. The breakdown of funding by commodity area is presented in Table 9.1(found on page 99) for 1999.

Table 9.1
Distribution of CSREES Investment in PA 213 for 1999

Description of SOI	Hatch	%	SRG	%	NRI	%	SBIR	%	Other Grants	%	CSREES	%
Weeds	697	26.4	1,040	39.4	598	22.6	225	8.5	80	3	2,641	100
Grain Crops	836	73.9	201	17.8	94	8.3	0	0	0	0	1,131	100
Vegetables	459	42.2	581	53.4	48	4.4	0	0	0	0	1,088	100
Deciduous & Small Fruit	79	12.2	566	87.8	0	0	0	0	0	0	645	100
Tropical / Subtropical	105	17	514	83	0	0	0	0	0	0	619	100
Top 3 SOI	1,992	41	1,822	37.5	740	15.2	225	4.6	80	1.6	4,860	100
2 Small Focus Areas	184	14.6	1,080	85.4	0	0	0	0	0	0	1,264	100
18 Other SOI	1,347	59.4	231	10.2	583	25.7	0	0	88	3.9	2,269	100
Total	**$3,523**	**42**	**$3,133**	**37.3**	**$1,323**	**15.8**	**$225**	**2.7**	**$168**	**2**	**$8,393**	**100**

In 2003, CSREES investment in PA 213 increased to $10,053,000. Hatch funds accounted for 32.5% of the total and together with non-competitive sources of funding for PA 213 accounted for 71.2% of the total, a reduction of 8.1% from the 1999 percentage of 79.3%. NRI funding in this PA increased from 1999 to 2003 by almost 2% of the total, while Small Business Innovation Research (SBIR) program funding was less than 1 % and is folded into Other Grants category. The continued maturation of the CSREES Integrated Research, Education and Extension grant programs also provided some funding for programs in PA 213. The CSREES investment in PA 213 in 2002 represented 12% of the total investment in all of plant protection. All PA had about a 1% decrease of the total research investment in plant protection areas from 1999 to 2003, except PA 216, which had a 5% increase. The breakdown of funding by commodity area is presented in Table 9.2 for 2003.

Table 9.2
Distribution of CSREES Investment in PA 213 for 2003

Description of SOI	Hatch	%	Mc-Sten	%	Evans-Allen	%	SRG	%	NRI	%	Other Grants	%	CSREES	%
Weeds	607	21.8	4	0.1	0	0	896	32.1	1,071	38.4	210	7.5	2,787	100
Plants, General	131	8.4	71	4.6	0	0	822	52.9	155	10	375	24.1	1,555	100
Grain Crops	680	58.6	0	0	0	0	444	38.3	36	3.1	0	0	1,160	100
Vegetables	370	40.6	0	0	96	10.5	446	48.9	0	0	0	0	912	100
Tropical/Subtropical	89	22.4	0	0	0	0.	309	77.6	0	0	0	0	398	100
Potato	13	8.7	0	0	96	64.0	40	26.7	0	0	0	0	150	100
Edible Tree Nuts	2	1.4	0	0	0	0	0	0	0	0	146	98.6	148	100
Top 4 SOI	1,788	27.9	75	1.2	96	1.5	2,608	40.7	1,262	19.7	585	9.1	6,414	100
3 Small Focus Areas	104	14.9	0	0	96	13.8	349	50.1	0	0	146	21	696	100
23 Other SOI	1,377	46.8	51	1.7	0	0	609	20.7	604	20.5	299	10.2	2,943	100
Total	**$3,269**	**32.5**	**$126**	**1.3**	**$192**	**1.9**	**$3,566**	**35.5**	**$1,866**	**18.6**	**$1,030**	**10.2**	**$10,053**	**100**

There was an 8.1 % increase in CSREES funding for PA 213 between 1999 and 2003, which was actually equivalent to 21 % when adjusted for inflation. A comparison of PA 213 to other PA's can be found in Table 6.5 (found on page 52).

9.3 Identification of Emerging Issues

CSREES is engaged in a continuous process of obtaining input from stakeholders and partners on new and emerging issues facing the agricultural community. As an example, CSREES conducted a one day workshop for stakeholder input in November, 2002. The Weed Science Society of America presented a concise "road map" for use for PA 213; this valuable contribution is being used by CSREES. Their major concerns are to maintain and strengthen (1) a long-term strategic plan for pest management, (2) bridging between agro-ecosystems and natural areas, (3) bridging between bio-security and crop protection, (4) minor crop and specialty use herbicide registrations, and (5) resistance management.

This systematic approach to identifying and prioritizing research and extension needs is illustrative of the philosophy employed by CSREES to insure that its programs are answering the needs of U.S. citizens. A majority of weed scientist faculty at Land-Grant Universities have joint appointments faculty in research, extension, and/or education.

9.4 Integration of CSREES Programs

It is evident from the data on funding sources that CSREES programs are being used in a comprehensive manner to address the needs identified in PA 213. The various programs are coordinated so that continuous attention is given to the research and extension needs of the agricultural community in regards to the reducing the impact of weeds on agricultural production. This coordination assures that critical levels of funding are available from appropriate sources to meet these challenges. In addition, the shift of emphasis, as reflected in the change in investment within PA 213 with an 8 % increase in Other Grants demonstrates the way that PA 213 programs are seeking new answers that are challenging agriculture protection regarding weeds and their control.

9.5 Multidisciplinary Balance / Interdisciplinary Integration

It is the very nature of PA 213 that research and extension efforts to increase pre- and post harvest quality and utility of crops is interdisciplinary. Whole plant physiologists, geneticists, plant breeders, soil and water scientists and others, must work jointly to increase crop quality and quantity at the whole crop production level. Many new hires of weed science faculty at the Land-Grant Universities are being selected to conduct research on weed and crop resistance and ecological aspects, with less emphasis on traditional weed management based primarily on herbicide selection.

Quality

9.6 Significance of Findings and Outputs

CSREES-funded projects focusing on weeds plants have resulted in many high-impact publications in well-regarded journals (see examples in 9.16). They have also supported graduate student and postdoctoral training in weed science and related disciplines.

9.7 Stakeholder Assessment

CSREES seeks stakeholder input with regard to portfolio composition, program direction and research priorities. Examples of activities soliciting stakeholder input are as follows:

(A) *Plants and Pest Biology stakeholder workshop,* Crystal City, VA, November 14, 2002 Provided a forum for stakeholders to review and contribute feedback on the agency's research priority issue areas that CSREES is considering multi year funding. The issue areas are: (1) Agricultural and Environmental Quality, (2) Agricultural Security, (3) Genomics and Food and Fiber Production, (4) Obesity, Human Nutrition and Food Security, (5) Food Safety, and (6) Rural and Community Development. Feedback from this workshop helped to focus CSREES portfolios including the Plant Protection portfolio.

(B) IR-4 uses an extensive stakeholder driven process to prioritize research to ensure that it is focusing on the most critical pest management needs of the specialty crop producers. The priority setting process engages representatives from state and federal agricultural scientific communities, state extension systems, commodity and growers groups, the crop protection industry, food processors, and state and federal regulators.

(C) Stakeholders are involved in every aspect of IPM, Sustainable Agricultural Research and Education Program (SARE) and NPDN Center management, planning and program delivery. The IPM Centers work to connect a diverse array of people who have an interest in pest management policy and implementation throughout the region. These include pest management users (farmers, nurserymen, park and turf managers, building superintendents, pest control operators, homeowners, gardeners, and others), consumer and environmental groups, governmental regulatory agencies, researchers, and educators. IPM Centers network these groups both through its internal organization (Advisory Committee, Stakeholder groups, State Project Leaders) and through development of electronic communications structures such as email lists, online bulletin boards, and web pages.

9.8 Alignment of Portfolio with Current Science

Peer review of submitted proposals and NPL expertise assure that funded projects are aligned with the current state of science-based knowledge.

9.9 Methodology and Use of Funded Projects

This portfolio leads to solutions to National plant protection problems, improved economic performance for procedure and long term protection of the nation's food system, plant biosecurity and the environment.

Performance

9.10 Portfolio Productivity

The objective of CSREES leadership and funding is to acquire and disseminate knowledge leading to the improvement of the pre-harvest quality and quantity of crops. One major factor for PA 213 is to minimize crop yield losses due to weed competition as measured by quantity and quality of the crop. Other aspects that are being addressed are the deleterious effects of weeds and the negative impact on the ecology of natural and non-crop areas including aquatic environs.

Research and Extension in PA 213 tend to be commodity specific. Recognizing this, the strategy chosen to identify and document impacts from CSREES investment in PA 213 are predominantly commodity specific. A search of the CSREES system was done that identified projects. From these projects, representatives were chosen to illustrate the types of activities funded under this PA.

Portfolio productivity is evidenced primarily by publications in well-regarded peer-reviewed journals (see Section 9.16 Examples of Research Accomplishments). Accomplishments described in annual CRIS reports, citations, and presentations at scientific and other professional meetings demonstrate productivity. Portfolio productivity in PA 213 is evidenced by commercially viable products and new discoveries.

9.11 Portfolio Completeness

Portfolio completeness is demonstrated through submitted annual progress reports (CRIS), termination reports and accomplishment reports. Some aspects of the portfolio in PA 213 are more complete than other aspects. Where possible, CSREES coordinates externally with other Federal agencies to address knowledge gaps. One example of such coordination is the partnership with the National Science Foundation (NSF) to administer the NSF/CSREES Microbial Genome Sequencing Program. (see Section 9.16 for examples of projects funded by CSREES through this program).

9.12 Portfolio Timeliness

Portfolio timeliness of PA 213 is evidenced through annual performance reports (CRIS), termination reports, and accomplishments reports. Peer review of competitive funding serves to ensure that funded projects are timely and take advantage of state-of-the-art methods.

9.13 Agency Guidance

Agency guidance to applicants is provided primarily in Requests for Applications (RFAs). Annual review and updating of RFA language is provided upon request for PA 213. Responses to congressional inquiries are provided as requested.

9.14 Portfolio Accountability

The agency solicits stakeholder input in determining the scope and priorities of its research, education and extension portfolio. Input is solicited in stakeholder workshops and other activities that solicit input from scientific communities (see Section 9.7 Stakeholder Assessment above). Accountability is provided through annual reports (CRIS), and accomplishment reports.

9.15 References and Evidentiary Materials

See file folders of evidentiary material, which includes publications, books, journal articles, websites, etc.

9.16 Examples of Research Accomplishments

(A) Noxious Weeds -- Weed Control

Issue
Topic 1l: Noxious Weeds -- Weeds Control Research/University of Florida
The United States is the world's largest lettuce producer, but weed control has been the most serious obstacle to production -- costing growers up to$750 per acre to mechanically remove weeds from fields. Until now, glyphosate (Roundup) could not be used to control weeds in this crop because the lettuce would be damaged or destroyed by the chemical. The high cost of hand hoeing to control weeds, coupled with the large amount of damage to the crop from hoeing, have been major factors in the rapid decline of lettuce production in Florida, California and other locations. High costs have caused many growers to abandon lettuce production in Florida.

What has been done?
In research that will revolutionize weed control in lettuce and other crops, a team of scientists at the University of Florida has developed the nation's first lettuce variety that is completely resistant to a popular and effective herbicide, glyphosate. The new herbicide-resistant lettuce is expected to boost Florida lettuce production and literally save the state's struggling lettuce industry from going out of business. UF researchers obtained the gene for glyphosate resistance and used tissue culture to incorporate the resistant gene in new breeding lines of lettuce. They also conducted experiments to demonstrate that genetic transformation of the lettuce cultivar was complete.The pioneering research was initiated by Robert Ferl, professor and assistant director of the UF's Interdisciplinary Center for Biotechnology Research; Daniel Cantliffe, chair of the UF

Department of Horticultural Sciences, and Russell Nagata, associate professor at the UF Everglades Research and Education Center, Belle Glade. Others working on the project include Joan Dusky, associate professor at the Belle Glade center; Thomas Bewick, associate professor in the horticultural sciences department, and Antonio Torres, a visiting scientist from Empresa Brasileira de Pesquisa Agropecuaria (EMBRAPA) in Brazil.

Impact
Prior to the development of the glyphosate-resistant lettuce cultivar, lettuce growers had no post-emergence weed control options other than expensive hand cultivation. Developed with genetic engineering, the new lettuce variety will allow growers to control weeds with an environmentally friendly herbicide -- saving up to $750 per acre. It provides lettuce growers with another weed control option that will allow them to more fully embrace the concepts of integrated pest management (IPM). "Because of biotechnology, we have new lettuce lines that are completely resistant to glyphosate herbicide," Ferl explains. "We can apply the herbicide when the lettuce is in a very young stage, which means we can also control weeds when they are just getting established. The end result is that we can achieve highly effective weed control in lettuce using very small amounts of herbicide. The weeds around the lettuce die, but the lettuce thrives." Ferl said the chemical has no effect on the appearance or quality of lettuce for consumers and no adverse effect on crop yield. "Most importantly," Ferl adds, "glyphosate is very compatible with the environment. It breaks down quickly and has a very low toxicity, especially to humans and other animals." "You can see the potential impact of what we have developed," he says. "It came home to me when I visited the South Florida production fields – mile upon mile of laser-planed soil growing huge amounts of lettuce and a seemingly endless number of migrant farm workers bent over hoeing fields to remove weeds. It was hard to believe we're using so much labor to produce a crop we see on our tables everyday, " he said Ferl says the UF research will also benefit consumers at the checkout counter with lower lettuce prices: "Not only will growers save the $750 per acre they now spend for hand hoeing, they will reduce damage to lettuce that's caused by the hand hoeing. When workers hand hoe a lettuce crop, they typically ruin about 20 percent of the crop, which means another 20 percent of the grower's profits are lost." "If we had this particular lettuce variety five years ago, lettuce production in Florida would be much higher today than it is," Ferl adds. The UF research team says development of their new lettuce variety is important because few -- if any -- commercial firms would be willing to invest the time and money in genetic engineering for a "minor crop" that's grown on limited acreage. "When you compare lettuce with major crops like wheat, corn and soybeans, lettuce acreage is just not high enough for commercial firms to justify this kind of research effort. Nevertheless, lettuce is an important niche market for growers, particularly in Florida and California. We recognized the importance of lettuce to growers and consumers and initiated this research program without major funding or grants from commercial or industry sources. It's a minor crop, but it's still a major source of income for growers," Ferl explains.

Primary Impact Area(s)
Extension
Research

Funding Sources
Hatch Act, McIntire-Stennis Cooperative Forestry, Smith-Lever 3(b) & (c)

(B) Transgenic Weed Control in Cotton and Soybean

Issue
Weed competition is often a limiting factor to profitable production of both soybean and cotton. In a 2000 survey published in the 2001 Proceedings of the Southern Weed Science Society annual meeting, it was estimated that herbicide costs for cotton and soybean weed control in Louisiana averaged 45 and 36$/A, respectively. In addition, total annual losses in yield, quality, extra land

preparation and cultivation, and increase cost of harvesting was estimated at 37,221,000 and 37,550,000$ for these respective crops. With increasing production costs and shrinking profit margins, producers need weed control programs that provide maximum efficacy at minimum costs and offer the potential to reduce costs associated with weed control in cotton and soybean.

What has been done?
New transgenic herbicide technology has been developed in both cotton and soybean. Numerous field studies have been conducted at the Northeast Research Station to evaluate transgenic programs for both efficacy and tolerance. Programs have been identified that allow for reduced herbicide and cultivation inputs while maintaining maximum yield and decreasing costs associated with weed control. Negative consequences from utilization of transgenic programs, including weed resistance and nontarget application to susceptible plant species, are also a focus of continuing research.

Impact
Results of this research on transgenic weed control programs have been used to make extension recommendations in the Louisiana Suggested Chemical Weed Control Guide. In addition, an extension publication entitled Managing Glyphosate Tolerant Cotton was developed based on research conducted within the cotton and soybean weed control programs. The impact to Louisiana farmers has been a decrease in the costs of controlling weeds in these crops. It is estimated that now over 70% and 85% of the acreage of cotton and soybean, respectively, in Louisiana are planted in a glyphosate tolerant variety. Many of the programs used for controlling weeds in these systems were tested and validated in the weed control programs. Producers using this technology have been able to eliminate application trips through the field as well as herbicide and cultivation inputs resulting in lower costs to controlling weeds. In addition, tolerance of these varieties to herbicide applications have been determined and producer guidelines for their use to reduce negative effects have been established and included in extension publications. With these programs, producers are achieving maximum production with decreased costs and lower inputs associated with weed control. In addition to glyphosate tolerant cotton, varieties tolerant to the broad spectrum herbicide glufosinate will also be made available in 2004. Research aimed at determining strengths and weaknesses as well as possible tank-mix partners and effect of nontarget application to non-tolerant crops has also been conducted. Producers will be able to take results and incorporate use of this new technology into individual production systems.

Primary Impact Area(s)
Research & extension

Funding Sources
Hatch Act
Smith-Lever 3(b) & (c)
Commodity ((Soybean and Feedgrain Research and Promotion Board; Cotton Incorporated State Support Group), and agrichemical industry have provided funding for weed control research)
Local ((Soybean and Feedgrain Research and Promotion Board; Cotton Incorporated State Support Group), and agrichemical industry have provided funding for weed control research)

Topics
Economic Response in Changing World
Precision Agriculture
Sustainable Agriculture
Waste Management

(C) WeedSOFT Aids Weed Management Decisions

Issue

Deciding how, when or whether to treat weeds in crops is challenging. Farmers must consider economic, environmental and regulatory factors along with the crop and weed situation in that particular field.

What has been done?
To help growers, crop consultants and Cooperative Extension educators make better weed management decisions, University of Nebraska agronomists developed WeedSOFT software. This weed management decision-making tool incorporates research from Nebraska's Institute of Agriculture and Natural Resources and other states. Software is improved and expanded annually. The latest versions provide comprehensive ecological and economic information on weed management. WeedSOFT was introduced in Nebraska in 1992. Today it is used by at least 560 people in seven states. As part of an Integrated Pest Management project to improve weed management and reduce herbicide use, researchers in several states are promoting wider use of this tool in the north central region. State-specific versions of WeedSOFT are available for Indiana, Illinois, Kansas, Michigan, Missouri, Nebraska and Wisconsin.

Impact
WeedSOFT is helping producers reduce crop herbicide use and associated costs, improve weed management and reduce weed-related yield losses. A survey of WeedSOFT users across the north central region indicated this software is responsible for about $13 million annually in cost savings and increased earnings for crop producers. A central Nebraska crop consultant said the program "is easy to use and offers unbiased information. It is a well-rounded program and it's worth its weight in gold."

Primary impact area(s)
Research
Extension

Funding sources
Hatch Act
Smith-Lever 3(b) & (c)
Other CSREES (USDA-CSREES)
State (University of Nebraska Agricultural Research Division; University of Nebraska Cooperative Extension)
Other (North Central Regional IPM Project)

Topics
Integrated Pest Management
Precision Agriculture

(D) Preparing Weed Scientists

Issue
Weeds are a major cause of yield loss in agronomic and horticultural crops across North Dakota and therefore are an important issue to producers. The need for agronomists and crop consultants to provide advice to producers is greater than the supply. This has caused an increased demand for students in the workforce that are knowledgeable in the area of weed science and related plant protection disciplines.

What has been done?
North Dakota State University offers an option in weed science within the crop and weed science major on the undergraduate level. This allows students to emphasize weed science to better serve producers following graduation. Sixty-five to 70 undergraduate students are currently enrolled in the crop and weed science major with two-thirds emphasizing weed science. NDSU also offers a plant protection major with 10-12 students currently enrolled. This program focuses on weed science, entomology and plant pathology. Ninety percent of students graduating with a

crop and weed science major have been involved in an undergraduate intern program, which provides increased hands-on experience in their field. NDSU also offers graduate programs in plant sciences with emphasis on weed science. There are 6-12 students enrolled in this program with the majority having an interest in weed management in annual crops. There also is increased interest in the area of weed management in non-tilled areas, such as natural resource management. The Bureau of Land Management and the Forest Service are demanding students with master's degrees for many of their job positions.

Impact
The weed science undergraduate, graduate and intern programs implemented at NDSU are preparing students to meet the weed control needs of producers when they enter the workforce. They are well prepared for jobs in the specialized area of weed science. The education has provided the knowledge to be strong agronomists, plant protection experts and crop consultants. These are just a few of the many career options. The intern program provides experience and job contacts for students pursuing careers. Throughout the College of Agriculture, Food Systems, and Natural Resources, students in the crop and weed science program are among the top salaries entering the workforce.

Primary impact area(s)
Education

Funding sources
State (Appropriated Funds)

Topics
Applying Knowledge to Practical Situations
Student Contributions to Society

(E) Executive Summary of the National Jointed Goatgrass Research Program CSREES-USDA Special Grant Matching Funds

For each CSREES dollar spent on research, nearly two dollars of wheat industry, state, and other non-federal funds are contributed to this program.

Impact:
This program is guiding wheat producers how to identify jointed goatgrass, how to prevent its spread, and how to manage it in a winter wheat cropping system. The program will continue to develop new management strategies and implement them through a commitment to technology transfer. Methods developed to control jointed goatgrass will also control other costly weeds in winter wheat, such as downy brome, feral rye, and other grasses. Overall, the economic impact of jointed goatgrass will be reduced and U.S. wheat production will remain profitable and competitive in the world market.

Accomplishments:
Over 30 scientists in 11 Great Plains and western states are currently engaged in an integrated, multidisciplinary effort to reduce the impact of jointed goatgrass on winter wheat production. Some of the topics they have or currently are researching include:

- Integrated management
- Technology transfer
- Planting practices
- Tillage systems
- Competitive cultivars
- Crop rotations
- Genetic diversity
- Gene flow

- BMP sites
- Herbicide resistance
- Population dynamics
- Controlling JGG seed production
- Seed longevity and viability

Several experiments are being conducted at multiple locations, cooperatively among scientists, using similar experimental designs and treatments to broaden the scope of implications from individual research results.

Administration:
The 14 member National Jointed Goatgrass Steering Committee (comprised of wheat producers, wheat commission administrators, extension specialists, plus state and federal researchers) establishes priorities, controls allocation of funds, and ensures coordination of all programs. There is no duplication of effort. Research grants are awarded annually through a national merit-based competition. Preferences are given to proposals that are multistate, multiscientist, and have strong economic and technology transfer components. This program is a model for efficient and constructive use of federal funds. An annual meeting of all investigators and steering committee members is held to review all research projects and enhance communication.

Funding Request:
The National Jointed Goatgrass Research Program requests that the CSREES funding be increased to $500,000 in FY 2005 from $343,000 in FY 2004. The direction of the program is to continue one more year and bring a conclusion to the program by focusing on technology transfer. The actual cost for this program exceeds $1 million to expand jointed goatgrass research, speed development of systems management strategies, and further extend technology transfer activities.

Participating States:
- Colorado
- Idaho
- Kansas
- Montana
- Nebraska
- Oklahoma
- Oregon
- Texas
- Utah
- Washington
- Wyoming

Section 10: Problem Area 214 Vertebrates, Mollusks and Other Pests Affecting Plants

Relevance

10.1 Scope

This problem area (PA) focuses on yield and quality affected by indigenous and exotic vertebrate pests (including birds and mammals), mollusks (including slugs and snails), and other plant pests.

This paragraph describes the scope of potential projects under PA 214. Projects under this PA include basic, applied and developmental research; educational programs at the Master's and Doctoral levels; and extension programs. Research, education and extension topics supported within PA 214 include biosystematics and taxonomy, population dynamics, and ecology. This includes the impact of climate and other abiotic factors on pest biology and behavior. Also included are studies on resistance, proceeding through a continuum of work from breeding (including genetic engineering) for host plant resistance to research on methods to circumvent pest resistance to control methods or strategies resistance, to use of cultural practices to reduce infestations or effects. Mission-oriented work from discovery to transfer of information on efficacy, product performance, application technology, and population management with conventional pesticides and biopesticides (including pheromones and growth regulators) related to these pests is also included. Development of sampling protocols (including economic injury levels, action thresholds, and remote sensing and other automated sampling methodologies) and predictive models for individual species are in this problem area. Biosecurity measures to limit invasive vertebrates, mollusks, and other pests in plant management systems also fall under this program area.

The paragraph above describes the potential scope of projects in PA 214; however, the actual projects in PA 214 on vertebrate damage to plants and crops currently have six major themes: 1) exclusion, e.g. fencing, netting; 2) repellents on or around plants; 3) lethal control e.g. hunting, trapping, poisoning; 4) population reduction by fertility control; 5) hazing and scaring; and 6) behavioral alteration. Only a few projects are on mollusks.

PA 214 excludes a number of areas covered by other PAs. The integration of control tactics into systems for managing single pests or pest complexes are included under integrated pest management systems PA 216 - Integrated Pest Management Systems. When biological control is the focus of the work problem area PA 215- Biological Control of Pests Affecting Plants is the appropriate program area. However, knowledge and materials from PA 214 are used in research in PA 215 and 216 to develop improved biological control methods and IPM systems.

Evaluation of germplasm for genetic variation in resistance to pests is covered in PA 202 – Plant Genetic Resources and Biodiversity. Development of sampling protocols and predictive models for pest complexes is under PA 216 – Integrated Pest Management Systems. Development of remote sensing instruments is under PA 404 – Instrumentation and Control Systems. Fundamental areas of plant genetics is in PA 201 – Plant Genome, Genetics, and Genetic Mechanisms.

Management of vertebrate pests in rangeland and forest systems, including agroforests and urban forests, is covered in PA 121 – Management of Range Resources, PA 123 – Management of Forest Resources, PA 124 – Urban Forestry, or PA 125 - Agroforestry. Management of vertebrate pests to protect property, endangered species, and community well-being is under PA 135 – Aquatic and Terrestrial Wildlife.

Although PA 214 contributes to the Plant Protection Portfolio in several important ways, particularly the impact of deer and other vertebrate pests on agriculture, the impact and continuity of PA 214 is impacted by two important considerations. These characterizations of PA 214 are based on a review of projects from a search of the CRIS database of projects coded for PA 214.

First, PA 214 includes an assortment of projects the majority of which deal with the "… and Other Pests..." portion of the PA. PA 214 does capture projects on vertebrates and mollusks, but only about 25% of the projects under the PA are on these two problem areas. Typically, projects in PA 214 are also coded with several other PAs. The majority of the projects that deal with "… and Other Pests..." should probably be captured by another PA. Lists of the PA 214 projects for FY 1999-2003 are in the Reference and Evidentiary Materials as "PA 214 Project Titles."

Second, this PA is a very small portion of the Plant Protection portfolio in terms of funds allocated to this PA. PA 214 represents less than 1% of the portfolio. Two large special grants, Exotic Pests and Diseases, CA and Tropical and Subtropical Agricultural Research (TSTAR) have a portion of their projects coded for PA 214; however, these two grants have few projects directed to research on vertebrates or mollusks that impact agriculture. When the funding for these two special grants are factored out, the actual size of PA 214 would be actually far less than 1% of the plant protection portfolio.

A question to the review panel is what CSREES should do about PA 214. Should the PA be re-titled by dropping "…and Other Pests…" from the title so PA 214 would become "Vertebrates, Mollusks Affecting Plants"? This would narrow the focus of PA 214 and prevent projects from being assigned to PA 214 that actually should be assigned to other more relevant PAs. Or should the projects in PA 214 be moved to other PAs? For example projects on mollusks could be moved to PA 211, "Insects, Mites and Other Arthropods Affecting Plants" and wildlife projects could be moved to PA 135, Aquatic and Terrestrial Wildlife." Either of these options would sharpen CSREES's tracking of projects in CRIS.

The logic model for PA 214 is illustrated in Figure 10.1(found on page 110). Major accomplishments and needs summaries for PA 214 are provided in Figure 10.2(found on page 111). Major subject area categories defined for PA 214 are shown at the bottom of Figure 10.2.

(A) Areas of work include but are not limited to:

- Population dynamics and ecology.
- Biosystematics/taxonomy.
- Breeding (including genetic engineering) for host plant resistance.
- Impact of climate and other abiotic factors on pest management.
- Cultural practices to reduce infestations or effects.
- Efficacy, product performance, application technology, and population management with conventional pesticides and biopesticides (including pheromones and growth regulators).
- Pest resistance to control methods or strategies.
- Development of sampling protocols (including economic injury levels, action thresholds, and remote sensing and other automated sampling methodologies) and predictive models for an individual species.
- Biosecurity measures to limit invasive vertebrates, mollusks, and other pests in plant management systems.

(B) Excludes:

- Integration of control tactics into systems for managing single pests or pest complexes. (Use PA 216)
- Biological control. (Use PA 215)
- Evaluation of germplasm for genetic variation in resistance to pests. (Use PA 202)
- Development of sampling protocols and predictive models for pest complexes. (Use PA 216)
- Development of remote sensing instruments. (Use PA 404)
- Fundamental areas of plant genetics. (Use PA 201)
- Management of vertebrate pests in rangeland and forest systems, including agroforests and urban forests. (Use PA 121, 123, 124, or 125)
- Management of vertebrate pests to protect property, endangered species, and community well-being. (Use PA 135)

Figure 10.1

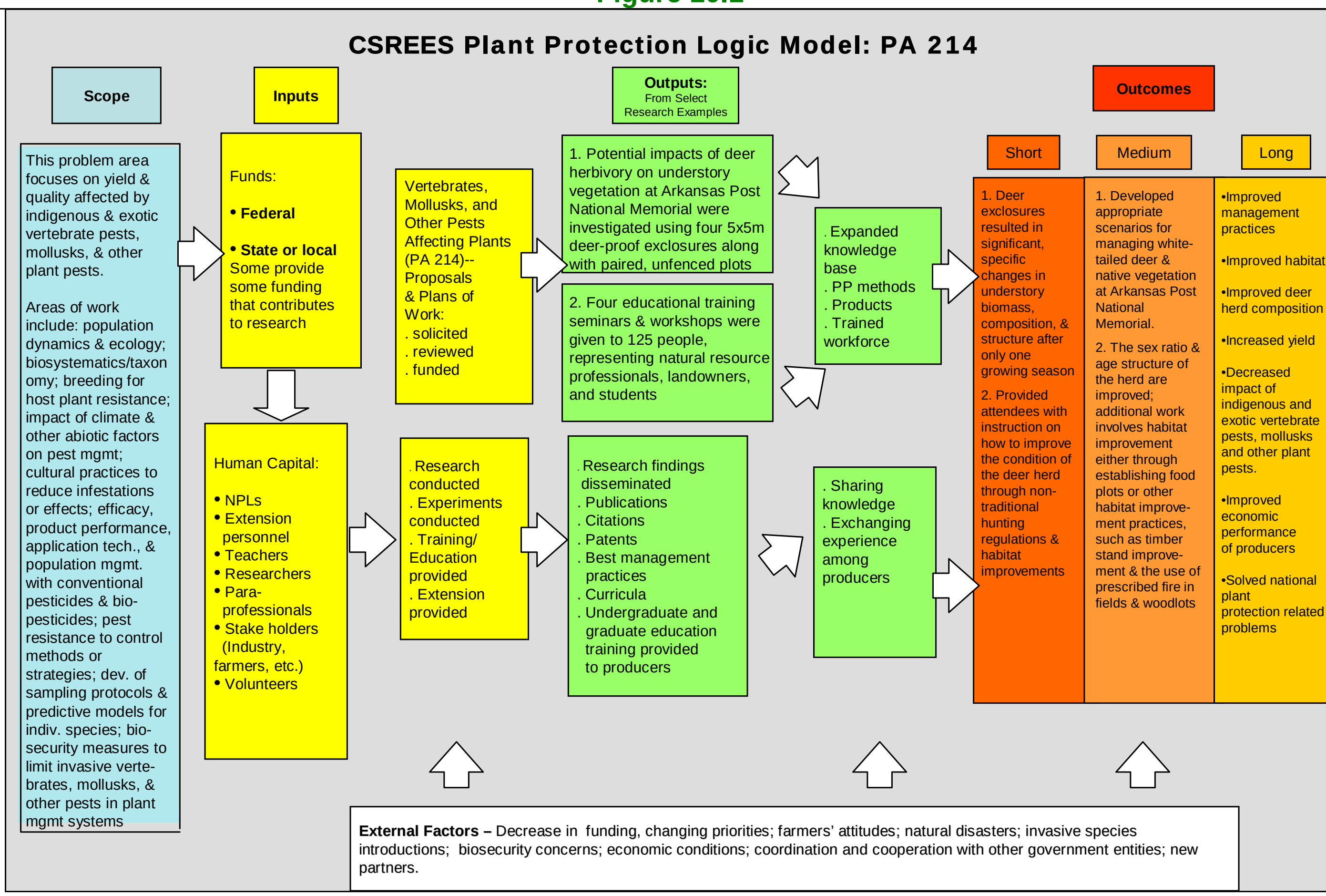


Figure 10.2
Accomplishments and Needs Summary for PA 214

Accomplishments

Prevention
- Novel barriers for birds and insects (patent)
- Novel barriers for deer
- Evaluation of deer repellents

Biology and Ecology
- Groundcovers for vole control
- Mating disruption in voles
- Deer fertility control
- Apple snail taxonomy/origin

Epidemiology
- Tick-borne disease risk

Detection and Diagnosis
- Evaluation of methods for deer population estimates

Management
- Deer management strategies
- Wildlife management strategies (ground squirrels, raccoons, etc)
- Evaluation/development of non-lethal methods
- Biobased slug control

Economics and Safety
- Depredation estimates

Needs

Prevention
- Improved prevention methods

Ecology and Biology
- Ecological impacts of management practices

Epidemiology
- Factors influencing population changes

Detection and Diagnosis
- Efficient use of remote sensing
- Real time detection tools

Management
- Improved non-lethal control (i.e. sterility)

Economics and Safety
- Improved damage estimates and thresholds
- Cost-effective wildlife control

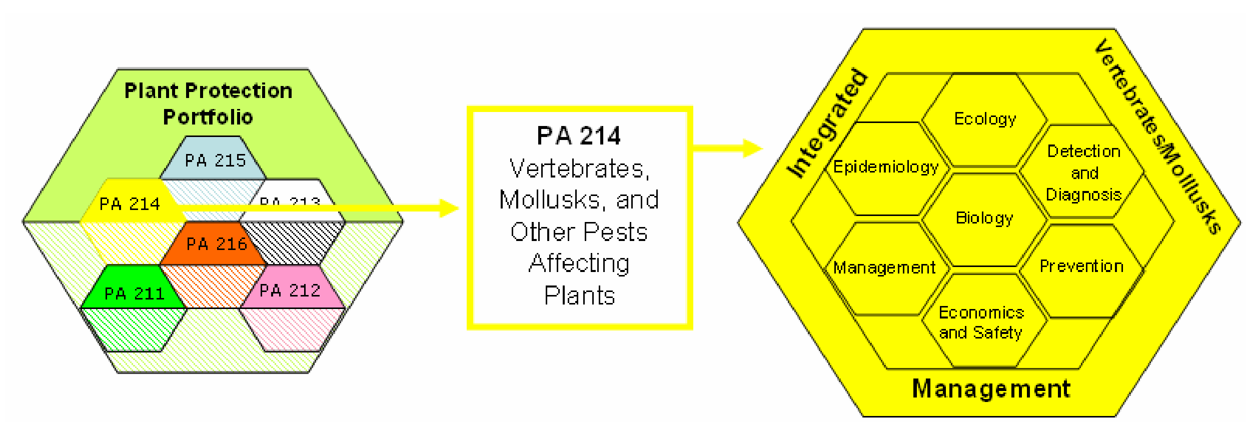
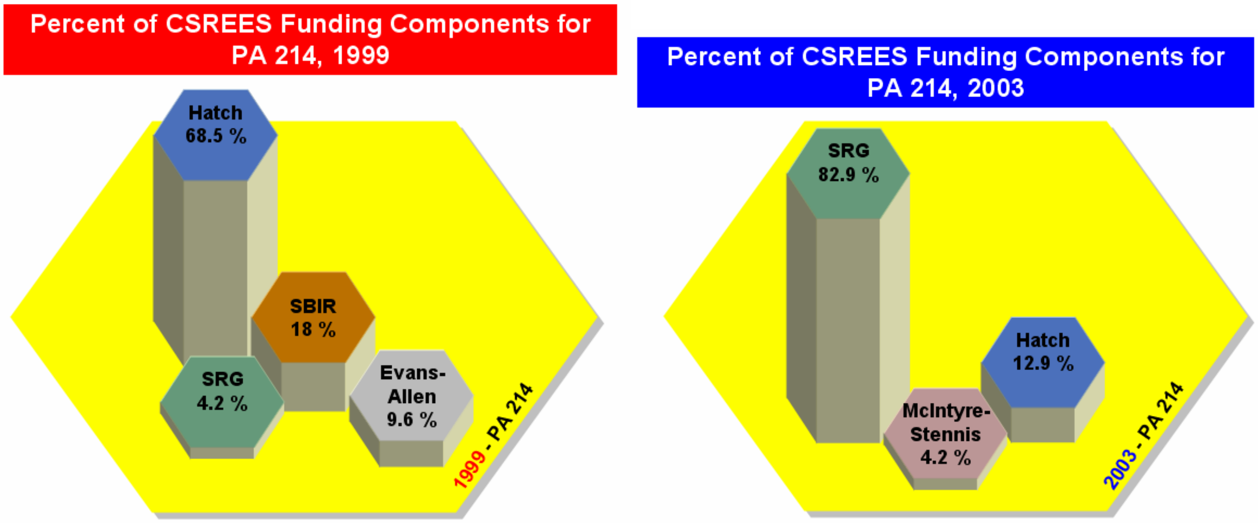


Figure 10.3



10.2 Focus of Critical Needs

The AREERA process requires that formula-funded projects reflect stakeholder priorities. The competitive review process, used for SBIR proposals, encourages innovative ideas that are likely to open new research approaches to enhancing U.S. agriculture through more focused research and education.

(A) Analysis of CRIS Data:

Figure 10.3 shows a graphic comparison of funding percentages for PA 214 from 1999 & 2003. In 1999, CSREES invested a total of $356,000 in PA 214. Of this total, 68% came from Hatch funds, 10% from Evans-Allen funds, and 4% from Special Research Grants (SRG). Together, these three non-competitive sources of funding accounted for 82% of all funds allocated by CSREES to PA 214. An additional 18% of funding for PA 214 came from the competitive Small Business Innovation Research (SBIR) program. The CSREES investment in PA 214 in 1999 represented 19% of the total funds invested in PA 214 and 0.55% of the CSREES funds invested in plant protection. The breakdown of funding by commodity area is presented in Table 10.1.

Table 10.1
Distribution of CSREES Investment in PA 214 for 1999

Description of SOI	Hatch	%	Evans-Allen	%	SRG	%	SBIR	%	CSREES	%
Vegetables	$113,000	75.3	$34,000	22.7	$4,000	2.7	0	0	$150,000	100
Deciduous & Small Fruit	$79,000	97.5	0	0	$3,000	3.7	0	0	$81,000	100
Ornamentals & Turf	$4,000	8	0	0	0	0	$45,000	90	$50,000	100
Top 3 SOI	$196,000	69.8	$34,000	12.1	$7,000	2.5	$45,000	16	$281,000	100
9 Other SOI	$48,000	29.8	0	0	$8,000	5	$19,000	11.8	$161,000	100
Total	**$244,000**	**68.5**	**$34,000**	**9.6**	**$15,000**	**4.2**	**$64,000**	**18**	**$356,000**	**100**

In 2003, CSREES investment in PA 214 had increased to $643,000. Of this total, 13% came from Hatch funds, 4% from McIntire-Stennis funds, and 83% from Special Research Grants. These accounted for 100% of CSREES's funding for PA 214. The CSREES investment in PA 214 in 2003 represented 34 % of the total funds invested in PA 214 and 0.79% of the total investment in all of plant production. From 1999 to 2003, CSREES increased funding for PA 214 by 81%, but

PA 214 remained the smallest PA of the Plant Protection Portfolio at less than 1%. The breakdown of funding by commodity area is presented in Table 10.2.

Table 10.2
Distribution of CSREES Investment in PA 214 for 2003

Description of SOI	Hatch	%	McIntire-Stennis	%	SRG	%	CSREES	%
Plants, General	0	0	0	0	$353,000	100	$353,000	100
Ornamentals & Turf	$6,000	6.5	0	0	$87,000	93.5	$93,000	100
Vegetables	0	0	0	0	$87,000	100	$87,000	100
Wildlife/Fisheries/E	$41,000	93.2	0	0	$3,000	6.8	$44,000	100
Grain Crops	$29,000	100	0	0	0	0	$29,000	100
Trees, Forest & For	0	0	$27,000	100	0	0	$27,000	100
Top 6 SOI	$76,000	12	$27,000	4.2	$530,000	83.7	$633,000	100
14 Other SOI	$7,000	70	0	0	$3,000	30	$10,000	100
Total	**$83,000**	**12.9**	**$27,000**	**4.2**	**$533,000**	**82.9**	**$643,000**	**100**

As described above, PA 214 represented a very small percentage of the overall Plant Protection Portfolio throughout the period from 1999 through 2003. In 1999 there were 30 individual projects involving PA 214. In 2003, there were 31 projects involving PA 214. In many cases, PA 214 was not the primary PA for a funded project. Over this period, the primary subjects of investigation for PA 214 were: Plants (General), Vegetables, Ornamentals & Turf, and Deciduous & Small Fruit. With the exception of SBIR competitively-funded projects, the PA 214 portion of the plant protection portfolio is funded with non-competitive funds.

10.3 Identification of Emerging Issues

Setting priorities is important to facilitate scientific and technological advances to meet the challenges facing US agriculture. Congress sets the budgetary framework by providing funds to CSREES. Members of Congress also make recommendations for the scientific and programmatic administration through appropriation language and through their questions and comments during Congressional hearings. Input into the priority-setting process is sought from a variety of customers and stakeholders. The scientific community provides input through the proposals it submits each year as well as through the proposal evaluation and funding recommendations of individual peer-review panels.

Review panels for competitive programs, Federal interagency working groups, stakeholder workshops, the National Research Council, participation in multi-state committees with AES, ARS, and other researchers are examples of important mechanisms for CSREES to identify emerging issues for PA 214. See Section 10.5 for a further discussion of multi-state committees pertinent to PA 214. National Program Leaders attend scientific and professional meetings to stay current on scientific trends that should be reflected in CSREES programs and in the coordination of priority setting with other federal agencies. NPLs also participate in meetings with representatives of key commodity groups and other user groups to discuss these stakeholders' current priorities, learn ways that CSREES can assist in meeting their needs, and solicit comments and suggestions.

The Regional IPM Centers are a new avenue for stakeholders to express their needs. Since 2003, the NE IPM Center has funded some wildlife damage control work (http://northeastipm.org/newsandreports/ar2004.pdf) - a FY2004 grant for Revision, Expansion, and Maintenance of the Internet Center for Wildlife Damage Management and assisted in sponsoring the publication of the Regional IPM Core Training Manual for Wildlife Control Operators in the Northeast. Wildlife control methods within communities are to be a topic at the 2005 Northeast Regional Community and Urban IPM Conference. Some new directions include approaching wildlife damage control from a landscape perspective and involving communities in determining control activities.

Included in the Reference and Evidentiary Materials for PA 214 is a survey by Cornell University entitled “Farmers’ Estimates of Economic Damages from White-tailed Deer in New York State,” March 2004. This publication summarizes the current impact of deer on New York agriculture and areas of need.

10.4 Integration of CSREES Programs

The Internet Center for Wildlife Damage Management, at http://wildlifedamage.unl.edu/, is operated from the University of Nebraska. This is a USDA, CSREES, IPM funded effort. The land-grant university system is the major contributor to training and education of professionals in wildlife damage. Most 1862 institutions offer one or more wildlife management courses that include elements of vertebrate damage control. A few offer courses that are largely or fully devoted to the subject and specialty programs, particularly at the M.S. and Ph.D. levels. Another example of major activities in the land-grant university system of wildlife damage is the Berryman Institute. The Berryman Institute for Wildlife Damage Management is headquartered at Utah State University and has an eastern office at Mississippi State University (www.berrymaninstitute.org). The Institute conducts research, educates graduate students, and offers competitive grants.

Through linking multi-functional projects, multi-institutional activities that create links across funding sources, CSREES creates a mechanism for integrating its PA 214 activities in competitive grants, formula funds, and special grants activities that may otherwise be disjointed.

10.5 Multidisciplinary Balance / Interdisciplinary Integration

CSREES linking projects are multi-institutional and multidisciplinary. Through these projects and activities, CSREES and their land-grant partners are able to stimulate the integration of current scientific advances with national stakeholder needs for applied research, extension activities, and educational programs.

Several multi-state projects, listed below, are involved with projects on management of vertebrate/wildlife in agro-forest ecosystems, suburban and rural landscapes, and agriculture, forestry and public lands. These multi-state committees are the only three groups in the U.S. with a focus and effort on agricultural depredation by wildlife:

NC1005 Landscape Ecology of Whitetailed Deer in Agro-Forest Ecosystems: A Cooperative Approach to Support Management

NE1005 Management of Wildlife Damage in Suburban and Rural Landscapes

WCC095 Vertebrate Pests of Agriculture, Forestry and Public Lands

Most States have at least one Cooperative Extension specialist whose responsibilities include wildlife damage control and public education. Brochures and other forms of educational materials on the topic are provided by virtually every state extension service. A national electronic depository of wildlife extension materials is maintained by the University of Wisconsin Cooperative Extension. Presently, there are 96 e-publications on animal damage control available at www.uwex.edu/ces/wlb/showpubs.cfm?categoryid=40.

The Northeast Wildlife Damage Management (WDM) Cooperative is a unique partnership and opportunity for extension efforts between state and Federal Wildlife Agencies and universities in the Northeast. Research conducted by the WDM Cooperative is supported by scientists from state agencies, federal agencies, and universities. The Northeast Regional Association of Agricultural Experiment Station Directors (NERA), comprised of scientists and extension specialists from 8 universities (Cornell, Connecticut, Maryland, Massachusetts, Penn State, Rhode Island, Virginia Tech, and West Virginia University) approved project NE-1005, Management of Wildlife Damage in Suburban and Rural Landscapes. Thirteen States participate actively in the cooperative. Applied research on white-tailed deer and resident Canada geese conducted as part of this regional effort complements priorities and related projects funded by the WDM Cooperative. The outreach efforts associated with NE-1005 were expanded during 2002 by formation of a Northeast Research and Extension Collaborative (NEREC), approved by both the Northeast Extension and Agricultural Experiment Station Directors of the participating universities. This partnership enhances ongoing wildlife damage management projects developed by wildlife agencies and academic institutions.

Quality

10.6 Significance of Findings and Outputs

CSREES-funded projects focusing on vertebrates, mollusks and other pests affecting plants have resulted in many high-impact publications in well-regarded journals (see examples below). They have also supported graduate student and postdoctoral training in wildlife management and related disciplines.

10.7 Stakeholder Assessment

CSREES seeks stakeholder input with regard to portfolio composition, program direction and research priorities. Examples of activities soliciting stakeholder input are as follows:

(A) *Plants and Pest Biology stakeholder workshop,* Crystal City, VA, November 14, 2002 Provided a forum for stakeholders to review and contribute feedback on the agency's research priority issue areas that CSREES is considering multi year funding. The issue areas are: (1) Agricultural and Environmental Quality, (2) Agricultural Security, (3) Genomics and Food and Fiber Production, (4) Obesity, Human Nutrition and Food Security, (5) Food Safety, and (6) Rural and Community Development. Feedback from this workshop helped to focus CSREES portfolios including the Plant Protection portfolio.

(B) IR-4 uses an extensive stakeholder driven process to prioritize research to ensure that it is focusing on the most critical pest management needs of the specialty crop producers. The priority setting process engages representatives from state and federal agricultural scientific communities, state extension systems, commodity and growers groups, the crop protection industry, food processors, and state and federal regulators.

(C) Stakeholders are involved in every aspect of IPM, Sustainable Agricultural Research and Education Program (SARE) and NPDN Center management, planning and program delivery. The IPM Centers work to connect a diverse array of people who have an interest in pest management policy and implementation throughout the region. These include pest management users (farmers, nurserymen, park and turf managers, building superintendents, pest control operators, homeowners, gardeners, and others), consumer and environmental groups, governmental regulatory agencies, researchers, and educators. IPM Centers network these groups both through its internal organization (Advisory Committee, Stakeholder groups, State Project Leaders) and through development of electronic communications structures such as email lists, online bulletin boards, and web pages.

10.8 Alignment of Portfolio with Current Science

Peer review of submitted proposals and NPL expertise assure that funded projects are aligned with the current state of science-based knowledge.

10.9 Methodology and Use of Funded Projects

This portfolio leads to solutions to National plant protection problems, improved economic performance for procedure and long term protection of the nation's food system, plant biosecurity and the environment.

Performance

10.10 Portfolio Productivity

Portfolio productivity is evidenced primarily by publications in well-regarded peer-reviewed journals (see Section 10.16 Examples of Research Accomplishments). Accomplishments described in annual CRIS reports, citations, and presentations at scientific and other professional meetings demonstrate productivity. Portfolio productivity in PA 214 is evidenced by commercially viable products and new discoveries.

10.11 Portfolio Completeness

Portfolio completeness is demonstrated through submitted annual progress reports (CRIS), termination reports and accomplishment reports. Some aspects of the portfolio in PA 214 are more complete than other aspects. Where possible, CSREES coordinates externally with other Federal agencies to address knowledge gaps. One example of such coordination is the partnership with the National Science Foundation (NSF) to administer the NSF/CSREES Microbial Genome Sequencing Program. (see Section 10.16 for examples of projects funded by CSREES through this program).

10.12 Portfolio Timeliness

Portfolio timeliness of PA 214 is evidenced through annual performance reports (CRIS), termination reports, and accomplishments reports. Peer review of competitive funding serves to ensure that funded projects are timely and take advantage of state-of-the-art methods.

10.13 Agency Guidance

Agency guidance to applicants is provided primarily in Requests for Applications (RFAs). Annual review and updating of RFA language is provided upon request for PA 214. Responses to congressional inquiries are provided as requested.

10.14 Portfolio Accountability

The agency solicits stakeholder input in determining the scope and priorities of its research, education and extension portfolio. Input is solicited in stakeholder workshops and other activities that solicit input from scientific communities (see Section 10.7 Stakeholder Assessment above). Accountability is provided through annual reports (CRIS), and accomplishment reports.

10.15 References and Evidentiary Materials

See file folders of evidentiary material, which includes publications, books, journal articles, websites, etc.

10.16 Examples of Research Accomplishments

Research and Extension programs for plant protection management systems are generally commodity specific. Therefore representative examples are provided in the Reference and Evidentiary Materials to illustrate the impact of CSREES investment in PA 214.

(B) Study Monitors Deer Impact on Arkansas Post National Memorial Habitat

Issue
Browsing by white-tailed deer of understory vegetation can lead to changes in successional patterns and also alter habitat that is critical for certain wildlife species. Arkansas Post National Memorial (ARPO), a unit of the National Park Service located in east-central Arkansas, supports a protected population of white-tailed deer at densities often exceeding a deer per 5 acres. This abundant and protected population of white-tailed deer provided an excellent opportunity to investigate the impacts of herbivory by deer in the southern United States. Concern by park officials over the perceived density, health, and environmental impacts of the deer population on ARPO led to the initiation of this study.

What has been done?
Potential impacts of deer herbivory on understory vegetation at ARPO were investigated using four 5x5 m deer-proof exclosures along with paired, unfenced plots. These were placed within each of five vegetation types (oak/hickory, oak/pine, oak/sweetgum, sweetgum, tall grass prairie) in June 1999. Percent cover in a randomly selected 1-m2 quadrat within each exclosure and unfenced plot was ocularly estimated once per month from June through October during 1999 and 2000. All vegetation within the selected quadrat was then clipped and sorted to the species level (except grasses). Biomass values were derived for species groups (trees, shrubs, grasses and sedges, vines, and forbs) and for individual plant families. Mean percent cover and dry biomass was compared between fenced and unfenced plots by month within each vegetation type.

Impact
Results indicate that deer exclosures resulted in significant, specific changes in understory biomass, composition, and structure after only one growing season. Continued monitoring of vegetation through the use of exclosures or other methods will provide information on potential long-term effects of deer herbivory on understory vegetation. This information may then be used to develop appropriate scenarios for managing white-tailed deer and native vegetation at ARPO.

Primary impact area(s)
Research

Funding sources
State (Arkansas Forest Resources Center, University of Arkansas)

(C) Quality Deer Management

Issue
The white-tailed deer is the most popular big game animal in Tennessee and the conterminous United States. Through restocking efforts and regulated hunting, white-tailed deer populations have rebounded from all-time lows in the early twentieth century to approximately 33 million animals today. A major reason for this success was a restriction on the doe harvest, allowing only

bucks to be killed during the hunting season. This process was expedited in that the majority of deer predators (e.g., red wolves, gray wolves, mountain lions, bobcats, and black bears) had been extirpated from the majority of the whitetail's range. As deer populations became re-established, states began to allow limited antlerless hunts; however, in some regions, it was too little, too late. By the 1990s, deer populations had exceeded carrying capacity in many areas, especially in the South and Northeast. The continued restriction on doe harvest created skewed populations favoring does with few mature bucks in most places. In Tennessee, yearling (1_ years old) bucks have comprised 70-80% of the bucks harvested annually over the last 15 years. Overpopulated deer herds with unbalanced sex ratios have created many human/deer conflicts, including forest and crop depredation, increased deer-vehicle collisions, habitat destruction (negatively affecting many wildlife species), and unnatural changes in the timing of reproduction, altering behavior and reduced fawn survival.

What has been done?
Four educational training seminars and workshops were given to 125 people, representing natural resource professionals, landowners, and students. The sessions concentrated on explaining deer population dynamics and the relationship of the deer herd with habitat conditions and the effect on other wildlife species. They were instructed how to improve the condition of the deer herd through non-traditional hunting regulations and habitat improvement. Over 1,000 Extension publications with this information was distributed. Demonstration food plots were established to determine germination rates, deer preference, and resistance to browsing. Data collected from these plots were incorporated into two Extension publications, reaching over 2,000 people. Quality Deer Management (QDM) programs were implemented on seven areas and a research project was initiated on the Hobart Ames Plantation. Funding from outside sources has provided $25,000 to support these projects. These programs are actively taking steps to improve the sex ratio and age structure of the herd. Additional work involves habitat improvement, either through establishing food plots or other habitat improvement practices, such as timber stand improvement and the use of prescribed fire in fields and woodlots.

Impact
A QDM, including population management and habitat management, was initiated on a 200-acre private estate in Blount County that had suffered extreme damage by deer browsing on ornamental shrubs and flowers. To date, hunters have killed 55 deer on the property and improved natural food resources for the deer herd by planting food plots, thinning forest stands, and using prescribed fire. Prior to initiation of the project, damage to ornamental plantings was in excess of $10,000 annually; now, damage by deer is non-existent. The sex ratio of the herd has been improved from six does per buck to two does per buck, which improves reproductive fitness and timing of birth. A deer census on the area has shown the population has been reduced to the point where the available habitat is better able to support the herd. Other sites are showing similar trends. That is, reduced deer damage to crops and ornamental plantings, improved sex ratios and age structure among the animals in the herd, increased weights, and earlier birthing dates, which improve fitness and fawn survival.

Primary impact area(s)
Research, education, and extension

Funding sources
Local (UT Agricultural Extension Service)
Other (Hobart Ames Foundation, Quality Deer Management Association)

Topics
Invasive Species/Response
Precision Agriculture

(D) Reducing Deer Damage

Issue
The over-populated white-tailed deer herd in West Virginia is creating problems. The deer damage crops, cause numerous vehicle accidents, and spread diseases. Hunters are the primary means to control the deer herd. However, in recent years wildlife managers have done an exceptional job of building a large deer herd in the state. Hunters may kill up to seven deer per year, but most kill only one. Very few kill more than three deer. The state's Department of Natural Resources (DNR) liberally issue special hunting permits to farmers and gardeners who are experiencing crop damage. These special permits, however, are not issued in response to forest damage. The primary means to reduce crop damage includes exclusion, repellents, and scare tactics.

What has been done?
The goal is to use educational programs to help communities reduce the amount of damage white-tailed deer inflict on agricultural enterprises, forests, and home landscapes and gardens. The primary method to disseminate education was through seminars, individual consultations (phone and e-mail), and distribution of deer-damage publications and fact sheets. Results of deer damage surveys in four urban-suburban areas were written up for publication. Money must now be found to print the information in quantity enough for dissemination.

Impact
Two more cities have adopted an urban deer hunting program to reduce the deer herd.
A workshop for professional foresters was especially useful in reaching 64 "teach the teachers." These professionals were primarily consulting foresters who are passing the deer damage information on to landowner clients.
• Number of publications distributed - 475
• Number of participants in seminars - 280
• Control measures adopted – 23

Primary impact area(s)
Extension

Funding sources
Smith-Lever 3(b) & (c)
State (W.Va. Department of Natural Resources and W.Va. Division of Forestry)
Other (W.Va. Farm Bureau)

Topics
Invasive Species/Response

Section 11: Problem Area 215
Biological Control of Pests Affecting Plants

Relevance

11.1 Scope

Biological control is the use of natural enemies (predators, parasitoids, and pathogens) to reduce or maintain pest population levels below that which would occur in their absence. Target pests can include weeds, insects and mites, pathogens, nematodes, and vertebrates. Because natural enemies often play a major role in the dynamics of pests, biological control should be the cornerstone of Integrated Pest Management (IPM), which is a strategy that provides a sustainable approach to managing pests by combining biological, cultural, physical, and chemical tools in a way that minimizes economic, health, and environmental risks. Three major approaches are typically used in biological control, including the classical approach, augmentation, and conservation. In the classical approach, natural enemies are collected from the place of origin of the pest and introduced into new areas where the pest has become a problem. Augmentation involves the mass production and periodic release of natural enemies. The conservation approach involves improving aspects of the environment to conserve resident and introduced beneficial organism and improve their effectiveness. Examples of conservation biological control include: using reduced pesticide applications and rates; use of "softer" pesticides such as microbials, insecticidal soaps and botanicals; use of more selective pesticides that are less harmful to natural enemies; use of flowers/refugia/intercropping/cover crops/cultivars, etc., that provide nectar, pollen, and protection for natural enemies; providing protein and sugar supplements to natural enemies; and using tillage and fertilization practices that enhance natural enemy densities and diversity. Biological control of invertebrate pests, weeds, and pathogens is desirable because the method is environmentally safe, cost-effective, energy self-sufficient, and often self sustaining. Furthermore, the benefits from the use of natural enemies accrue annually at no extra cost, compared to the utilization of chemicals which represent a recurrent expense to the agricultural producer.

Areas of work in biological control include, but are not limited to: the biology and ecology of the natural enemy species and the target host; population modeling; ecological niche/habitat association modeling; multi-trophic level interactions; intra-guild predation; genetic improvement of natural enemies; assessment of natural enemy efficacy and non-target impacts; taxonomy of natural enemies and target host; assessment of host races of natural enemies through behavioral and molecular genetic studies; development of optimal sampling/monitoring strategies for natural enemies and pests; integration of biological control with other pest management strategies; pre-release studies to determine the compatibility of multiple natural enemy species; optimal release strategies (numbers to release, frequency of release, timing of release, etc.); risk analysis of natural enemies and the target host; strategies for determining the safest and most effective natural enemy species; overwintering survivorship; diapause studies; host-specificity testing; retrospective studies of the natural enemies; and development of mass-rearing techniques.

In the broader context, biological control is among a number of other pest management strategies generally termed "bio-based". These include: microbial control (the use of viruses, fungi, bacteria, and other microorganisms to control pests); behavior-modifying tools (e.g., use of pheromones in mating disruption of pests or for attract and kill strategies); genetic manipulation (male-sterile technique, lethal genes, transgenesis and paratransgenesis, etc.); use of transgenic crops (e.g., B.t. cotton and corn, roundup-resistant soybeans, etc.); and plant immunization (e.g., resistance conferred to plants from exposure to chemicals or pathogens).

This area focuses on classical, augmentative, or inundative use of natural enemies (including microbial biological control agents) to manage plant pests (pathogens, insects, mites, nematodes, weeds, vertebrates, etc.).

The logic model for PA 215 is illustrated in Figure 11.1(found on page 122). Major accomplishments and needs summaries for PA 215 are provided in Figure 11.2 (found on page 123). Major subject area categories defined for PA 215 are shown at the bottom of Figure 11.2.

(A) Areas of work include but are not limited to:

- Basic biology and genetic improvement of natural enemies.
- Ecology and conservation of natural enemies.
- Population dynamic-epidemiologic-multitrophic interactions among natural enemies.
- Collection and discovery of natural enemies.
- Biosystematics/taxonomy.
- Maintenance, mass production, quality control, and delivery systems for natural enemies.
- Development of sampling protocols (including remote sensing and other automated sampling methodologies) and predictive models for natural enemies.

(B) Exclude:

- Management of plant pests using methods other than biological control, including chemical, cultural, physical, and host plant resistance. (Use PAs 211-214)
- Integration of control tactics into systems for managing single pest species or pest complexes. (Use PA 216)
- Development of sampling protocols and predictive models for pest management complexes. (Use PA 216)
- Development of remote sensing instruments. (Use PA 404)

Figure 11.1

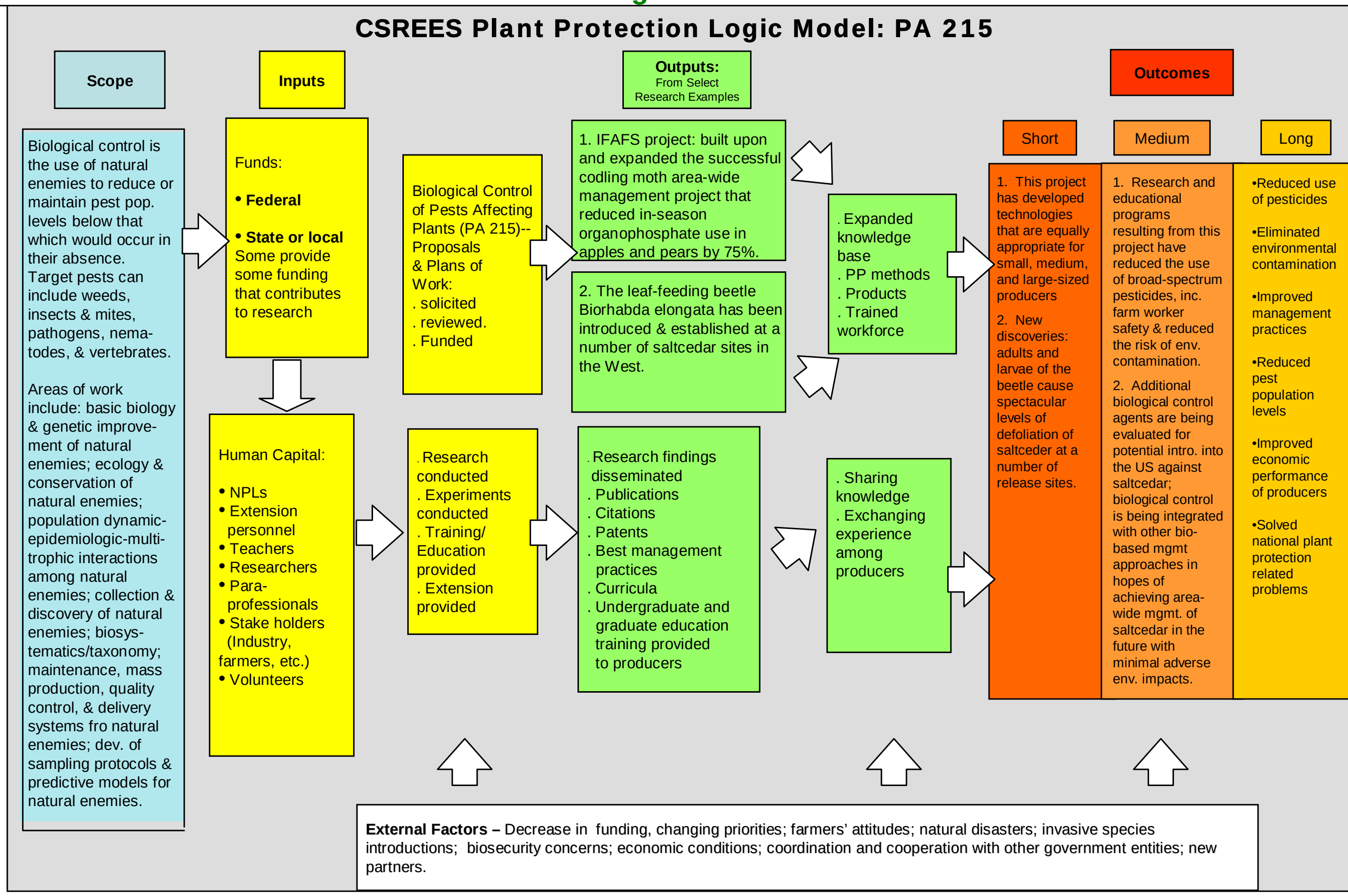

CSREES Plant Protection Logic Model: PA 215
Scope
Inputs
Outputs: From Select Research Examples
Outcomes
Short
Medium
Long
Biological control is the use of natural enemies to reduce or maintain pest pop. levels below that which would occur in their absence. Target pests can include weeds, insects & mites, pathogens, nema-todes, & vertebrates.
Areas of work include: basic biology & genetic improve-ment of natural enemies; ecology & conservation of natural enemies; population dynamic-epidemiologic-multi-trophic interactions among natural enemies; collection & discovery of natural enemies; biosys-tematics/taxonomy; maintenance, mass production, quality control, & delivery systems fro natural enemies; dev. of sampling protocols & predictive models for natural enemies.
Funds:
• Federal
• State or local
Some provide some funding that contributes to research
Human Capital:
• NPLs
• Extension personnel
• Teachers
• Researchers
• Para-professionals
• Stake holders (Industry, farmers, etc.)
• Volunteers
Biological Control of Pests Affecting Plants (PA 215)--Proposals & Plans of Work: . solicited . reviewed. . Funded
. Research conducted . Experiments conducted . Training/ Education provided . Extension provided
1. IFAFS project: built upon and expanded the successful codling moth area-wide management project that reduced in-season organophosphate use in apples and pears by 75%.
2. The leaf-feeding beetle Biorhabda elongata has been introduced & established at a number of saltcedar sites in the West.
. Research findings disseminated . Publications . Citations . Patents . Best management practices . Curricula . Undergraduate and graduate education training provided to producers
. Expanded knowledge base . PP methods . Products . Trained workforce
. Sharing knowledge . Exchanging experience among producers
1. This project has developed technologies that are equally appropriate for small, medium, and large-sized producers
2. New discoveries: adults and larvae of the beetle cause spectacular levels of defoliation of saltceder at a number of release sites.
1. Research and educational programs resulting from this project have reduced the use of broad-spectrum pesticides, inc. farm worker safety & reduced the risk of env. contamination.
2. Additional biological control agents are being evaluated for potential intro. into the US against saltcedar; biological control is being integrated with other bio-based mgmt approaches in hopes of achieving area-wide mgmt. of saltcedar in the future with minimal adverse env. impacts.
•Reduced use of pesticides
•Eliminated environmental contamination
•Improved management practices
•Reduced pest population levels
•Improved economic performance of producers
•Solved national plant protection related problems
External Factors – Decrease in funding, changing priorities; farmers' attitudes; natural disasters; invasive species introductions; biosecurity concerns; economic conditions; coordination and cooperation with other government entities; new partners.

Figure 11.2
Accomplishments and Needs Summary for PA 215

Accomplishments

Biological Control
- Biological control of arthropod pests with predators, parasitoids and pathogens
- Biological control of weeds with arthropods, pathogens, and grazing animals
- Biological control of plant pathogens with other pathogens

Microbial Pesticides
- Novel formulations that enhance field stability and efficacy
- Non-target impact assessment
- Improved efficacy through use of recombinant pathogen strains

Behavior Modifying Chemicals
- Mating disruption
- Attract and kill strategies
- Improved pest and natural enemy monitoring and collection tools

Genetic Manipulation
- Sterile male technique
- Lethal genes (e.g., pink bollworm)
- Transgenesis/Paratransgenesis – gene insertions that prevent disease transmission

Transgenic Crops
- Stacked genes in crop plants for resistance to multiple pests
- Non-target impacts

Plant Immunization
- Enhanced resistance through exposure to chemicals and pathogens
- Cross-protection from exposure to mild pathogen strains

Needs

Biological Control
- Better predictions of biological control agent efficacy
- Improvement of biological control agents (e.g., expand host range of entomopathogenic nematodes and fungi, increase longevity, reduced susceptibility to UV light)
- Improved prediction and assessment of non-target impacts and host shifts (risk analysis)
- Improved environmental safety of biological control agents
- Better continuity in funding for bio-based pest management; large-scale efficacy trials for pathogens; area-wide pest management projects

Microbial Pesticides
- Improvements in the regulatory process for natural enemies of arthropods, weeds, and pathogens

Behavior Modifying Chemicals
- Improved pheromone delivery systems

Genetic Manipulation
- Greater transparency in development of genetically modified crops and other biological organisms

Transgenic Crops
- Improved understanding of necessary size and distance of refugia for GMO crops

Plant Immunization
- Improved assessment of non-target effects of plant immunization (e.g., use of endophytic fungi to confer resistance – toxic to livestock?)

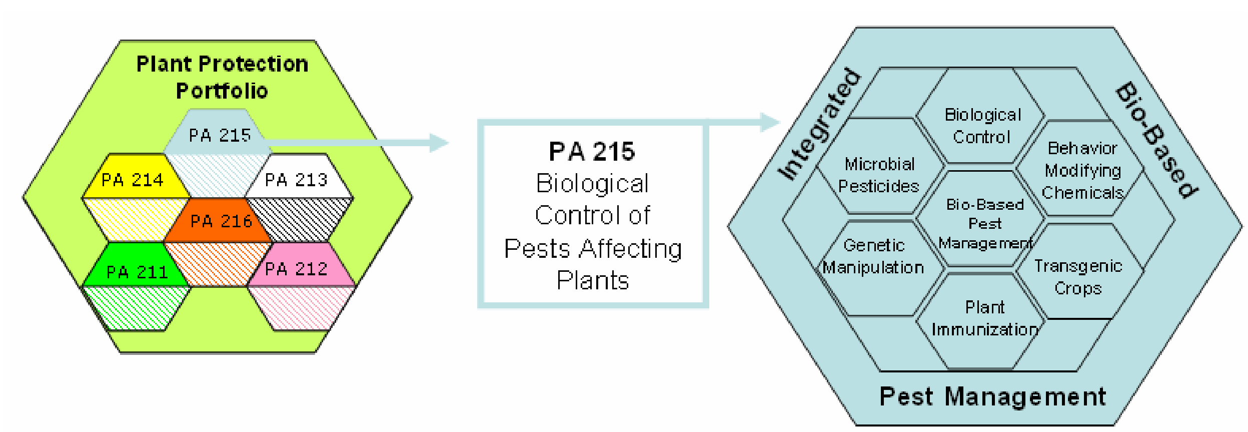
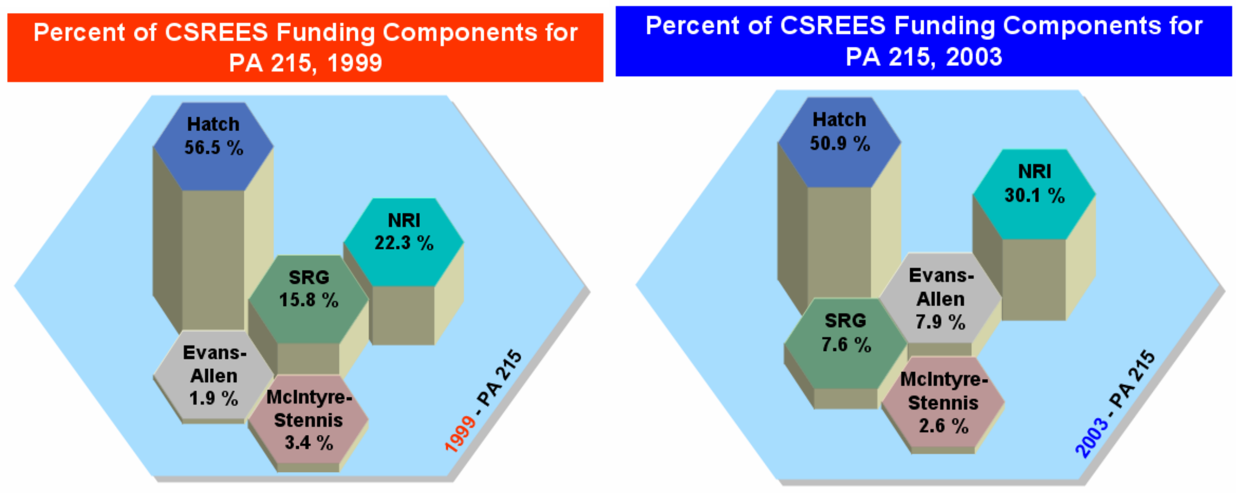


Figure 11.3



11.2 Focus on Critical Needs

CSREES has been very responsive to critical issues and the needs of the national, such as in addressing concerns for pesticide residues on foods, groundwater and the environment. With the elimination and phase-out of many pesticides, due to the Food Quality and Protection Act of 1996, CSREES has developed a number of Integrated Pest Management funding programs that emphasize safer, more bio-based pest management approaches. These include the Risk Avoidance and Mitigation Program (RAMP), the Crops at Risk Program (CAR), the Methyl Bromide Transitions Program, the Organic Transitions Program, and the Sustainable Agricultural Research and Education Program (SARE) and the Pest Management Alternative Program.

(A) Analysis of CRIS Data:

Figure 11.3 shows a graphic comparison of funding percentages for PA 215 from 1999 & 2003. In 1999, CSREES invested a total of $9,536,000 in PA 215. Of this total, 57% came from Hatch funds, 3% from McIntyre-Stennis, 2% from Evans-Allen funds and 16% from Special Research Grants (SRG). The National Research Initiative (NRI) invested $2,128,000 in biological control programs dedicated to PA 215, which was 22% of the total CSREES investment. Together, these four non-competitive sources of funding accounted for 78% of all funds allocated by CSREES to PA 215, and combined with the NRI Program represented 15% of all the CSREES funds invested in plant protection. The breakdown of funding by commodity area is presented in Table 11.1 (found on page 125).

Table 11.1
Distribution of CSREES Investment in PA 215 for 1999

Description of SOI	Hatch	%	Mc-Stennis	%	Evans-Allen	%	SRG	%	NRI	%	CSREES	%
Invertebrates	735	37.6	124	6.3	39	2	217	11.1	840	42.9	1,956	100
Vegetables	687	51.5	0	0	0	0	562	42.2	84	6.3	1,333	100
Microorganisms	450	42.7	9	0.9	48	4.5	57	5.4	491	46.5	1,055	100
Trees, Forest & For	539	67.9	155	19.5	0	0	0	0	100	12.6	794	100
Grain Crops	359	49.8	0	0	0	0	0	0	363	50.3	721	100
Deciduous & Small Fruit	383	62	0	0	0	0	158	25.6	77	12.5	618	100
Weeds	127	54	0	0	0	0	108	46	0	0	235	100
Misc & New Crops	131	100	0	0	0	0	0	0	0	0	131	100
Top 6 SOI	3,153	48.7	288	4.4	87	1.3	994	15.3	1,955	30.2	6,477	100
2 Small Focus Areas	258	70.5	0	0	0	0	108	29.5	0	0	366	100
24 Other SOI	1,977	73.4	39	1.4	98	3.6	406	15.1	173	6.4	2,693	100
Total	**$5,388**	**56.5**	**$327**	**3.4**	**$185**	**1.9**	**$1,508**	**15.8**	**$2,128**	**22.3**	**$9,536**	**100**

In 2003, CSREES investment in PA 215 had increased to $9,908,000. Hatch funds accounted for 51% of the total and together with other non-competitive sources of funding for PA 216 accounted for 69% of the total. The continued maturation of the CSREES Integrated Research, Education and Extension grant programs, such as the Initiative for Future Agricultural and Food Systems (IFAFS), the Risk Avoidance and Mitigation Program, the Crops at Risk Program, the Methyl Bromide Transitions Program, and the Organic Transitions Program, accounted for some funds invested in PA 215. The National Research Initiative Program invested $2,984,000 in biological control programs dedicated to PA 215 in 2003, which was 30% of the total CSREES investment. The CSREES investment in PA 215 in 2003 represented 12% of the total investment in all of plant protection. The breakdown of funding by commodity area is presented in Table 11.2.

Table 11.2
Distribution of CSREES Investment in PA 215 for 2003

Description of SOI	Hatch	%	Mc-Stennis	%	Evans-Allen	%	SRG	%	NRI	%	CSREES	%
Invertebrates	802	48.9	30	1.8	181	11	0	0	627	38.2	1,640	100
Vegetables	728	46.7	0	0	443	28.4	48	3.1	339	21.8	1,558	100
Microorganisms	507	36.1	53	3.8	114	8.1	167	11.9	564	40.2	1,440	100
Grain Crops	319	34.7	0	0	0	0	72	7.8	528	57.5	919	100
Soil & Land	9	8.6	0	0	0	0	0	0	97	92.4	105	100
Top 4 SOI	2,356	42.7	83	1.5	738	13.4	287	5.2	2,058	37.3	5,521	100
1 Small Focus Areas	9	8.6	0	0	0	0	0	0	97	92.4	105	100
27 Other SOI	2,675	62.5	177	4.1	45	1.1	470	11	829	19.4	4,282	100
Total	**$5,040**	**50.9**	**$260**	**2.6**	**$783**	**7.9**	**$757**	**7.6**	**$2,984**	**30.1**	**$9908**	**100**

11.3 Identification of Emerging Issues

CSREES engages in continuous feedback with stakeholders and partners to ensure that new emerging issues are being addressed. This is accomplished through feedback from multi-state committees, input from federal and nonfederal partners in the development of RFA's, feedback from professional societies, and a budget crosscutting process that identifies critical issues of shared interest across federal agencies. A number of emerging issues have been identified by our stakeholders and partners. These include the improvement of biological control agents (e.g., expanding the host range of entomopathogenic nematodes and fungi, increasing their longevity, and reducing their susceptibility to UV radiation); the need to develop standardized criteria for assessing the effect of biological control on non-target species, including the evaluation of host shifts; improving the environmental safety of biological control agents (e.g., Bacillus cerus); improving the regulatory process (e.g., importation of biological control agents and permits from APHIS, USFWS); and developing risk analysis methods for determining potential risks from invaders or biological threats.

11.4 Integration of CSREES Programs

CSREES has funded a number of large-scale/regional, bio-based pest management projects that address multiple crops and pest complexes. These include projects in the Risk Avoidance and Mitigation Program (RAMP), and the Initiative for Future Food and Agricultural Systems Program (IFAFS). These multi-state, multi-agency, multi-disciplinary, integrated (involving research, education, and extension) projects are funded at levels that enable the researchers to address very complex pest problems on a grand scale, while still delivering applied pest management information to the growers. CSREES has also participated with other USDA Agencies in the development of joint white papers on research (e.g., Bio-based Pest Management, and Invasive Species; federal partner: ARS), and a budget-crosscut for invasive species (federal partners: APHIS-PPQ, ARS, ERS, NRCS, and USFS), which will emphasize integrated pest management, including bio-based strategies.

11.5 Multidisciplinary Balance / Interdisciplinary Integration

The biological, ecological, and environmental complexities associated with our agricultural pests (including their associated natural enemies) necessitate that an interdisciplinary approach be used to help solve our agricultural pest problems. The Risk Avoidance and Mitigation Program, and the Crops at Risk Program are hallmark examples where interdisciplinary research has been conducted and management approaches implemented to address pest complexes, often across a number of states, regions and crop commodities.

Quality

11.6 Significance of Findings and Outputs

CSREES-funded projects focusing on biological control agents affecting plants have resulted in many high-impact publications in well-regarded journals (see examples 11.16). They have also supported graduate student and postdoctoral training in biological control and related disciplines.

11.7 Stakeholder Assessment

CSREES seeks stakeholder input with regard to portfolio composition, program direction and research priorities. Examples of activities soliciting stakeholder input are as follows:

(A) *Plants and Pest Biology stakeholder workshop,* Crystal City, VA, November 14, 2002 Provided a forum for stakeholders to review and contribute feedback on the agency's research priority issue areas that CSREES is considering multi year funding. The issue areas are: (1) Agricultural and Environmental Quality, (2) Agricultural Security, (3) Genomics and Food and Fiber Production, (4) Obesity, Human Nutrition and Food Security, (5) Food Safety, and (6) Rural and Community Development. Feedback from this workshop helped to focus CSREES portfolios including the Plant Protection portfolio.

(B) IR-4 uses an extensive stakeholder driven process to prioritize research to ensure that it is focusing on the most critical pest management needs of the specialty crop producers. The priority setting process engages representatives from state and federal agricultural scientific communities, state extension systems, commodity and growers groups, the crop protection industry, food processors, and state and federal regulators.

(C) Stakeholders are involved in every aspect of IPM, SARE and NPDN Center management, planning and program delivery. The IPM Centers work to connect a diverse array of people who have an interest in pest management policy and implementation throughout the region. These include pest management users (farmers, nurserymen, park and turf managers, building superintendents, pest control operators, homeowners, gardeners, and others), consumer and environmental groups, governmental regulatory agencies, researchers, and educators. IPM Centers network these groups both through its internal organization (Advisory Committee, Stakeholder groups, State Project Leaders) and through development of electronic communications structures such as email lists, online bulletin boards, and web pages.

11.8 Alignment of Portfolio with Current Issues

Peer review of submitted proposals and NPL expertise assure that funded projects are aligned with the current state of science-based knowledge.

11.9 Methodology and Use of Funded Projects

This portfolio leads to solutions to National plant protection problems, improved economic performance for procedure and long term protection of the nation's food system, plant biosecurity and the environment.

Performance

11.10 Portfolio Productivity

Portfolio productivity is evidenced primarily by publications in well-regarded peer-reviewed journals (see Section 11.16 Examples of Research Accomplishments). Accomplishments described in annual CRIS reports, citations, and presentations at scientific and other professional meetings demonstrate productivity. Portfolio productivity in PA 215 is evidenced by commercially viable products and new discoveries.

11.11 Portfolio Completeness

Portfolio completeness is demonstrated through submitted annual progress reports (CRIS), termination reports and accomplishment reports. Some aspects of the portfolio in PA 21 are more complete than other aspects. Where possible, CSREES coordinates externally with other Federal agencies to address knowledge gaps. One example of such coordination is the partnership with the National Science Foundation (NSF) to administer the NSF/CSREES Microbial Genome Sequencing Program. (see Section 11.16 for examples of projects funded by CSREES through this program).

11.12 Portfolio Timeliness

Portfolio timeliness of PA 215 is evidenced through annual performance reports (CRIS), termination reports, and accomplishments reports. Peer review of competitive funding serves to ensure that funded projects are timely and take advantage of state-of-the-art methods.

11.13 Agency Guidance

Agency guidance to applicants is provided primarily in Requests for Applications (RFAs). Annual review and updating of RFA language is provided upon request for PA 215. Responses to congressional inquiries are provided as requested.

11.14 Portfolio Accountability

The agency solicits stakeholder input in determining the scope and priorities of its research, education and extension portfolio. Input is solicited in stakeholder workshops and other activities that solicit input from scientific communities (see Section 11.7 Stakeholder Assessment above). Accountability is provided through annual reports (CRIS), and accomplishment reports.

11.15 Reference and Evidentiary Material

See file folders of evidentiary material, which includes publications, books, journal articles, websites, etc.

11.16 Examples of Research Accomplishments

Research and Extension programs for plant protection management systems are generally commodity specific. Therefore representative examples from each of the major commodity groups are listed to illustrate the impact of CSREES investment in PA-215.

(A) RAMP Project: Enhancing Pheromone Mating Disruption Programs for Lepidopterous Pests in Western Orchards

This RAMP project has built upon the successful area-wide management project that targeted the key pest in apples and pears, the codling moth, and reduced the use of the in-season organophosphate insecticides by 75%. The original project goals were to further reduce broad-spectrum pesticide use, expand the use of mating disruption using the pheromones of key insect pests, and to improve opportunities for biological control of other pests in orchards. Apple and pear production systems are at risk under the 1996 Food Quality and Protection Act (FQPA) due to safety concerns and re-registration obstacles for currently used pesticides, and the fact that apples and pears comprise a significant fraction of the "risk cup" in the diets of infants and children. The approaches outlined in the objectives include: a) establishment of large-scale sites to determine the difficulties and advantages of replacing broadly toxic insecticides with new selective products; b) evaluation and development of new non-insecticidal, e.g., pheromones, programs for both the primary and secondary pests; c) evaluation and improvement of new monitoring systems to reduce grower risk; d) reductions in insecticide use rates through use of feeding stimulants and baits; and e) extension of these new programs to new acreage, pests and crops. This project is multi-state, multi-institutional, and multi-disciplinary. The research and education programs developed by this project have reduced the use of broad-spectrum pesticides, increased farm worker safety and reduced the risk of environmental contamination. Researchers are also investigating ways to enhance biological control in the orchards, and in the process establish a low-cost, more sustainable management system. This project is expected to increase acreage under mating disruption, improve program efficacy, reduce program risks, and reduce costs to help U.S. agriculture compete in a global economy.

(B) IFAFS Project: Building a Multi-Tactic Pheromone-Based Pest Management System in Western Orchards

This project has built upon and expanded the successful codling moth area-wide management project that reduced in-season organophosphate use in apples and pears by 75%. The original project goals were to further reduce broad-spectrum pesticide use, expand the use of mating disruption in pome fruits and new cropping systems, and increase efficacy of biological control in orchards for secondary pests. Apple and pear production systems are at risk under the 1996 Food Quality and Protection Act (FQPA) due to safety concerns and re-registration obstacles for currently used pesticides, and the fact that apples and pears comprise a significant fraction of the "risk cup" in the diets of infants and children. The approaches outlined in the objectives include:

1) establish large-scale sites to assess the replacement of organophosphate and carbamate insecticides with new selective products; 2) extend pheromone-based management principles to new acreage, pests and crops; 3) evaluate and improve non-pheromone-based monitoring systems to reduce risk; 4) manipulate the orchard and near-orchard habitats to improve efficacy of biocontrol of secondary pests; and 5) develop alternative methods for managing locally invasive secondary pests, such as true bugs. This multi-state, multi-institutional, and multi-disciplinary project has developed technologies that are equally appropriate for small, medium, and large-sized producers. The research and educational programs resulting from this project have reduced the use of broad-spectrum pesticides, increased farm worker safety and reduced the risk of environmental contamination.

(C) RAMP Project Consortium for Integrated Management of Stored Product Insect Pests (CIMSPIP); Fourth Year Review summarized by R. T. Arbogast, USDA-ARS-CMAVE, Gainesville, FL, Salt Lake City, UT, November 13, 2004.

The presentations of research results at this review demonstrated clearly that the overall objective of the project – to develop pest management methods that will reduce or eliminate risk from pesticide residues – is being well addressed and that excellent progress has been made. Examples of significant progress include:

Sampling and IPM Decision Making:
A new male-produced aggregation pheromone has been discovered in the sawtoothed grain beetle, and the active compounds have been fractionated from male frass. Research is now underway to identify the compounds, which could eventually be synthesized to produce a commercially available product that will provide the first good monitoring tool for this important pest.

Population Ecology, Dispersal, Migration:
Data from experimental landscape studies of how flour patch size and abundance influence movement of red flour beetles provides a baseline for additional studies relating insect movement and oviposition to landscape. Ultimately, this can be used to understand and model pest population structure in food processing and storage facilities.

Monitoring spatial and temporal distribution of the lesser grain borer in an agricultural landscape over a two-year period indicated that the beetles may overwinter in woods and disperse to farm bins in spring and summer, then back to the woods in the fall. This information is basic to developing a wide area management strategy for this important pest.

Behavior and Genetics:
Basic research, such as that on transposone-mediated mutagenesis and on molecular characterization of digestive proteinases, will provide a foundation for a new generation of non-pesticide control methods that will target neural regulators, digestion and growth.

Research on heat shock proteins will provide better understanding of the biological processes that accompany heat treatment.

The results of research on Indianmeal moth population genetics, using microsatellite markers, can be expected to provide insight into population structure, dispersal, and the genetic relationship and gene flow among sub-populations. This insight will be useful in developing management strategies for this important storage pest.

Methods of suppression without or with minimum use of traditional chemical pesticides:
Progress in development of attract and kill methods may provide an effective method of control with very limited use of insecticide. Further development of juvenile hormone analogs, such as hydroprene and methoprene, should provide low risk pest control in a variety of commercial settings.

A female attractant derived from food materials has been developed for stored product moths and is being marketed for moth suppression. Laboratory tests with sticky traps showed that this material is attractive to Indianmeal moths, almond moths, and Mediterranean flour moths, but not to rice moths. It is interesting that the three species that responded to the attractant are all phycitine pyralids, while the rice moth is in another subfamily (Galleriinae). Field tests have been less successful in demonstrating attraction, so additional research is needed to learn the reason and to determine if the problem can be overcome. Also, research is needed to determine the degree to which moth populations can be suppressed in various commercial settings and how suppression can be maximized.

Significant advances were made in acquiring information needed to control insect infestation of stored grain by temperature management and by integration of temperature management with other methods. Pilot-bin trials of aeration and chilled aeration of stored corn indicated that maintaining the temperature of a grain bulk below 18 %C could be effective in suppressing population growth of beetle pests. However, to be effective – at least in the case of the maize weevil and red flour beetle – low grain temperatures must be achieved early in the spring and maintained throughout the summer. In contrast, it was found that temperature management alone will not effectively control population growth of the Indianmeal moth; other tools, in addition to temperature management, are needed to ensure effective control during the summer. These tools might include surface treatment of the bulk with a protectant such as Spinosid and physical exclusion from the headspace. Field studies of stored corn in Indiana showed that Spinosid can provide long term control of key stored grain pests.

Biological Control:
Biological control by means of predators, parasitoids, and pathogens offers considerable promise as an element of future IPM programs. Excellent progress has been made under CIMSPIP in developing information needed to employ *Trichogramma* species as biological control agents. These minute parasitoids should be especially well suited for commercial settings in which biological control agents must be inconspicuous. Comparative studies of foraging success have provided guidance in selecting *Trichogramma* species and release strategies for management of the Indianmeal moth in finished products. *Trichogramma deion* was the most promising of three species for managing this pest in retail stores.

Research on the role of volatiles in host recognition and recognition of host infection status by entomopathogenic nematodes has provided information that will be useful in improving the efficacy of these natural enemies for management of stored product insect pests.

Section 12: Problem Area 216 Integrated Pest Management Systems

Relevance

12.1 Scope

This problem area focuses on the development of coordinated strategies for managing pests in agricultural, residential and public areas. This work synthesizes and adapts the discipline-based science developed in Problem Areas 211-215 (arthropods, pathogens, nematodes, weeds, vertebrates and biological control) into a system for managing pests in an economically, socially, and environmentally sound manner. Successful IPM programs employ a continuum of tactics to prevent, avoid, monitor and suppress pests. IPM strategies are science-based and information-driven, relying on education programs to deliver new pest management techniques to agricultural producers, private consultants, pesticide applicators, and other persons making pest management decisions.

Research and extension topics supported within PA 216 include the study of crop-pest-beneficial interactions (system ecology) and interactions among pest control tactics, the impact of climate on pest management systems, the epidemiology and ecology of pests, and the development of sampling protocols and predictive models for complexes of pests. Emphasis is placed on adaptive research, the validation of IPM systems, and the demonstration of new pest management approaches to end-users, and regional coordination of research and extension efforts through the Regional IPM Centers and the National Plant Diagnostic Network. This problem area also includes work with stakeholders to identify priority needs and identify barriers to the implementation of IPM systems.

The logic model for PA 216 is illustrated in Figure 12.1 (found on page 132). Major accomplishments and needs summaries for PA 216 are provided in Figure 12.2 (found on page 133). Major subject area categories defined for PA 216 are shown at the bottom of Figure 12.2.

(A) Areas of work include but are not limited to:

- Understanding the biology of crop-pest-beneficial interactions (system ecology).
- Interactions among pest control tactics (may include cultural, mechanical, biological and pesticide application tactics) and impacts on crop productivity.
- Implementation of new knowledge and technologies on an area-wide or regional scale.
- Impact of climate and other abiotic factors on pest management systems.
- Determination of environmental impacts resulting from the use of IPM systems.
- Development of sampling protocols (including economic injury levels, action thresholds, and remote sensing and other automated sampling methodologies) and predictive models for use in managing pest complexes and natural enemy populations.
- Pest management problem specification in affected communities including growers/producers, processors, marketers, and consumers.
- Determination of constraints to adoption of IPM methods, barriers to progress along the IPM continuum, and impacts.

(B) Exclude:

- Single pest control tactics. (Use PAs 121, 123, 124, 125, or 211-215)
- Evaluation of germplasm for genetic variation in resistance to pests. (Use PA 202)

- Application of remote sensing and other automatic sampling methodologies in managing plant population densities, fertility, irrigation, and other cultural practices. (Use PA 205)
- Development of sampling protocols and predictive models for single pests or natural enemies. (Use PAs 121, 123, 124, 125, or 211-215)
- Movement and dispersal resulting from airborne transport of pests. (Use PA 132)
- Development of remote sensing instruments. (Use PA 404)
- Determination of economic and social impacts of IPM systems. (Use PA 601, 605, or 803)
- Impacts of pest management policies. (Use PA 610)
- Consumer economics, including response to product labeling. (Use PA 607)

Figure 12.1

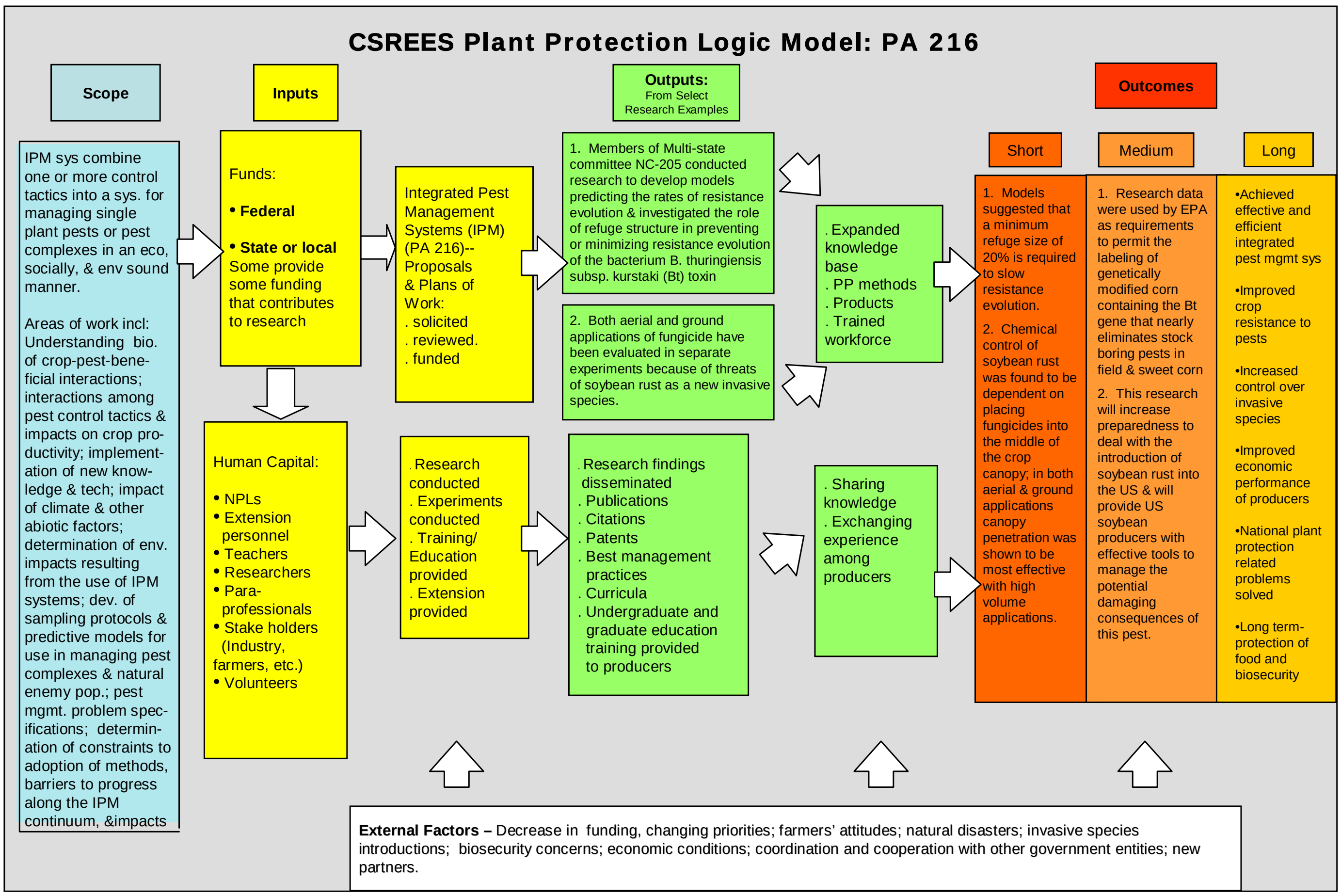


Figure 12.2
Accomplishments and Needs related to Avoidance, Prevention, Suppression and Monitoring for IPM.

Accomplishments

- Regional IPM Centers established
- National Plant Diagnostic Network established
- Crop Profiles developed
- Pest Management Strategic Plans developed for 73 commodities
- Pest Alerts published and distributed nationaly

Prevention
- Pest-free seeds and transplants
- Prevention of weed reproduction
- Irrigation scheduling
- Field sanitation practices
- Elimination of alternate hosts
- Plant biosecurity course developed
- Regional/national research and extension efforts organized for inviasive species, including soybean aphid, soybean rust and sudden oak death
- Education of pest managers and the general public

Avoidance
- Crop rotation
- Host plant resistance
- Trap crops
- Pheromone traps

Monitoring
- Sampling protocols for pest complexes
- Predictive models
- Record keeping systems

Suppression
- Cover crops and mulches
- Pheromone traps
- Mating disruption

Needs

Prevention
- Identify vulnerable cropping systems and vulnerable stages in the pest life cycle
- Training on the use of advanced IPM tactics

Avoidance
- Measurement of effectiveness of
  - Crop rotation
  - Trap crops
  - Buffer strips
  - Refugue for suseptables
- Pheromone trapping

Monitoring
- Develop economical high-resolution environmental and biological monitoring systems
- Develop new diagnostic tools for plant diseases and detection of pesticide resistance
- Enhanced decision support systems
- New action thresholds for vector borne diseases

Suppression
- Low risk biologically-based tactics
- Economical reduced risk pesticides
- Mating disruption technologies for additional crops/pests

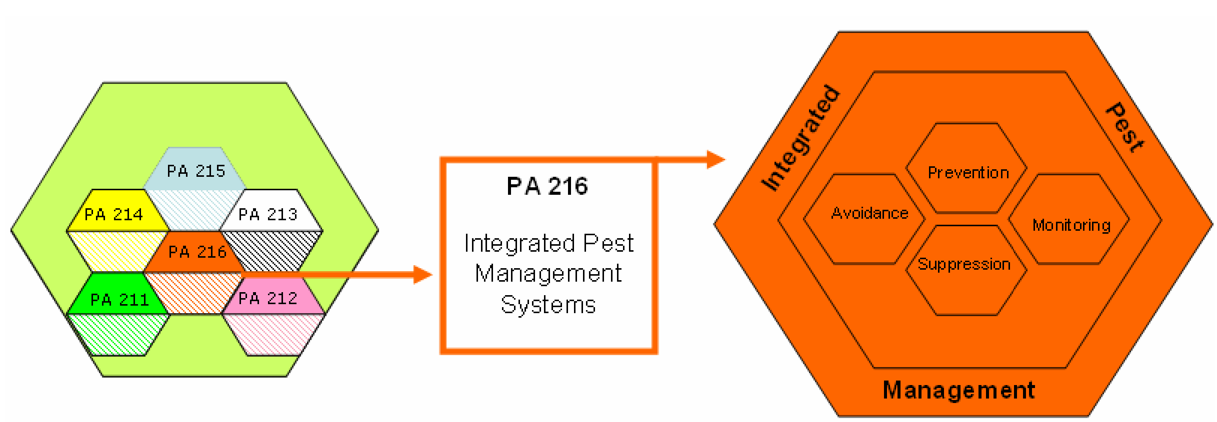
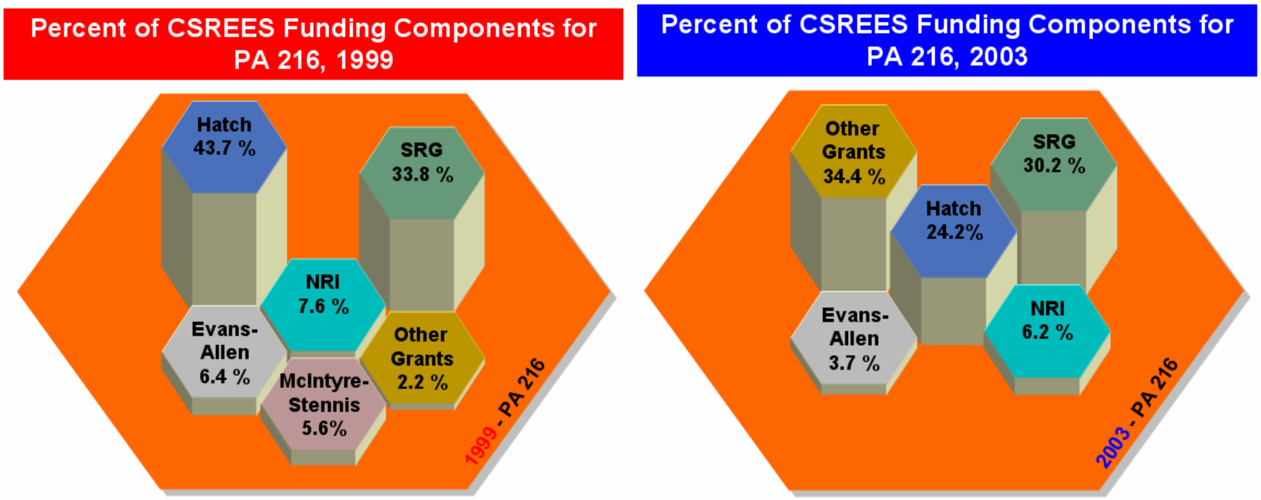


Figure 12.3



12.2 Focus on Critical Needs

Yield and quality losses resulting from disease, insect and weed pests are major factors limiting the productivity and profitability of agriculture. In addition, pests of landscapes, recreation areas and structures reduce the aesthetic value of urban environments and endanger human and animal health.

The peer review process ensures that competitively-awarded CSREES projects focus on scientifically critical areas. The AREERA process requires that formula-funded projects reflect stakeholder priorities. The competitive review process encourages innovative ideas that are likely to open new research approaches to enhancing US agriculture. A proven mechanism for stimulating new scientific research, the process increases the likelihood that investigations addressing important, relevant topics using well-designed and well-organized experimental plans will be funded. Each year, panels of scientific peers meet to evaluate and recommend proposal based on scientific merit, investigator qualifications, and relevance of the proposed research to US agriculture.

(A) Analysis of CRIS Data:

Figure 12.3 shows a graphic comparison of funding percentages for PA 216 from 1999 & 2003. In 1999, CSREES invested a total of $9,061,000 in PA 216. Of this total, 43.7% came from Hatch funds, 5.3% from McIntire-Stennis funds, 6.4% from Evans-Allen funds and 33.8% from Special Research Grants (SRG). The National Research Initiative (NRI) invested $685,000 in programs dedicated to PA 216, which was 7.6% of the total CSREES investment. Together, these four non-competitive sources of funding accounted for 89.5% of all funds allocated by CSREES to PA 211. The CSREES investment in PA 216 in 1999 represented 14% of the total investment in all of plant protection. The breakdown of funding by commodity area is presented in Table 12.1 (found on page 135).

Table 12.1 Distribution of CSREES Investment in PA 216 for 1999														
Description of SOI	Hatch	%	Mc-Stennis	%	Evans-Allen	%	SRG	%	NRI	%	Other Grants	%	CSREES	%
Vegetables	556	28	0	0	419	21.1	706	35.5	306	15.4	0	0	1,987	100
Deciduous & Small Fruit	379	33.8	0	0	0	0	697	62.1	47	4.2	0	0	1,122	100
Grain Crops	636	65.8	0	0	9	0.9	247	25.5	15	1.6	60	6.2	967	100
Invertebrates	299	40.6	0	0	0	0	221	30	150	20.4	65	8.8	736	100
Microorganisms	42	15.4	6	2.2	24	8.8	81	29.8	118	43.4	0	0	272	
Agricultural Supplies	38	21.8	0	0	0	0	136	78.2	0	0	0	0	174	100
Top 3 SOI	1,571	38.5	0	0	428	10.5	1,650	40.5	368	9	60	1.5	4,076	100
3 Small Focus Areas	379	32.1	6	0.5	24	2	438	37.1	268	22.7	65	5.5	1,182	100
26 Other SOI	2,009	52.8	504	13.3	127	3.3	975	25.6	49	1.3	75	2	3,803	100
Total	**$3,959**	**43.7**	**$510**	**5.6**	**$579**	**6.4**	**$3,063**	**33.8**	**$685**	**7.6**	**$200**	**2.2**	**$9,061**	**100**

In 2003, CSREES investment in PA 216 increased to $14,999,000. Hatch funds accounted for 24.2% of the total and together with other non-competitive sources of funding for PA 211 accounted for 58.1% of the total. The National Research Initiative invested $925,000 in PA 216 in 2003, which was 6.2% of the total CSREES investment. The continued maturation of the CSREES Integrated Research, Education and Extension grant programs, such as the Initiative for Future Agricultural and Food Systems (IFAFS) and the Organic Transitions Program, accounted for some funds invested in PA 216. The CSREES investment in PA 216 in 2003 represented 18.5% of the total investment in all of plant protection. The breakdown of funding by commodity area is presented in Table 12.2.

Table 12.2 Distribution of CSREES Investment in PA 216 for 2003												
Description of SOI	Hatch	%	Evans-Allen	%	SRG	%	NRI	%	Other Grants	%	CSREES	%
Vegetables	523	13.5	237	6.1	342	8.9	0	0	2,757	71.4	3,860	100
Plants, General	95	4	0	0	1,678	71.4	43	1.8	534	22.7	2,350	100
Deciduous & Small Fruit	338	15.7	0	0	455	21.1	68	3.2	1,297	60.1	2,158	100
Invertebrates	292	21.3	0	0	859	62.6	210	15.3	12	0.9	1,373	100
Grain Crops	552	43.5	0	0	262	20.6	140	11	315	24.8	1,269	100
Atmosphere	0	0	0	0	0	0	306	100	0	0	306	100
Agricultural Supplies	51	20.2	155	61.5	0	0	0	0	45	17.9	252	100
Top 5 SOI	1,800	16.3	237	2.2	3,596	32.7	461	4.2	4,915	44.6	11,010	100
2 Small Focus Areas	51	9.1	155	27.8	0	0	306	54.8	45	8.1	558	100
28 Other SOI	1,774	51.7	159	4.6	932	27.2	158	4.6	195	5.7	3,431	100
Total	**$3,625**	**24.2**	**$551**	**3.7**	**$4,528**	**30.2**	**925**	**6.2**	**$5,155**	**34.4**	**$14,999**	**100**

12.3 Identification of Emerging Issues

CSREES identifies emerging issues for its IPM programs in a variety of ways. Agency staff are active participants on IPM-related multi-state research and extension projects (see Table 6.9, found on page 59-60), which bring together agricultural scientists to address pest management issues. The annual meetings of scientists involved in these projects provide agency staff with an opportunity to keep abreast of emerging issues and needs. The advisory committees of the four regional IPM centers are another resource for the agency as it works to identify and prioritize IPM needs and issues. Each advisory committee is a diverse group that includes agricultural producers and their representatives, private consultants, pest control operators and representatives of non-profit organizations and government agencies. Emerging issues are also identified by Pest Management Strategic Plans, which are developed for individual commodities by pest managers, research and extension experts, and government regulatory staff; more than 88 have been developed and are available at pestdata.ncsu.edu/pmsp/index.cfm.

CSREES also uses conferences and stakeholder forums to identify emerging issues. National IPM symposia have been held every five years since late 1980. More than 600 IPM experts from around the world attend the national symposia to discuss new advancements and future needs.

Setting priorities is important to facilitate scientific and technological advances to meet the challenges facing U.S. agriculture. Congress sets the budgetary framework by providing funds to CSREES. Members of Congress also make recommendations for the scientific and programmatic administration through appropriation language and through their questions and comments during Congressional hearings. Input into the priority-setting process is sought from a variety of customers and stakeholders. The scientific community provides input through the proposals it submits each year as well as through the proposal evaluation and funding recommendations of individual peer-review panels.

Review panels for competitive programs, Federal interagency working groups, stakeholder workshops, the National Research Council, participation in multi-state projects with AES, ARS, and other researchers are examples of important mechanisms for CSREES to identify emerging issues for PA 216. National Program Leaders attend scientific and professional meetings to stay current on scientific trends that should be reflected in CSREES programs and in the coordination of priority setting with other federal agencies. NPLs also participate in meetings with representatives of key commodity groups and other user groups to discuss these stakeholders' current priorities, learn ways that CSREES can assist in meeting their needs, and solicit comments and suggestions.

12.4 Integration of CSREES Programs

Through linking multi-functional projects, multi-institutional activities that create links across funding sources, CSREES creates a mechanism for integrating its PA 216 activities in competitive grants, formula funds, and special grants activities that may otherwise be disjointed.

12.5 Multidisciplinary Balance/ Interdisciplinary Integration

CSREES linking projects are multi-institutional and multidisciplinary. Through these projects, CSREES is able to stimulate the integration of current scientific advances with national stakeholder needs for applied research. Both mission-linked research and fundamental research are supported by CSREES. Mission-linked research targets specific problems, needs, or opportunities. Fundamental research – the quest for new knowledge about agriculturally important organisms, processes, systems, or products – opens new directions for mission-linked research. Both mission-linked research and fundamental research are essential to the sustainability of agriculture.

Quality

12.6 Significance of Outputs and Findings

CSREES-funded projects focusing on integrated pest management systems affecting plants have resulted in many high-impact publications in well-regarded journals (see Section 12.16). They have also supported graduate student and postdoctoral training in plant protection related disciplines.

12.7 Stakeholder Assessment

Although the benefits of the use of IPM methods have been well established, the extent of adoption has been limited by several factors. A series of stakeholder workshops sponsored by the U.S. Environmental Protection Agency (EPA) and USDA in 1992 and 1993 identified many factors constraining adoption of IPM systems, and recommended that the public and private sectors make a national commitment to overcoming these constraints (Sorensen, 1993, 1994). Among the major impediments to greater adoption of IPM methods are inadequate knowledge of currently available IPM tactics, a shortage of consultants and other pest management professionals to provide IPM services, the high level of management input required for implementation of some IPM systems, and the lack of alternative pest control tactics for some pests. Before reforms were enacted in 1996, Federal commodity programs were another impediment to IPM adoption in cases where planting requirements restricted producers' ability to rotate crops for pest control.

CSREES seeks stakeholder input with regard to portfolio composition, program direction and research priorities. Examples of activities soliciting stakeholder input are as follows:

(A) *Plants and Pest Biology stakeholder workshop,* Crystal City, VA, November 14, 2002 provided a forum for stakeholders to review and contribute feedback on the agency's research priority issue areas that CSREES is considering multi year funding. The issue areas are: (1) Agricultural and Environmental Quality, (2) Agricultural Security, (3) Genomics and Food and Fiber Production, (4) Obesity, Human Nutrition and Food Security, (5) Food Safety, and (6) Rural and Community Development. Feedback from this workshop helped to focus CSREES portfolios including the Plant Protection portfolio.

(B) IR-4 uses an extensive stakeholder driven process to prioritize research to ensure that it is focusing on the most critical pest management needs of the specialty crop producers. The priority setting process engages representatives from state and federal agricultural scientific communities, state extension systems, commodity and growers groups, the crop protection industry, food processors, and state and federal regulators.

(C) Stakeholders are involved in every aspect of IPM and NPDN Center management, planning and program delivery. The IPM Centers work to connect a diverse array of people who have an interest in pest management policy and implementation throughout the region. These include pest management users (farmers, nurserymen, park and turf managers, building superintendents, pest control operators, homeowners, gardeners, and others), consumer and environmental groups, governmental regulatory agencies, researchers, and educators. IPM Centers network these groups both through its internal organization (Advisory Committee, Stakeholder groups, State Project Leaders) and through development of electronic communications structures such as email lists, online bulletin boards, and web pages.

12.8 Alignment of Portfolio with Current Issues

Peer review of submitted proposals and NPL expertise assure that funded projects are aligned with the current state of science-based knowledge. The National IPM Roadmap (see Evidentiary Materials) serves as the strategic plan which guides the agencies investment in research, education and extension.

12.9 Methodology and Use of Funded Projects

This portfolio leads to solutions to National plant protection problems, improved economic performance for procedure and long term protection of the nation's food system, plant biosecurity and the environment.

Attainment of these goals benefits agricultural producers; the environment; pest management professionals and organizations; and the general public in the following ways found in Table 12.3.

Table 12.3
Key Program Benefits

To Agricultural Producers:	**To the Environment:**
Reduction in producer's economic risk through the promotion of low cost and carefully targeted pest management practices.	Reduction of environmental risk associated with pest management by encouraging the adoption of more ecologically benign control tactics.
Proactive avoidance of future pest management crisis; through research directed at potential short, medium, and long term challenges.	Protection of at-risk ecosystems and non-target species through reduced impact of pest management activities.
Reduction of health risk to agricultural workers by fostering best management practice adoption.	Promotion of sustainable bio-based pest management alternatives.
To Pest Management Professionals & Organizations:	**To the General Public:**
Augmentation of private research development efforts to develop lower risk pest control tactics and expand the use of existing low risk tactics to specialty markets.	Reduction of risk to the public by promoting responsible pest management in public spaces including schools, recreational facilities and playgrounds.
Promotion of innovative practices that improve pest management effectiveness, which can increase customer satisfaction and reduce the risk of customer complaints.	Promotion of lower risk residential and community pest control through educational programs tailored to homeowners.
Creation of a demand for new, innovative, and marketable products and services.	Assurance of safe, reliable, low cost pest control through improved pest management.

A comprehensive evaluation of farm-level data from 61 IPM programs in the United States concluded that the adoption of IPM methods generally results in lower pesticide use, production cost and risk, and higher net returns to producers (Norton and Mullen, 1994). It has been estimated that use of IPM strategies saves U.S. agricultural producers more than $500 million per year due to reductions in pesticide use and better management (Rajotte et al., 1987).

Performance

12.10 Portfolio Productivity

Portfolio productivity is evidenced primarily by publications in well-regarded peer-reviewed journals (see Section 12.16 Examples of Research Accomplishments). Accomplishments described in annual CRIS reports, citations, and presentations at scientific and other professional meetings demonstrate productivity. Portfolio productivity in PA 216 is evidenced by commercially viable products and new discoveries.

From 1999 to 2003, CSREES supported IPM research and extension projects in every state and territory. A majority of IPM projects supported by the agency funds were conducted at 1862 land-grant universities, but agency-supported IPM projects were conducted at other land-grant institutions as well as other public and private research institutions. The agency invested its IPM resources in research and extension projects addressing the needs of numerous commodities (plant as well as animal) and focus areas (production agriculture, natural resources, recreational environments, residential and public areas). Research was conducted to enhance our understanding of pest and beneficial life cycles, population dynamics, the biochemical nature of resistance, the mode of action of pesticides, epidemiology, ecology, and the development of pest-resistant crop varieties and livestock breeds. Research projects emphasized the study of the basic ecology of organisms and their hosts, evaluation of effects and impacts of pests, and the development of IPM systems.

12.11 Portfolio Completeness

Portfolio completeness is demonstrated through submitted annual progress reports (CRIS), termination reports and accomplishment reports. Some aspects of the portfolio in PA 216 are more complete than other aspects. Where possible, CSREES coordinates externally with other Federal agencies to address knowledge gaps.

12.12 Portfolio Timeliness

Portfolio timeliness of PA 216 is evidenced through annual performance reports (CRIS), termination reports, and accomplishments reports. Peer review of competitive funding serves to ensure that funded projects are timely and take advantage of state-of-the-art methods.

12.13 Agency Guidance

Agency guidance to applicants is provided primarily in Requests for Applications (RFAs). Annual review and updating of RFA language is provided upon request for PA 216. Responses to congressional inquiries are provided as requested.

12.14 Portfolio Accountability

The agency solicits stakeholder input in determining the scope and priorities of its research, education and extension portfolio. Input is solicited in stakeholder workshops and other activities that solicit input from scientific communities (see Section 12.7 Stakeholder Assessment). Accountability is provided through annual reports (CRIS), and accomplishment reports.

12.15 Reference and Evidentiary Material

See file folders of evidentiary material, which includes publications, books, journal articles, websites, etc.

References cited in text:

- Rajotte, E. G., G. W. Norton, R. F. Kazmierczak, M. T. Lambur, and W. A. Allen. 1987. The National Evaluation of Extension's Integrated Pest Management (IPM) Programs. Virginia Polytechnic and State University, Blacksburg, Virginia.
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- Sorensen, A. A. 1994. Proceedings of the National Integrated Pest Management Forum; June 17-19, 1992, Arlington, Virginia. American Farmland Trust, Center for Agriculture and the Environment, DeKalb, Illinois.

12.16 Examples of Research Accomplishments

Accountability is ensured differently in different CSREES-administered programs. NRI and other competitive programs ensure accountability by the competitive process itself: grantees that do not deliver are less likely to receive future grants. Hatch project accountability is monitored at the AES level, and through state annual reports and AREERA plans of work. Special grant accountability mechanisms are highly variable. The following are selected examples of economic condition outcomes as reported by the Extension IPM Program Performance Planning and Accountability System. These are selected end results of land grant university IPM research, education, and extension.

(A) ***North Carolina***
The North Carolina State University's cotton IPM program includes grower education, statewide monitoring, and weekly pest alerts. As a result growers use an average of 1.3 fewer insecticide sprays on each field for a $6 million statewide savings annually. Peanut growers using a web-based disease forecasting system save an average of one spray per field, worth $250,000 statewide. A new program addressing soil insects reduced insecticide use by 20,000 lbs. (active ingredient) and saved growers $30,000.

(B) ***North Dakota***
Weed management specialists developed a micro-rate program for post-emergence herbicides on sugarbeets. The practice, used by 95% of the state's producers, caused a 50% reduction in use of these herbicides on 237,500 acres for $4.2 million annual savings. Use of disease-tolerant wheat varieties saves approximately $39.6 million. Wheat yield and quality improvements from use of a new, more effective fungicide are worth $15.8 million. Better prediction and scouting techniques for orange wheat blossom midge, an important insect pest, led to reduction in pesticide applications worth about $2 million. All together North Dakota wheat producers (and subsequently, all who consume wheat products) gained a total of $57.4 million in 2000.

(C) ***Nebraska***
A "bread basket" state, Nebraska has vast acreage of field crops. More than 1770 individuals participated in twelve Crop Protection Clinics in 2000. As a result of information learned at these meetings, farmers planned changes in IPM practices on over 16 million crop acres at a predicted value of $128 million.

(D) ***Alaska***
Potato late blight (PLB), the same disease that led to the terrible Irish potato famine, is a recent threat to Alaska's disease-free potato seed production. Alaska's IPM Program and other state agencies cooperated on border quarantine, a scouting program, verification of seed sources, a brochure for home gardeners, and grower educational programs. The $3 million state potato production has been free of PLB since 1998.

(E) The University of Wisconsin, USDA, and the Wisconsin Potato and Vegetable Growers Association continued development of "WISDOM", a decision support system for potato and vegetable growers. Growers used this software on more than 70,000 acres of potato, saving Wisconsin growers an estimated $10 million on production costs during the growing season.

(F) Researchers at the University of Idaho and Washington State University evaluated the impact of cover cropping on natural control of pests, crop nutrient status, and crop yield and quality in large on-farm studies in local vineyards. They concluded that the use of rye grass and hairy vetch as ground covers significantly reduces infestations of weeds and leafhoppers, and has a positive effect on vine nutrition in irrigated vineyards. This information was shared with grape growers in the Pacific Northwest as part of an effort to help them reduce their reliance on pesticides and lower operating costs using IPM methods.

(G) Researchers and Extension staff at the University of Georgia developed and helped landscape managers implement new IPM methods for lawns and landscapes. The project demonstrated that the use of IPM methods reduces pollution from pesticides and fertilizers in urban landscapes by up to 50 percent. A series of workshops and training programs were developed and presented to a wide audience. The knowledge and educational materials developed by this project provide a basis for implementing IPM methods on urban landscapes throughout the Southeastern United States.

(H) The University of Minnesota, Montana State University, and North Dakota State University identified five new fungicides and a bacteria-based biocontrol alternative to triphenyltin hydroxide (TPTH), which is currently the only effective fungicide currently registered for control of Cercospora leafspot on sugar beet. The EPA has identified TPTH for label cancellation. Cercospora leafspot is an economically important disease that costs growers in Minnesota, Montana, and North Dakota (States accounting for more than 60 percent of U.S. sugar beet production) between $130 and $340 per acre in net profits.

(I) Researchers at land-grant universities in Connecticut, Maine, Massachusetts, New Hampshire, New York, Rhode Island, and Vermont demonstrated that a predatory mite (*Typhlodromus pyri*) can be successfully used for biological control of European red mite in apple orchards. Apple growers were able to increase their net profitability by $50 per year by eliminating the need for the application of miticides.

BOOK IV:

EMPHASIS AREAS CROSSCUTTING PORTFOLIO

Section 13:
Higher Education

Relevance

13.1 Scope

Plant protection programs, goals, objectives and NPL leadership impact, both directly and indirectly, higher education programs and curricula of the land grant universities and other key partners.

Formula funding (Hatch, Smith-Lever, etc.), special grants, multi-state projects and Congressionally Designated Line Items provide focus and resources to develop and support higher education efforts in plant protection. Resources invested locally provide support for graduate students.

The NRI, 406 Integrated and other competitive and non-competitive grant programs relate directly to training and higher education in the broad sense and contribute to education and training in several ways. First, these funds are used by recipients to support graduate student and post-doctoral research that results in the development of the next generation of scientists. Secondly, the USDA EPSCOR program assists small and under-represented institutions to strengthen their programs and lastly, CSREES-funded programs delivered through the Cooperative Extension system help the public to understand agriculture and to solve real-world problems using research-based information. The National Research Council in their review of the National Research Initiative (2000)[8] estimated that the NRI alone supported 425 graduate students per year through project awards to investigators. In addition, this report estimated that more than 300 post-doctoral researchers were supported annually.

Multi-state research collaborations using Hatch base funding have likewise provided support for graduate students and post-doctoral researchers. In just one example, S-74, the first soybean arthropod pest management multi-state project (duration 12 years, 1969-1981) resulted in 54 MS and 42 Ph.D. dissertations. This is NOT a unique and isolated example of the education and training resulting from Hatch multi-state research support. What is remarkable and common is that many of the students supported under the S-74 project are now the leading scientists in the arthropod pest management area today. Currently, many of these individuals are mentoring a new generation of scientists using support from Hatch funding and from CSREES competitive grants.

The regional Sustainable Agricultural Research and Education (SARE) programs in the north central and southern regions fund higher education grants to graduate students studying plant protection related graduate studies at the MS and PhD levels. SARE grants encompass research and include an outreach component.

National Program Leaders at CSREES are leaders of discipline-based and issue-based reviews (Examples being: Department of Agronomy Reviews or IPM program reviews) at Land Grant partner institutions. Many of these reviews have a significant higher education component that involves the review of curriculum and courses for both undergraduate and graduate level programs that relate to plant protection. CSREES conducts reviews at the request of cooperating

[8] **National Research Initiative: A Vital Competitive Grants Program in Food, Fiber, and Natural-Resources Research** (2000) Board on Agriculture and Natural Resources. 189 pp.

institutions. Reviews are neither mandated by federal statues nor required by CSREES. High priority is placed on reviews in allocating scientists' time and other resources. CSREES reviews are an aide in assessing and managing programs and organizations in planning for the future. These reviews are viewed as process to maintain and build science and education programs at the partner institutions. National Program Leaders work with the peer review teams to reach consensus on recommendations made to university administrators and faculty for higher education program direction and improvement that are transmitted to the institution orally at the conclusion of a site visit and in writing in a document transmitted through a program Deputy Administrator at CSREES (see Evidentiary Materials). Recommendations from the review team are based on thoughtful dialogue with the unit's teaching faculty. These recommendations are designed to provide a constructive critique to help the unit improve both undergraduate and graduate program.

Higher Education target audiences include but are not limited to graduate students at land grants working in basic and applied fields of interest in plant protection. Underserved audiences are targeted through programs such as the Tribal Colleges Equity education Program (TCEG). T he TCEG Program began in 1996 as an effort to strengthen teaching programs in the food and agricultural sciences (including plant protection) at the thirty-three (33) 1994 Land Grants. New programs ranging from associate to BS degrees have been instituted and curricula have been redesigned. Funding generally ranges from $49,000 – 51,000 annually to 1994 Land grants. The tribal Colleges and Universities are making progress and contributions to the entire higher education program that promotes food and agricultural sciences including plant protection.

13.2 Focus on Critical Needs

Institutions identify the purposes and the needs associated with reviews and graduate student support these priorities are transmitted to CSREES (see Evidentiary Material sample).

13.3 Identification of Emerging Issues

Departments or units being reviewed develop a self-study and strategic plan prior to the site review. The self study is provided to the review team members for study prior to the visit and the document is used as the basis for further presentation of the program and discussion with the review team. Emerging issues in the Sustainable Agricultural Research and Education Program (SARE) are prioritized by the regional administrative councils and awards addressing these issues are competitively funded.

13.4 Integration of CSREES Programs

The composition of the review team and the review itself reflects the degree of integration of the unit being reviewed. Interactions of the unit through collaborations, partnerships and affiliations with other disciplines and functional units are assessed by the review team. The SARE program at the regional level is highly integrated with input from CSREES, land grants, ARS, EPA and other local and regional programs.

13.5 Multidisciplinary Balance/ Interdisciplinary Integration

Unit interactions and interdisciplinary integration is assessed during the review. SARE grants to students are assessed by host institutions through progress of students and graduation.

Quality

13.6 Significance of Outputs and Findings

Following each review CSREES requests a follow-up report from the institution to provide feedback on the usefulness of recommendations and the actions that were taken to implement recommended changes. (See Evidentiary Material). SARE funded studies carry a requirement for a final report.

13.7 Stakeholder Assessment

Academic program reviews are a grassroots process. Needs are established by the institution faculty and administration. SARE program priorities and activities are established by an interdisciplinary regional administrative council.

13.8 Alignment of Portfolio with Current Issues

Review team members are generally the leading scientists/educators in their areas of expertise and are able to provide excellent guidance and recommendations to institutions and faculty. Issues addressed through the SARE program are established by stakeholder input. Underserved audiences are targeted through the Tribal Colleges Equity Education Program.

Performance

13.9 Reference and Evidentiary Material

See file folders of evidentiary material, which includes publications, books, journal articles, websites, etc.

13.10 Examples of Higher Education Accomplishments

(A) Haskell Indian Nations University, KS
A 4-year environmental program has been developed that reflects native values and traditions for the purpose of training students to become informed leaders in holistic environmental stewardship and natural resource development and policy development.

(B) Blackfeet Community College (MT0)
A Natural Resources Management degree is offered to include hands-on education and a teaching laboratory experience. This project features education for students in forest restoration, revegitation projects, bioengineering for slope stabilization, and wetlands mitigation.

(C) Sustainable Agriculture Research and Education (SARE) program
The regional SARE program offers competitively-based graduate student grants support in two regions, the North Central and Southern regions. More than 33 grants have been awarded to graduate students working on plant protection studies in support of sustainable agriculture (see Evidentiary Material.

(D) CSREES-led Evaluations of Higher Education Academic Programs Related to Plant Protection.

Through the partnership with our Land Grant university institutions CSREES NPLs lead, facilitate and participate in Academic program reviews of both graduate and undergraduate programs that are related to plant protection. These reviews may focus on a single discipline or may focus on a cluster of plant-related disciplines. The scope of such reviews is determined, in part, by the Departmental structure at the institution, or may be determined by the Agricultural Administration of the institution. Reviews are not mandated by USDA, CSREES. Rather, this activity is done as a service for our partners to provide a critical examination of academic program strengths and weaknesses as seen by a group of respected peers from other institutions or organizations. The following summaries of higher education recommendations directed toward teaching, academic programs and curricula and are taken from recent reviews in areas where there is a significant plant protection component. The following examples of higher education are but a few of the many department and program reviews. The evidentiary material available provides details of the current process and guidelines, both for institutions and review teams.

Academic Review Department of Entomology and Applied Ecology, University of Delaware October 15-17, 2000. The following recommendations are made with regard to the academic programs:

- The Review team recommends that the Department takes the necessary steps and makes the appropriate curriculum changes to allow wildlife undergraduates to have academic course background to become certified by the Wildlife Society, should the student so desire.
- The Review team recommends the development of a student handbook for the Department and suggests that this is a readily accomplishable priority. The handbook should cover undergraduate and graduate curricula, programs, policies, support, activities and opportunities. A joint student and faculty committee should work together in its development.
- The Review Team recommends that the timing of the decision for graduate student support be moved forward in the calendar year to allow the Department to more competitively recruit and compete campus-wide, regionally and nationally for quality graduate students.
- With the growing enrollment in the undergraduate major, the Department needs a new faculty line in the wildlife area. The Review Team recommends a new faculty line in the vertebrate wildlife area.

Review of the University of Idaho Plant, Soil and Entomological Sceinces Teaching Program, June 1-6, 2003

Overall program

- The review team recommended that the PSES department might broaden their partnership with WSU to offer botany, population genetics, turf management, and other courses.
- The review team recommends that interaction among the divisions should be strengthened to provide students with a multi-disciplinary perspective.
- We recommend that the department evaluate the option of considering teaching effort separately from research effort on the annual performance evaluation.
- We recommend that student recruitment efforts be a high priority and be improved by a high quality web site and a brochure to be distributed at high schools within the state.
- *Undergraduate program*
- We recommend that the Department offer Extension Internships for credit at the Research & Extension Centers.
- The review team recommends that the PSES department continue to improve and grow the Soils and Land Resources and the Horticulture undergraduate programs in order to provide opportunities for these students.
- The review team unanimously recommends that PSES discontinue the B.S. program in Entomology and that resources be used to strengthen the M.S. and Ph.D. programs in Entomology and the other undergraduate and graduate programs in the department.
- *Graduate program*
- The review team recommends that the department consider requiring a teaching experience for all graduate students as part of their degree requirements.
- We recommend additional training in grant writing be included in the graduate program as part of each student's graduate experience.

- To encourage interaction across disciplines within the department, the review team recommends that the department assign graduate carrels randomly rather than by program or division.
- *Distance-based educational programs*
- The team recommends that the department proceed with development of the distance education program following confirmation that distance learning remains a high priority commitment of the university/college.
- The review team recommends that the college hire a consulting firm or an individual with nationally recognized expertise to explore how to effectively develop a web-based distance program. In addition, the department must re-evaluate the credit cost for distance learning.
- The department must put policies in place that both allows interested faculty to participate and rewards them for their efforts in the distance education effort.

Kansas State University Department of Entomology review, April 11-14, 1999.
Academic Programs

- The Department is encouraged to seek out other groups of students who might also benefit from a minor in Entomology. For instance, students majoring in education, economics or several areas of fine arts might also benefit from a minor in Entomology.
- The Department needs to actively advertise the minor and aggressively recruit students into the minor. Additionally the Department should assist these students in gaining employment following graduation.
- A second major effort to bring an additional group of students into the entomology classroom is through the new Insects and People course (Entom 250). It is important that the Department either recruit a new faculty member to teach the course or reallocate personnel resources within the Department so that the best teacher available can devote the necessary effort to this essential Departmental effort.
- The Review Team also recommends that the Department resist the temptation to team teach this course. Such approaches have not proven successful in the past.
- The Department is also encouraged to combine the overlapping portions of the specialty introductory courses producing a module course with specific laboratory sections designed to present the unique material for each specialty.
- The Department should also consider developing new offerings of single credit mini-courses on specific entomological topics of interest to broad audiences.
- The Department should also take advantage of the developing work surrounding the prairie ecosystem (Konza Prairie) to teach summer intensive courses for special students outside the University. Such a course might be of interest to teachers who are working toward advanced degrees, as well as scientists who want to learn more about insects in a prairie system.
- We recommend development of a course offered in the Department that would prepare students to present information both orally and in writing.

Section 14:
Basic Science

Relevance

14.1 Scope

A broad array of research, both basic and applied, is funded through the Hatch Act at Agricultural Experiment Stations throughout the U.S. Much of this work is directed toward the basic science foundations for mission-oriented applied agricultural research, with a significant part that contributes to present or future plant protection. In addition, plant protection-related programs within the National Research Initiative (NRI) provide opportunities for competitively awarded research in basic science areas through several programs with a focus on animal, plant and ecosystem level groupings. Basic science components of agricultural research are funded through the National Research Initiative (NRI). The National Research Initiative Competitive Grants Program is the office in the CSREES of the USDA charged with funding research on key problems of national and regional importance in biological, environmental, physical, and social sciences relevant to agriculture, food, and the environment on a peer-reviewed, competitive basis.

The NRI was established in 1991 in response to recommendations outlined in "*Investing in Research: A Proposal to Strengthen the Agricultural, Food and Environmental System*", a 1989 report by the National Research Council's (NRC) Board on Agriculture. This publication called for increased funding of high priority research, funded by USDA through a competitive peer-review process, directed toward:

- Increasing the competitiveness of U.S. agriculture.
- Improving human health and well-being through an abundant, safe, and high-quality food supply.
- Sustaining the quality and productivity of natural resources upon which agriculture depends.

Continued interest in and support of the NRI is reflected in two subsequent NRC reports, *Investing in the National Research Initiative: An Update of the Competitive Grants Program of the U.S. Department of Agriculture*, published in 1994, and *National Research Initiative: A Vital Competitive Grants Program in Food, Fiber, and Natural Resources Research,* published in 2000.

The NRI is the primary program supporting the basic science underpinnings applied agricultural research. Competition is open to scientists at all academic institutions, Federal research agencies, private and industrial organizations. The NRI Program Description and Request for Applications (RFAs) are distributed widely within the scientific community and among other interested groups. The fiscal year FY 2003 Request for Applications, identified 25 research programs within the following eight major research areas:

- Natural Resources and the Environment
- Nutrition, Food Safety, and Health
- Animals
- Biology and Management of Pest and Beneficial Organisms
- Plants
- Markets, Trade, and Rural Development

- Enhancing Value and Use of Agricultural and Forest Products
- Agricultural Systems Research

In FY 2002, a total of 2,581 proposals were submitted to the NRI, requesting a total of $722,484,903 in funding. Awards totaling $109,613,947 were made to the highest-ranked 597 proposals submitted to the NRI that year. The success rate (in terms of number of proposals funded, supplements, and continuing increments of the same grant) was 23.1 percent. The average grant award for new standard research projects in FY 2002 was $183,608 for 2.25 years. In FY 2002 the NRI provided funds totaling $14,809,350 in Agricultural Research Enhancement Awards. This funding line supports Postdoctoral Fellowships, New Investigator Awards, and Strengthening Awards.

Programs in the NRI which relate to basic science underpinnings for plant protection include the following programs described below.

1. Integrative Biology of Arthropods and Nematodes
2. Arthropod and Nematode Gateways to Genomics
3. Managed Ecosystems
4. Biology of Plant-Microbe Associations, and
5. Biology of Weedy and Invasive Plants
6. Functional Genomics of Agriculturally Important Organisms (sections on Microbes and Arthropods and Nematodes)

Integrative biology of Arthropods and Nematodes. The long-term objective of this program is to improve pest management options for the future and reduce our dependence on pesticides that are harmful to the environment. Emphasis is placed on ecological studies of insects, mites, ticks or nematodes with plants or animals of agricultural importance. Fundamental and mission-linked applications for innovative research in the following priority areas: (1) population biology, (2) biological control, (3) chemical ecology, (4) behavioral ecology, and (5) fundamental resistance management.

Arthropod and Nematode Gateways to Genomics . This program invites both fundamental and mission-linked proposals for innovative research in the following areas: 1) molecular characterization of signaling pathways between arthropods or nematodes and their hosts; 2) cellular and molecular basis of interactions of arthropods or nematodes with plant resistance genes, plant defensive compounds, pheromones or semiochemicals; 3) cellular and molecular studies of arthropod or nematode interactions with microbes; 4) genetic manipulations to evaluate the function of arthropod or nematode genes, and 5) characterization of novel targets for pest control, including pesticide resistance studies.

***Managed Ecosystems*.** The goals of this program are to understand the impact of agriculture, forest, rangeland and other natural resource management practices on ecological systems and to promote their sustainability for the production of food, fiber, and forage. Sustainable productivity depends on the ability to utilize the earth's renewable natural resources without depleting them. This program strives to understand how agricultural practices for farm, forest, and rangelands affect natural and managed ecosystems, while developing improved management strategies to achieve sustainable production. Ecological issues in agriculture and natural resources management are complex, requiring a systems approach to integrate physical, biological, ecological, social, and economic factors.

Biology of Plant-Microbe Associations. This program will support fundamental and mission-linked research on interactions between plants and their associated microbes, including fungi and fungal-like microbes, bacteria, viruses, viroids, and mycoplasma-like organisms. Applications must address plant-microbe associations using: (1) economically important plants and/or microorganisms; or (2) plants and/or microorganisms that are important to agricultural sustainability. Studies of model systems may be submitted to the program only if knowledge gained is applied to systems of economic or societal importance within the submitted project. Studies on the biology of the microbes themselves, the interactions between the microbes and plants, the response of plants to microbes and the influence of biotic and abiotic environmental factors on plant-microbe interactions are within the scope of this program. Microbes studied may be foliar or soil-borne, free-living or living within plant hosts.

Biology of Weedy and Invasive Plants. The goal of this program is to support: (1) research on general processes and principles that contribute to plant competitiveness or invasiveness; or (2) development of novel methods to alter plant species competitiveness, invasiveness, or abundance. It is expected that the knowledge gained from these studies will ultimately be applied to agricultural settings or closely related systems involving weedy or invasive plants. This program also invites applications for projects that integrate research, extension, and/or education to address novel and environmentally sound forms of controlling weedy or invasive plants.

Quality

14.2 Significance of Outputs and Findings

Highlights and Cover Stories from the NRI
NRI Research Highlights are a series of short articles documenting the impact of NRI-funded research. Cover stories are lead stories featured on covers of leading peer-reviewed journals. These cover stories represent relevant articles that were chosen by the journal editors as the featured cover story for that volume of the scientific publication. These highlights and cover stories are by no means a comprehensive list of accomplishments, but rather an illustration of the value recognized of the fundamental and mission-oriented research funded by the NRI. Highlights and cover stories of NRI competitive program funding can be viewed on the CSREES web page at: www.csrees.usda.gov/funding/nri/nri_highlights.html. Examples of plant protection related research are listed below under Performance, Section 14.3 (A-E).

Performance

14.3 Examples of Accomplishments

(CRIS summaries from NRI funded research -- 51.2 and 51.7 programs)

(A) Resistance Management to Genetically Modified Crops
Genetic engineers have modified crops to continuously express the toxin, *Bacillus thuringiensis* (Bt), in these plants. However, insects have the innate ability to develop resistance to genetically modified crops just as quickly as they have in crops bred for insect resistance using traditional breeding methods. Prudent management strategies are needed to minimize the onset of resistance to genetically modified crops. One recent approach has been to apply a noninsecticidal chemical to crop plants. This induces the genes to express the Bt protein to targeted sites on the plant. If Bt is not continuously expressed in the plant, then exposure of insect pests to the Bt toxin will be lessened. In this way it is believed that susceptibility to the Bt toxin will be maintained and development of resistance will be delayed. Other research is aimed at studying the genes that lead to resistance and using molecular maps to localize these genes. A better understanding of how these genes function could lead to better ways to interfere with the development of resistance in the field.

(B) Genetic Improvement of Biological Control Agents and Beneficial Insects
Several promising biological control agents such as entomophagous nematodes or baculoviruses have had limited commercial potential because they can attack one or a few hosts, or they do not persist long enough to provide effective control. Molecular techniques are now available to

manipulate the genes that regulate the range of hosts attacked. This approach is an important step in making biological control agents more effective against a wider range of pests. Other examples include manipulation of nematode genes to enhance their ability to resist desiccation from ultra-violet light or to suppress the immune response of their hosts.
Publication(s) Kazi, A. A. and Cox-Foster, D. L. 2002. `Heterorhabditis bacteriophora' surface coat proteins disrupt coagulation, encapsulation and melanization immune response by insect hemocytes. ISMIS 2002. Abstracts of the Fourth International Symposium on Molecular Insect Science. 70 pp. Journal of Insect Science, 2:17, Available online: insectscience.org/2.17
In addition, improvement of pollinators such as the European honey bee is being investigated to enhance their resistance to diseases such as American Foul Brood. Other research supported by the NRI includes the development of microarray approaches to study the molecular basis of honey bee responses to pheromones.

(C) Transgenesis of Pests

Pests can be genetically modified to render them sterile or incapable of transmitting diseases to plants or livestock. Genetic techniques are being studied to replace natural pest populations with genetically modified ones. For example, researchers are studying a gene transfer system called *Piggy bac* for use in vectoring desired traits into insects, such as the oriental fruit fly, *Bactrocera dorsalis,* or the fall army worm, *Spodoptera exigua*. Other approaches involve genetically sterilizing insects such as the stored products pest *Plodia interpunctella*. Sterilization is brought about using gene silencing or RNA interference of genes that are critical for embryonic development.

(D) NRI Highlights

2003 Highlights

- Sequencing the rice genome and how this will change agriculture - Rod A. Wing, The University of Arizona; Robin Buell, The Institute for Genomic Research; William R. McCombie; Cold Spring Harbor Laboratory; Richard Wilson, Washington University.

2002 Highlights

- Seed dormancy may the hold key to improved weed management - Michael E. Foley, USDA-Agricultural Research Service, Fargo, ND Shahryar Kianian, North Dakota State.
- Soybean researchers pin hopes on disease resistance genes - Nevin Young, University of Minnesota.
- Nematode resistance genetics should boost tomato health - Isgouhi Kaloshian and Philip A. Roberts, University of California, Riverside.

2001 Highlights

- Boosting lysine improves nutritional value of corn - Brian A. Larkins, University of Arizona.
- Crop, forestry residues used as new sources to produce ethanol - Lonnie Ingram, University of Florida.
- Plant gene cloning may lead to better timing of flowering - Jorge Dubcovsky, University of California at Davis.
- Researchers study genetics to prevent cereal diseases - Roger P. Wise (USDA-ARS), Iowa State University.

(E) NRI Cover Stories

- Rds and Rih Mediate Hypersensitive Cell Death Independent of Gene-for-Gene Resistance to the Oat Crown Rust Pathogen, Puccinia coronata f. sp. avenae. Gong-Xin Yu, Ed Braun, and Roger P. Wise. 2001. Molecular Plant Microbe Interactions 14(12):1376-1383.

- The Arabidopsis thaliana ABC Protein Superfamily: A Complete Inventory. Sánchez-Fernández, R., T.G.E. Davies, J.O.D. Coleman, and P.A Rea. 2001. The Journal of Biological Chemistry, 276(32): 30231-30244.
- A Putative, Ubiquitin-Dependent Mechanism for the Recognition and Elimination of Defective Spermatozoa in the Mammalian Epididymis. Peter Sutovsky, Ricardo Moreno, Joao Ramalho-Santos, Tanja Dominko, Winston E. Thompson and Gerald Schatten. 2001. Journal of Cell Science. 114(9): 1665-1675.
- The Arabidopsis Compact Inflorescence Genes: Phase-specific Growth Regulation and the Determination of Inflorescence Architecture. Goosey, L., and R.A. Sharrock. 2001. The Plant Journal 26(5): 549-559.
- ABP1 is Required for Organized Cell Elongation and Division in *Arabidopsis* Embryogenesis. Chen, J.-G., H. Ullah, J.C. Young, M.R. Sussman, and A.M. Jones. 2001. Genes & Development 15(7): 902-911.
- Optical Biosensors for Food Pathogen Detection. A. Garth Rand, Jianming Ye, Chris W. Brown, and Stephen V. Letcher. 2002. Food Technology 56(3): 32-39.
- Wheat Puroindolines Enhance Fungal Disease Resistance in Transgenic Rice. Krishnamurthy, K., C. Balconi, J.E. Sherwood and M. Giroux. 2001. Molecular Plant-Microbe Interactions 14(10):1255-1260.

Section 15:
IR - 4

Relevance

15.1 Scope

The Pest Management for Specialty Crops Program, National Research Support Project-4 (IR-4), is a highly effective, collaborative effort among the state agricultural experiment stations, CSREES, the USDA Agricultural Research Service (ARS), the United States Environmental Protection Agency (EPA), commodity growers, and the crop protection industry. IR-4's mission consists of the development and assembly of the necessary regulatory data on new products and products with existing clearances for EPA to register safe, and effective pest management solutions for United States specialty crop growers. Specialty crops are high value, small acreage food crops such as fruits, vegetables, nuts, and herbs in addition to non-food crops such as turf, floral, forestry, nursery and ornamental landscape plants. Specialty crops have an annual income value of approximately $43 billion and represent approximately 46 percent of the total farm crop value in the United States.

The agricultural chemical industry cannot justify investing in registering pest management tools for many small acreage specialty crops due to the high-risk from product liability and low-profit potential. The agricultural chemical industry must first justify and then recuperate the time and expense required to research, develop and register crop protection products for use on specialty crops. IR-4 has successfully stepped into this void and become remarkably effective in interacting with the agricultural industry and the regulatory community to enable the development and labeling of needed pest management tools for producers of specialty crops. This industry/IR-4 partnership has worked extremely well in achieving a significant number of plant protection registrations for specialty crops and serves as a unique and effective model to other nations for working with their specialty crop growers.

15.2 Focus on Critical Needs

IR-4 uses an extensive stakeholder driven process to prioritize research to ensure that it is focusing on the most critical pest management needs of the specialty crop producers. The priority setting process engages representatives from state and federal agricultural scientific communities, state extension systems, commodity and growers groups, the crop protection industry, food processors, and state and federal regulators.

15.3 Identification of Emerging Issues

Examples of IR-4 engagement with emerging issues:

- Registration of safer pest management tools, including effective biopesticides.
- Research on soil pest management in the post methyl bromide era.
- February 2005 revision and updating of the IR-4 five-year strategic plan.
- The annual Fall IR-4 stakeholder priority setting workshops, which redefine high priority needs for the next season’s specialty crop research.
- Registration of new aquatic herbicides (under consideration).

15.4 Integration of CSREES Programs

IR-4 integrates a number of important activities which all lead to the development of strong registration petitions for submission to EPA's Office of Pesticide Programs. These integrated petitions of data include Good Laboratory Practice based research on chemical residues in/on specialty crops. This involves integrating information from multiple resources, engaging science from several disciplines and engaging talent from the Land-Grant University System, Federal Research Laboratories and State and/or Federal Regulatory officials.

- IR-4 works closely with the EPA/Office of Pesticide Programs to provide the appropriate data in a standard format to facilitate the labeling of needed pest management tools for specialty crop producers.
- Competitive research grants programs for Biopesticides and for Methy Bromide Alternatives are managed by IR-4.
- IR- 4 provides program coordination, technical guidance and funding for both field and laboratory research data, which is required for the expansion of labeling existing products for specialty crops. This program is a jointly funded effort between CSREES, ARS and the Agricultural Experiment Station Administrators of the Land Grant University System.
- System-wide and day-to-day management of the program and its resources is provided by the administrative and program leadership team in IR-4 Headquarters at Rutgers University.

15.5 Multidisciplinary Balance/ Interdisciplinary Integration

All plant protection disciplines and Program Areas (PAs) are represented in the work accomplished by IR-4. IR-4 works on development of pest management products for insects, nematodes, diseases, rodents and weeds for use on specialty crops.

Quality

15.6 Significance of Outputs and Findings

The IR-4 program provides the best measurable evidence of successes, accomplishments and impacts from secondary sources of any of the CSREES plant protection programs (2). EPA registrations, commodity group support and data from the Economic Research Service provide measurements that verify IR-4 program successes.

- The IR-4 program supported clearances accounting for approximately 50% of all EPA pest management products approved between 2001 and 2004.
- Section 18 emergency-use labeling of pesticides provides specialty crop growers with tools to address emergency pest or disease problems. Between 1998 through 2003, EPA used IR-4 time-limited tolerance data to support 831 Section 18's that resulted in a 6 year cumulative economic loss avoidance of $7.5 Billion.

15.7 Stakeholder Assessment

In September, IR-4 holds its annual research priority setting Food Use Workshop to obtain stakeholder input and cross commodity prioritization to ensure that the program is addressing the most critical specialty crop pest management issues. Identified research needs are ranked and highest ranked projects are assigned by IR-4 scientists, through a facilitated process, to field and laboratory scientists whose agenda and skills will allow them to accomplish the work.

15.8 Alignment of Portfolio with Current Issues

The IR-4 September priority setting process engages representatives that are working in all aspects of specialty crop production. Participants bring the perspective from the State and

Federal agricultural scientific communities, State extension systems, commodity and growers groups, the crop protection industry, food processors, and state and federal regulators. The IR-4 priority setting process also uses information from IPM Center Pest Management Strategic Plans which includes research, extension and regulatory needs for certain specialty crops.

Performance

15.9 Portfolio Productivity

The IR-4 program provides the best measurable evidence of successes, accomplishments and impacts from secondary sources of any of the CSREES plant protection programs (2). EPA registrations, commodity groups and data from the Economic Research Service provide measurements that verify IR-4 program success.

- The IR-4 program supported clearances accounting for approximately 50% of all EPA pest management products approved between 2001 and 2004.
- Since the program began in 1963, IR-4 generated data has contributed to the approval of over 8,400 food-use and over 10,800 ornamental pest management product clearances and registrations.
- From 1999 through 2004, IR-4 data packages contributed to the registration of 3,780 food-crop products and 3,520 ornamental products, which is 45.5% and 32%, respectively, of all IR-4 supported registrations in the 41-year history of the program.

Figure 15.1
Total IR-4 Trials, Food Use and Ornamental

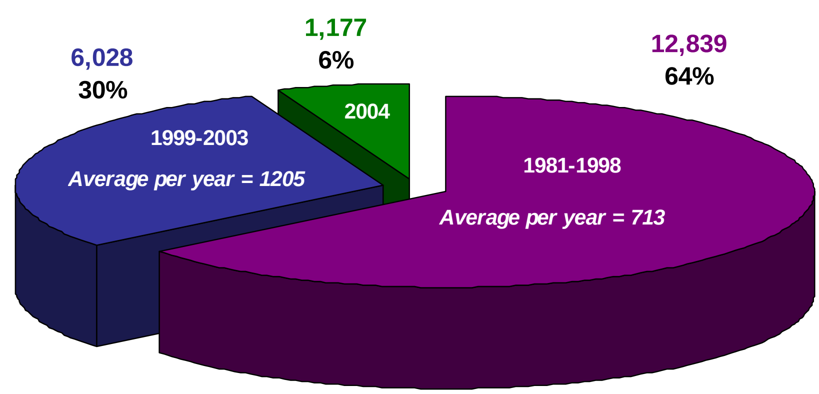
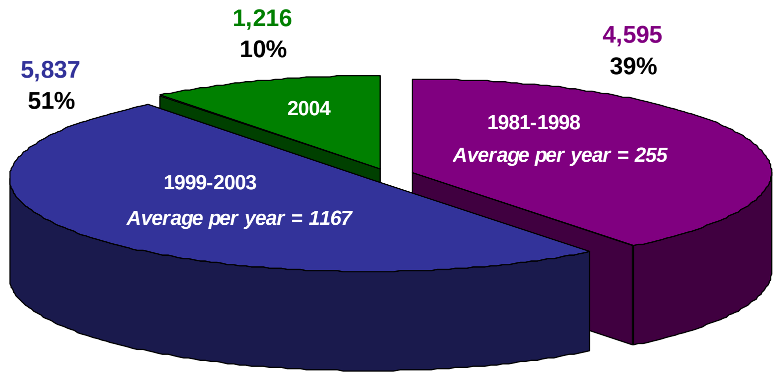


Figure 15.2
Total IR-4 Registrations, Food Use and Ornamental



15.10 Portfolio Completeness

In the EPA's 2003 fiscal year, IR-4 was credited with eliminating 95 of the 120 Section 18's or 80% by conversion to full Section 3 tolerances.

15.11 Portfolio Timeliness

EPA credits the IR-4 program in FY 2003 with 12 of the 26 reduced risk classifications granted by EPA and lowering the Reduced Risk Alternatives petition turn-around time from 28 months in FY 2002 to 18 months in FY 2003. Because of the trusted working relationship established by IR-4, the present completion time goal for IR-4 petitions has been reduce to only 30-months, which is comparable to the crop protection industry average.

15.12 Agency Guidance

Funding for IR-4 comes from the USDA, through the Cooperative State Research, Education and Extension Service (CSREES), the Agricultural Research Service (ARS), state land grant universities, commodity groups and the crop protection industry. IR-4 Headquarters is located at Rutgers University with a number of IR-4 staff serving in adjunt faculty roles. Each state has a person working on the faculty or staff that serves as an IR-4 State Liaison at their land grant university. The IR-4 program has four regional research centers located at NY State Agriculture Experiment Station/Cornell University, Geneva, Michigan State University, University of California, Davis and University of Florida. There are numerous field research centers and satellite laboratory as well. The ARS minor use program is an integral part of IR-4, supplying data through its own regional field and laboratory facilities.

Figure 15.3
Total IR-4 Monies Received

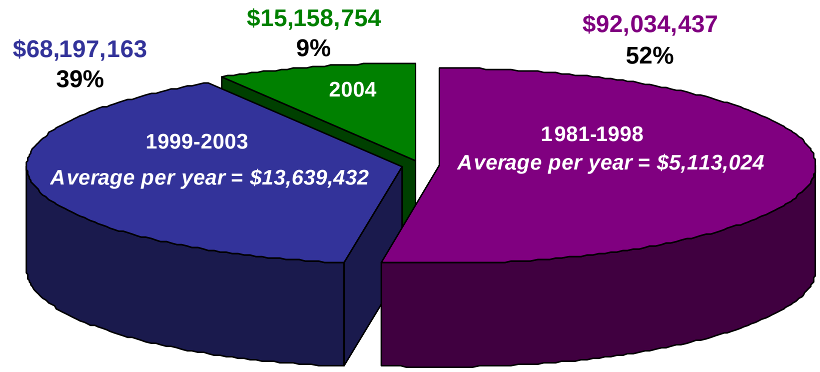
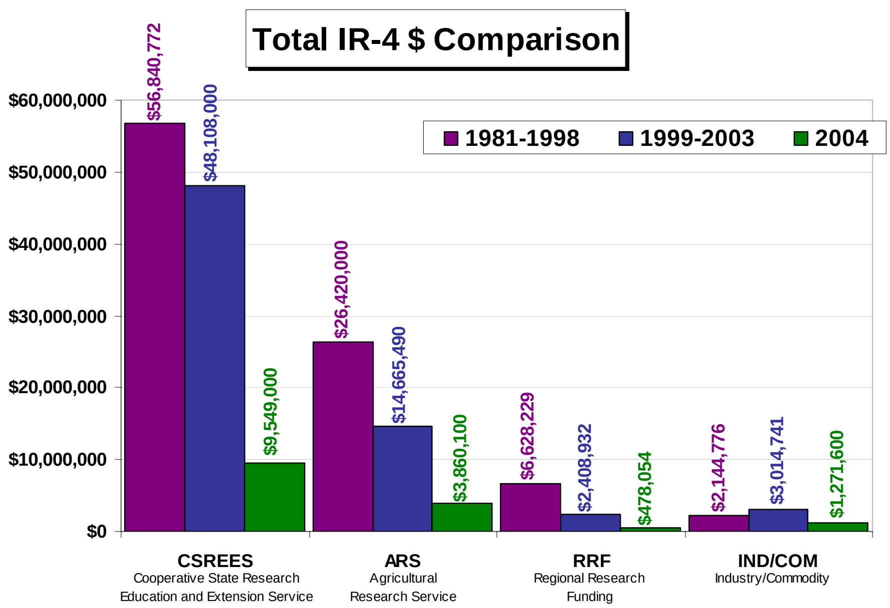


Figure 15.4



15.13 Reference and Evidentiary Material

The evidentiary materials supporting the above claims are included in the section entitled IR-4 of the separate evidentiary book.

- The IR-4 Project: A Strategy for Meeting the Challenge of Pest Management for Minor Crops, 2001 to 2005. Published 2001.
- IR-4 A Program Overview. Published 2003.
- 2003 Review Report of the National Research Support Project-4 (IR-4), A National Program to Clear Pest Management Agents for Minor Crop Uses.
- The IR-4 Newsletter.

15.14 Examples of Research Accomplishments

(A) Clearance of Crop Protection Products for Specialty Crop Growers.

The IR-4 program supported clearances accounting for approximately 50% of all EPA pest management products approved between 2001 and 2004. Since the program began in 1963, IR-4 generated data has contributed to the approval of over 8,400 food-use and over 10,800 ornamental pest management product clearances and registrations. From 1999 through 2004, IR-4 data packages contributed to the registration of 3,780 food-crop products and 3,520 ornamental products, which is 45.5% and 32%, respectively, of all IR-4 supported registrations in the 41-year history of the program.

(B) Crop Grouping Project

IR-4 has established an International Consulting Committee on Crop Grouping. The purpose of the committee is to assist the IR-4/EPA Crop Grouping Working Group, whose members include Dr. Bernie Schneider & Dr. Yuen-shaung Ng of the EPA, and Dr. Hong Chen of IR-4, in clarifying data needs and providing crop information for a proposal that requests a significant expansion of the existing crop groups.

The purpose of the International Consulting Committee is to help in completing the scientific information required to prepare proposal packages to the EPA. The 130 member committee represents 13 countries and provides expert opinions on many U.S. and international agriculture issues related to pesticide registration, MRL, and international harmonization. Besides representing their own countries, some of them also represent the European Commission and Codex Committee on Pesticide Residues. Their primary committee responsibility is to provide feedback within one month of each inquiry.

"Our goal is to complete the data packages for all the proposals produced from the USDA/IR-4 International Crop Grouping Symposium and submit them to the EPA, as well as assist in the regulatory procedures to bring the proposals to Federal approval," stated IR-4 HQ Crop Grouping Project Coordinator and Committee Chair, Hong Chen. "We also hope to assist the international harmonization of crop classification and determination of MRLs through our participation in US Delegation to the CODEX Committee on Pesticide Residues."

The first crop group petition, Bulb Vegetables, was completed in 2004 and includes 22 commodities versus 7 in the current crop group. Significant progress is being made by committees with much larger crop groups such as the Small Fruit Workgroup, the Cereal Grains and Grasses Workgroup and the Tropical Fruits Workgroup. The inclusion of new crops and crop common names in the crop groups will facilitate the international harmonization of commodity vocabulary and benefit participating countries in establishing import tolerances (MRL'S).

(C) IR-4 EPA Technical Working Group

The EPA/IR-4 Technical Working Group (TWG) was initiated in 1999 for the purpose of meeting quarterly to explore initiatives that facilitate specialty crop tolerances. The TWG also provides a means for the EPA to review the annual IR-4 residue program and discuss the data evaluations and record/summaries that are prepared for final reports. The TWG has also taken a leadership role with agency on electronic petition submission. EPA credits IR-4 with helping to lower the Reduced Risk/OP Alternative petition turnaround time from 28 months in FY 2002 to 18 months in FY 2003.

IR-4 has also provided crop tours for EPA scientist to give them an opportunity to visit working farms and interact with growers to learn about their needs and innovative approaches to pest management.

(D) NAFTA and Other International Cooperation

IR-4 and Agriculture and Agri-Food Canada (AAFC) are cooperating jointly in generating data on specialty crops and are now recognized as members of the North American Free Trade

Agreement (NAFTA) Technical Working Group (TWG) on Pesticides. The NAFTA TWG on Pesticides was formed to establish and address pest control issues while recognizing the environmental and human health objectives that arose from liberalized trade. Its vision is to make the North American region a world model for common approaches to pest control regulation and free trade in pest control chemicals and food.

A major objective of the NAFTA TWG is to provide equal access to markets and pest control tools, including lower-risk alternatives that are essential for promoting trade, improving pest management and supporting sustainable agricultural initiatives. By harmonizing data requirements, reducing duplicative efforts and minimizing trade barriers, the TWG works to ensure that trade is done in a way that protects human health and the environment throughout North America.

The partnership between the US IR-4 Project and the Canadians began in 1996 and over the past eight years has contributed to over 175 joint residue trials conducted in Canada. Members of the AAFC Pest Management Centre have been active participants in annual IR-4 Food Use Workshops and National Research Planning Meetings.

In the past four years, IR-4 supported over 2900 new uses that were registered in the US but only a few of these uses were made available to growers in Canada. The recognition of the cooperative projects allows the EPA and PMRA to simultaneously review submissions to be accepted in the US and Canada. This provides for streamlined processing and approval. Over the last five years, the US and Canada have coordinated the development of residue data to support the registration of minor use products and have jointly registered the first minor use product, fenhexamid, on caneberries, in 2002.

Working in collaboration has allowed the NAFTA TWG on Pesticides to: accomplish harmonization of data requirements between the countries, provide greater access to pest control tools for minor use or specialty crops, increase the availability of lower risk pest management products, promote integrated pest management programs for crops of special interest, and establish a worker safety training program. These accomplishments have contributed to providing a wide range of safe and effective pest management tools for North American growers. By having these tools at their disposal, growers will be better equipped to combat pests and protect the continent's food supply as well as allow for greater ease of imports and exports.

(E) Japanese Cooperation

In February 2004, IR-4 Executive Director, Dr. Robert Holm, and IR-4 Associate Director, Dr. Jerry Baron were invited to present lectures at the Pesticide Science Society of Japan at its 29 Annual Meeting at Kobe University. In addition to the lectures, Drs Holm and Baron were invited to meet with the Japanese Ministry of Agriculture, Forestry and Fisheries and also delivered a public seminar in Tokyo. The trip was sponsored by the Japan Crop Protection Association and marked the beginning of a partnership of shared knowledge and experience.

Section 16:
Applied Mission-oriented Programs: 406 IPM, PMAP and SBIR Applications

Relevance

16.1 Scope

(A) Background -- Food Quality Protection Act

In 1996, Congress unanimously passed landmark pesticide food safety legislation supported by the Administration and a broad coalition of environmental, public health, agricultural and industry groups. President Clinton promptly signed the bill on August 3, 1996, and the Food Quality Protection Act of 1996 became law (P.L. 104-170, formerly known as H.R. 1627).EPA regulates pesticides under two major federal statutes.

- Under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), EPA registers pesticides for use in the United States and prescribes labeling and other regulatory requirements to prevent unreasonable adverse effects on health or the environment.
- Under the Federal Food, Drug, and Cosmetic Act (FFDCA), EPA establishes tolerances (maximum legally permissible levels) for pesticide residues in food.

For over two decades, there had been efforts to update and resolve inconsistencies in the two major pesticide statutes, but consensus on necessary reforms remained elusive. The 1996 law represented a major breakthrough, amending both major pesticide laws to establish a more consistent, protective regulatory scheme, grounded in sound science. The FQPA mandates a single, health-based standard for all pesticides in all foods; provides special protections for infants and children; expedites approval of safer pesticides; creates incentives for the development and maintenance of effective crop protection tools for American farmers; and requires periodic re-evaluation of pesticide registrations and tolerances to ensure that the scientific data supporting pesticide registrations will remain up to date in the future.

(B) Highlights of the Food Quality Protection Act of 1996

Health-Based Safety Standard for Pesticide Residues in Food: The new law establishes a strong, health-based safety standard for pesticide residues in all foods. It uses "a reasonable certainty of no harm" as the general safety standard.

- A single, health-based standard eliminates longstanding problems posed by multiple standards for pesticides in raw and processed foods.
- Requires EPA to consider all non-occupational sources of exposure, including drinking water, and exposure to other pesticides with a common mechanism of toxicity when setting tolerances.

Special Provisions for Infants and Children: The new law provides added protection for infants and children by incorporating language to implement key recommendations of the National Academy of Sciences report, "Pesticides in the Diets of Infants and Children."

- Requires an explicit determination that tolerances are safe for children.
- Includes an additional safety factor of up to ten-fold, if necessary, to account for uncertainty in data relative to children.

- Requires consideration of children's special sensitivity and exposure to pesticide chemicals.

Limitations on Benefits Considerations: Unlike previous law, which contained an open-ended provision for the consideration of pesticide benefits when setting tolerances, the new law places specific limits on benefits considerations.

- Apply only to non-threshold effects of pesticides (e.g., carcinogenic effects); benefits cannot be taken into account for reproductive or other threshold effects.
- Further limited by three "backstops" on the level of risk that could be offset by benefits considerations. The first is a limit on the acceptable risk in any one year -- this limitation greatly reduces the risks. The second limitation is on the lifetime risk, which would allow EPA to remove tolerances after specific phase-out periods. The third limitation is that benefits could not be used to override the health-based standard for children.

Tolerance Reevaluation: Requires that all existing tolerances be reviewed within 10 years to make sure they meet the requirements of the new health-based safety standard.

Endocrine Disruptors: Incorporates provisions for endocrine testing, and also provides new authority to require that chemical manufacturers provide data on their products, including data on potential endocrine effects.

Enforcement: Includes enhanced enforcement of pesticide residue standards by allowing the Food and Drug Administration to impose civil penalties for tolerance violations.

Right to Know: Requires distribution of a brochure in grocery stores on the health effects of pesticides, how to avoid risks, and which foods have tolerances for pesticide residues based on benefits considerations. Specifically recognizes a state's right to require warnings or labeling of food that has been treated with pesticides, such as California's Proposition 65.

Uniformity of Tolerances: States may not set tolerance levels that differ from national levels unless the state petitions EPA for an exception, based on state-specific situations. National uniformity, however, would not apply to tolerances that included benefits considerations.

16.2 Focus on Critical Needs

CAR, RAMP, MBT and PMAP (applied pest management programs) and the SBIR plant production and protection topic area.
These programs are designed to help develop alternatives to ease the burden on growers faced with the potential loss of older chemicals during FQPA or other regulatory-driven transitions. A fifth program with a different funding authority, the Small Business Innovation Research Program, also addresses the need for alternative, lower risk pest management tools and their applications.

(A) Crops at Risk Program (CAR) and Risk Avoidance and Mitigation Program (RAMP).
These two CSREES grant programs for pest management address FQPA implementation directly. On November 19, 1999, the Secretary published in the Federal Register [64 FR 63560] a notice that the administration of this grant program had been delegated to CSREES and also solicited public comment regarding priorities to be addressed by the program. A public meeting was held on December 6, 1999 to obtain public input. Both public comment and consultation with the National Agricultural Research, Extension, Education, and Economics Advisory Board were used to develop the first RFPs for the program. The first requests for proposals (RFPs) were published in the Federal Register (Vol. 65, No. 68, pages 18822-63) on April 7, 2000. A key activity in FQPA implementation is the focused research to assist growers in the development and implementation of alternative safer pest management practices and strategies.

(B) Methyl Bromide Transitions Program (MBT)

A third program in the 406 Integrated category is designed to support the discovery and implementation of practical pest management alternatives for commodities affected by the methyl bromide phase-out. An International Protocol on Substances that Deplete the Ozone Layer was agreed upon on September 16, 1987 at the Headquarters of the International Civil Aviation Organization in Montreal. This Montreal Protocol stipulates that the production and consumption of compounds that deplete ozone in the stratosphere--chlorofluorocarbons (CFCs), halons, carbon tetrachloride, and methyl chloroform--are to be phased out by 2005.

(C) Pest Management Alternatives Program (PMAP).

A fourth program that fits in the sequence from single tactic-single crop to multiple tactic-multiple crops arises from another legislative authority, but shares common goals with the FQPA-driven CAR and RAMP. The Pest Management Alternatives Program (PMAP) was established in fiscal year 1996 as a vehicle to respond to the environmental and regulatory issues confronting agriculture. The purpose of this program is to develop replacement tactics and technologies for pesticides under consideration for regulatory action by EPA, and for which effective alternatives are not available. The program is structured to fund short-term projects aimed at adaptive research and implementation of tactics that have shown promise in previous testing. The focus of the program is primarily towards replacement of individual tactics in a pest management program on a single crop basis, and not towards entire crop or cropping system pest management issues. For example, this program might fund an implementation program aimed at replacing an organophosphate insecticide in potato with a new and safer insecticide.

(D) Small Business Innovation Research: Plant Production and Protection

Plant production and protection is one of 11 topic areas in the USDA SBIR program. Proposals submitted to this topic area are divided between two review panels. Panel B deals with biological approaches and Panel E deals with engineering approaches. (B) Biological Approaches improve the efficiency of crop production using innovative methods of biotechnology, tissue culture and genomics to produce crops with improved quality and yield, reduce the harmful impact of plant pathogens and insect pests, and develop new crop plants and new uses for existing crop plants. (E) Engineering Approaches develop improved crop production and protection methods by utilizing precision farming technology, improved sensors, remote sensing, and innovative farm equipment. Engineering approaches also develop improved farm and greenhouse structures and methodologies for growing plants under controlled conditions, and improved strategies for efficient use of energy.

16.3 Identification of Emerging Issues

Emerging and priority pest management issues pertinent to these programs are identified through stakeholder input. The quarterly meetings with IPM Centers Directors are key to this process. Directors communicate the grassroots priority needs of their constituents.

16.4 Integration of CSREES Programs

CAR, RAMP and MBT are announced and issued within the same IREE (Integrated research, Education and Extension) RFA because of the close linkage between the program goals to integrate research, education and extension within the programs and because all are important to finding pest management solutions exacerbated by regulatory issues. In addition, CAR and RAMP are paneled together because the goals fit in a logical interlocking sequence from a single crop focus to cropping systems-level issues.

16.5 Multidisciplinary Balance/ Interdisciplinary Integration

The 406 programs have integration as a primary objective. As examples of the integration and disciplinary balance, see Table 16.1 which shows FY 04 funding for CAR, RAMP and MBT by priority area.

Table 16.1
Integrated 406 Pest Management Program funding for FY 2004

Crops at Risk Proposals for FY 2004				
	Total Funding Requested	**Funding Amount**	**# of Projects**	**# of Projects Funded**
2004 Totals	***$10,963,261***	***$1,246,804***	***31***	***6***
Priority Area				
Integrated - multi-discipline	$1,991,358	$624,000	6	3
Pathogens	$2,415,806	$240,000	7	1
Weeds	$1,757,260	$117,804	6	1
Nematodes	$138,107	$0	1	0
Entomology	$4,660,730	$265,000	11	1
Total	*$10,963,261*	*$1,246,804*	*31*	*6*
Risk Avoidance and Mitigation Program Proposals for FY 2004				
2004 Totals	***$30,778,047***	***$3,104,165***	***23***	***3***
Priority Area				
Integrated - multi-discipline	$19,490,096	$2,539,772	12	2
Pathogens	$1,345,722	$0	2	0
Weeds	$1,978,630	$564,393	2	1
Nematodes	$0	$0	0	0
Entomology	$7,386,683	$0	5	0
Pesticide risk	$83,962	*$0*	1	0
Other	$492,954	$0	1	0
Total	*$30,778,047*	*$3,104,165*	*23*	*3*
Methyl Bromide Transitions Program Proposals for FY 2004				
2004 Totals	***$11,600,681***	***$2,956,439***	***28***	***8***
Primary Priority Area				
Pathogens	$5,172,197	$1,053,402	13	3
Weeds	$3,292,733	$766,729	7	2
Nematodes	$1,355,067	$0	3	0
Entomology	$1,780,684	$1,136,308	5	3
Total	*$11,600,681*	*$2,956,439*	*28*	*8*
Priority Area				
Integrated - multi-discipline	$7,989,013	$1,799,139	19	5
Pathogens	$1,379,298	$476,873	3	1
Nematodes	$1,355,067	$0	3	0
Entomology	$877,303	$680,427	3	2
Total	*$11,600,681*	*$2,956,439*	*28*	*8*

Performance

16.6 Reference and Evidentiary Material

See file folders of evidentiary material, which includes publications, books, journal articles, websites, etc.

16.7 Examples of Research Accomplishments

(A) Crops at Risk (CAR): Descriptive Examples of Research Accomplishments

1. Controlled Ambient Aeration as a Pest Management Strategy in Stored Rice
Stored rice can be infested by a variety of insect pests that cause product damage and reduce quality. Controlled aeration is a potential alternative to chemical treatment of stored rice. A new web-based program called ***Post-Harvest Grain Management*** (http://beaumont.tamu.edu/RiceSSWeb) has been developed through funding from the Crops at Risk program through the collaborative efforts of The **Texas A&M University**, Agricultural Research and Extension Center at Beaumont, in cooperation with the **University of Arkansas** Rice Processing Program, the **USDA-ARS at Manhattan, Kansas**, and the **University of Missouri**.

Post-Harvest Grain Management is an interactive web-based application that predicts temperature and grain moisture, and the population dynamics and damage of rice weevil and lesser grain borer inside bins. The web-based application is directly linked to a weather database for Arkansas, Missouri, and Texas. The weather database is updated automatically with data from several weather data sources, mainly NOAA weather data. The program allows users to choose historic and near real-time (for some stations) weather data to evaluate the effectiveness of regional weather on bin aeration and pest populations. The program provides advanced options for graphic display and analysis of simulation results, and sensitivity analysis. This web-based program is now used as a strategic tool for post-harvest grain management.

2. Developing a Blueberry IPM Program to Address Critical Insect Management Issues
Sooty blotch and flyspeck (SBFS), the most serious summer disease of apples in the eastern half of the US, has been the focus of recent research at the **University of Illinois-Champaign**, **Iowa State University**, and the **University of Wisconsin-Madison** funded by the Crops at Risk program.

The SBFS fungi appear as brown or black smudges and speckles on the fruit cuticle that often make apples unmarketable. To defend against SBFS, most Midwest growers apply fungicides every 10 to 14 days during the summer. The expense of these chemicals, as well as their risk to human and environmental health, have persuaded growers and plant pathologists in the Midwest to test a ***disease-warning system for SBFS***. Using the warning system in commercial orchards in Illinois, Iowa, and Wisconsin in 2001 and 2002 commercial growers were able to limit fungicide applications to periods when they are most necessary. In the cooperator trials, the SBFS warning system saved an average of 2.6 sprays per season over all the site-years. Based on an estimated cost of $20 per spray per acre - a figure that includes labor costs and machinery depreciation as well as fungicide – 2.6 fewer fungicide sprays per year translates to an average annual savings of $1,040 in a 20-acre orchard.

Table 16.2
List of Funded Projects from CAR Between FY 2000-2003

Idaho	Eigenbrode, Sanford; Bechniski, Edward	University of Idaho	Developing an Attract-and-Kill Method for Managing the Sugarbeet Root Maggot Fly
Iowa	Gleason, Mark L.; Taylor, Elwynne; Domoto, Paul A.	Iowa State University	Implementing New Tactics for Apple IPM in the FQPA Era
Massachusetts	Prokopy, Ronald J.; Cooley; Daniel R; Phelan, P. Larry	University of Massachusetts	New Multi-Tactic Alternatives to Current Pesticides Against Key Apple Pests
Oklahoma	Edelson, Jonathan; Damicone, John; Criswell, Jim; Cuperus, Gerrit	Oklahoma State University	Managing Pests of Leafy Green Crops Destined for Processing Markets
Oregon	Ingham, Russell E.; Connor, Jeffrey D.	Oregon State University	Nematode Management in Potato without Nematicides, Opportunities and Challenges
Arkansas	Howell, Terry	University of Arkansas	Controlled Ambient Aeration as a Pest Management Strategy in Stored Rice
Michigan	Hausbeck, Mary	Michigan State University	Seeking Alternatives to B2 Fungicides and Carbamate Insecticides for Asparagus Production
Michigan	Isaacs, Rufus	Michigan State University	Developing a Blueberry IPM Program to Address Critical Insect Management Issues
New York	Mutschler, Martha	Cornell University	Deploying Genetic Resistance & Reducing Sprays to Manage Tomato Late & Early Blights
South Carolina	Keinath, Anthony	Clemson University	Integrated Management of Foliar Diseases of Melons in the Eastern U.S.
California	Michailides, Themis	University of California, Kearney	Decision Support System for IPM of Brown Rot of Stone Fruits
Colorado	Schwartz, Howard	Colorado State University	Integrated Management of Xanthomonas Leaf Blight of Onion by Cultural Practices, Disease Forecasting and Biologically-Based Pesticides
Iowa	Gleason, Mark	Iowa State University	Implementing Innovative Tactics for Management of Diseases, Insects, and Weeds in Partnership with Cucurbit Growers
South Carolina	Zehnder, Geoffrey	Clemson University	Assessment and Integration of Multiple Tactics for Management of Aphid-Transmitted Virus Diseases
Louisiana	Reagan, Thomas	Louisiana State University	Development and Implementation of an IPM Program for Exotic and Native Stalk Borers Threatening Sugarcane and Rice in Louisiana and Texas
Maryland	Everts, Kathryne	University of Maryland	Integrated Management of White Mold Processing Lima Bean in the East
Massachusetts	Averill, Anne	University of Massachusetts	Assessment and Integration of Cultural and Reduced-Risk Chemical Approaches for Key Lepidopteran Pests in Northeast Cranberry
New York	Rutz, Donald	Cornell University	Development and Implementation of a Cost-Effective, Integrated Pasture Fly Management Program for the Eastern U.S.
Oregon	Sugar, David	Oregon State University	Alternatives to Thiabendazole for Management of Postharvest Decay of Pears
Texas	Pendleton, Bonnie	West Texas A&M University	Alternatives to Organophosphates and Carbamates for Managing Aphids in Wheat and Sorghum

(B) Risk Avoidance and Mitigation Program (RAMP): Descriptive Examples of Research Accomplishments

1. Consortium for Integrated Management of Stored Product Insect Pests

Stored product insects cause significant economic losses and quality deterioration in stored grain and processed food. A *Consortium for Integrated Management of Stored Product Insect Pests* (Kansas State University, Oklahoma State University, Purdue, USDA-ARS Grain Marketing and

Production Research Center, and industry) was established with funding from the Risk Avoidance and Mitigation Program.

This Consortium has been able to achieve successful management of stored grain pests by using effective sampling and monitoring techniques, modeling populations, manipulating factors that create conducive environments for insect pest reproduction in storage such as temperature and moisture, and the use of natural and alternative chemical method(s) to suppress insect survival. The current regulatory climate, coupled with consumer demand for food free of pesticide residues, and pesticide resistance in insects, necessitates development of effective alternatives to pesticides, which this RAMP project emphasizes.

Table 16.3
List of Funded Projects from RAMP

Title	Investigator	Institution
ENHANCING PHEROMONE MATING DISRUPTION PROGRAMS FOR LEPIDOPTEROUS PESTS IN WESTERN ORCHARDS	Welter, S. C.	UNIV OF CALIFORNIA BERKELEY, CALIFORNIA
ENHANCING PHEROMONE MATING DISRUPTION PROGRAMS FOR LEPIDOPTEROUS PESTS IN WESTERN ORCHARDS	Welter, S. C.	UNIV OF CALIFORNIA BERKELEY, CALIFORNIA
REDUCED-RISK TACTICS FOR THRIPS AND TOSPOVIRUSES ON SOLANACEOUS CROPS	Funderburk, J. E.	UNIVERSITY OF FLORIDA GAINESVILLE, FLORIDA
ADVANCING IPM AND REDUCING PESTICIDE RISKS IN EASTERN PEACHES	Scherm, H.	UNIVERSITY OF GEORGIA ATHENS, GEORGIA
REDUCED RISK NIGHTSHADE MANAGEMENT SYSTEMS FOR TOMATOES	Masiunas, J. B.	UNIVERSITY OF ILLINOIS URBANA, ILLINOIS
CONSORTIUM FOR INTEGRATED MANAGEMENT OF STORED PRODUCT INSECT PESTS	Ramaswamy, S. B.	KANSAS STATE UNIV MANHATTAN, KANSAS
CONSORTIUM FOR INTEGRATED MANAGEMENT OF STORED PRODUCT INSECT PESTS	Ramaswamy, S.	KANSAS STATE UNIV MANHATTAN, KANSAS
SOYBEAN APHID IN THE NORTH CENTRAL US: IMPLEMENTING IPM AT THE LANDSCAPE SCALE	Landis, D. A.	MICHIGAN STATE UNIV EAST LANSING, MICHIGAN
A PARTNERSHIP AMONG EASTERN US CARROT STAKEHOLDERS TO DEVELOP AND IMPLEMENT IPM	Hausbeck, M.	MICHIGAN STATE UNIV EAST LANSING, MICHIGAN
A PARTNERSHIP AMONG EASTERN US CARROT STAKEHOLDERS TO DEVELOP AND IMPLEMENT IPM	HAUSBECK, M.	MICHIGAN STATE UNIV EAST LANSING, MICHIGAN
A STRATEGY TO ADVANCE IPM FOR CELERY GROWERS IN MICHIGAN, CALIFORNIA AND FLORIDA	Hausbeck, M.	MICHIGAN STATE UNIV EAST LANSING, MICHIGAN
REDUCED RISK PEST MANAGEMENT SYSTEMS FOR US TART CHERRY PRODUCTION	Whalon, M. E.	MICHIGAN STATE UNIV EAST LANSING, MICHIGAN
REDUCED-RISK PEST MANAGEMENT PROGRAMS FOR EASTERN TREE FRUITS	Shearer, P. W.	RUTGERS UNIVERSITY NEW BRUNSWICK, NEW JERSEY
DEVELOPMENT AND IMPLEMENTATION OF REDUCED-RISK INSECT PEST MANAGEMENT STRATEGIES FOR BLUEBERRIES	Polavarapu, S.	RUTGERS UNIVERSITY NEW BRUNSWICK, NEW JERSEY
DEMONSTRATION & EVALUATION OF CUCURBIT PEST & CROP MANAGEMENT SYSTEMS	Petzoldt, C. H.	CORNELL UNIVERSITY ITHACA, NEW YORK
REDUCED-RISK PEST MANAGEMENT PROGRAMS FOR EASTERN TREE FRUITS	Agnello, A. M.	N Y AGRICULTURAL EXPT STATION GENEVA, NEW YORK
SITE-SPECIFIC WEED MANAGEMENT TO REDUCE HERBICIDE USAGE AND ENHANCE UNDERSTANDING OF WEED ECOLOGY IN A CORN/COTTON/PEANUT SYSTEM	WILCUT, J.	NORTH CAROLINA STATE UNIV RALEIGH, NORTH CAROLINA
DEVELOPMENT OF GROWER DECISION-MAKING TOOLS TO REDUCE RISK AND ENHANCE SUSTAINABILITY OF SOUTHERN SWEETPOTATO PEST MANAGEMENT SYSTEMS	Kennedy, G. G.	NORTH CAROLINA STATE UNIV RALEIGH, NORTH CAROLINA
A SITE-SPECIFIC FIELD CORN IPM PROGRAM THAT INCORPORATES TRANSGENIC TECHNOLOGY	Calvin, D. D.	PENNSYLVANIA STATE UNIVERSITY UNIVERSITY PARK, PENNSYLVANIA
ECOLOGICALLY BASED SWEET CORN PEST MANAGEMENT FOR NORTHEASTERN FARMS	Fleischer, S. J.	PENNSYLVANIA STATE UNIVERSITY UNIVERSITY PARK, PENNSYLVANIA
NOVEL TACTICS FOR RISK REDUCTION, RESISTANCE MANAGEMENT, AND PROFIT THROUGH PEST SUPPRESSION	Wyman, J. A.	UNIV OF WISCONSIN MADISON, WISCONSIN

(C) Methyl Bromide Transitions Program (MBT): Descriptive Examples of Research Accomplishments

1. Sodium Azide and Furfural-based Biofumigants for Soil Pest Control

Many high-value agricultural crops (nursery and vegetable) depend on fumigation with methyl bromide as a part of their product system. This project examines the effectiveness of sodium azide as a substitute to fumigation with methyl bromide to control nematodes, weeds and pathogens in bell peppers and ornamental nursery crops. The impact of this work will be that vegetable and turf growers who require methyl bromide fumigation will have a suitable alternative.

2. *Non-chemical Pest Control in Harvested Nuts with Electromagnetic Energy*

An alternative to methyl bromide is needed for insect control in harvested nuts, specifically for control of insect pests in walnuts during storage and particularly prior to export shipment. The purpose of this research was to develop radio frequency energy treatments as a non-chemical alternative to methyl bromide fumigation for control of insects in harvested nuts. There is interest by consumers and shippers in a non-chemical alternative, providing it is economical and effective. Electromagnetic treatment has the potential to provide such a non-chemical alternative and may result in improved quality of walnuts by reducing rancidity. This has economic benefits to the grower and shipper, food quality and safety benefits to consumers and benefits to the environment.

3. Biologically-based Sustainable Tomato Production Systems Without Use of Methyl Bromide.

Since methyl bromide is destroying the stratespheric ozone shield, agricultural uses will cease. Biologically-based tomato production systems will be developed for Florida and Virginia, in which cover crops suppress pests, and yields are increases through better irrigation, fertigation and addition of organic matter to soil. The appropriate use of cover crops and optimized irrigation schedules and rates will directly benefit the growers by reducing cost of production per unit, substantially increasing yields, and improving fruit quality. After methyl bromide is no longer available, this new set of practices will allow the continuation of profitable tomato production in Miami-Dade.

Table 16.4
List of Funded Projects from MBT

Title	Investigator	Institution
SODIUM AZIDE AND FURFURAL-BASED BIOFUMIGANTS FOR SOIL PEST CONTROL IN CROPS	Rodriguez-Kabana, R.	AUBURN UNIVERSITY AUBURN, ALABAMA
NON-CHEMICAL PEST CONTROL IN HARVESTED NUTS WITH ELECTROMAGNETIC ENERGY	Mitcham, E. J.	UNIV OF CALIFORNIA DAVIS, CALIFORNIA
EVALUATION OF FUMIGANT EFFICACY WITH VIF PLASTIC	Ajwa, H. A.	UNIV OF CALIFORNIA DAVIS, CALIFORNIA
ALTERNATIVE FUMIGANTS FOR THE CONTROL OF SOIL PESTS: STRAWBERRY AS A MODEL SYSTEM	Fennimore, S. A.	UNIV OF CALIFORNIA DAVIS, CALIFORNIA
DEVELOPMENT AND ASSESSMENT OF ALTERNATIVE PRE-PLANT FUMIGATION STRATEGIES FOR NUT CROPS	Lampinen, B. D.	UNIV OF CALIFORNIA DAVIS, CALIFORNIA
DEVELOPMENT OF A REACTIVE SURFACE BARRIER TO REDUCE FUMIGANT EMISSIONS FROM SOIL SURFACES	Yates, S.	UNIVERSITY OF CALIFORNIA RIVERSIDE, CALIFORNIA
EFFECTS OF MANAGEMENT PRACTICES ON PESTS, PATHOGENS, AND BENEFICIAL IN SOIL ECOSYSTEMS	McSorley, R. T.	UNIVERSITY OF FLORIDA GAINESVILLE, FLORIDA
EFFECTS OF MANAGEMENT PRACTICES ON PESTS, PATHOGENS, AND BENEFICIALS IN SOIL ECOSYSTEMS	Gallaher, R. N.	UNIVERSITY OF FLORIDA GAINESVILLE, FLORIDA
EFFECTS OF MANAGEMENT PRACTICES ON PESTS, PATHOGENS AND BENEFICIALS IN SOIL ECOSYSTEMS	McGovern, R. J.	UNIVERSITY OF FLORIDA GAINESVILLE, FLORIDA
BIOLOGICALLY-BASED SUSTAINABLE TOMATO PRODUCTION	Klassen, W.	UNIVERSITY OF FLORIDA

SYSTEMS WITHOUT USE OF METHYL BROMIDE.		GAINESVILLE, FLORIDA
MULTI-TACTIC APPROACH TO PEST MANAGEMENT FOR METHYL BROMIDE DEPENDENT CROPS IN FLORIDA	Dickson, D. W.	UNIVERSITY OF FLORIDA GAINESVILLE, FLORIDA
DEVELOPMENT OF HERBICIDE/FUMIGANT COMBINATIONS FOR SOLANACEOUS MULCHED VEGETABLES IN FLORIDA	Gilreath, J. P.	UNIVERSITY OF FLORIDA GAINESVILLE, FLORIDA
REPLACING METHYL BROMIDE USING INTEGRATED SYSTEMS INCLUDING MULCHES, HERBICIDES, AND SOIL FUMIGANTS	Culpepper, A. S.	UNIVERSITY OF GEORGIA ATHENS, GEORGIA
REPLACEMENT OF METHYL BROMIDE BY INTEGRATING THE USE OF ALTERNATIVE SOIL FUMIGANTS, CULTURAL PRACTICES, AND HERBICIDES FOR TOMATO, PEPPER	Langston, D. B.	UNIVERSITY OF GEORGIA ATHENS, GEORGIA
UTILIZATION OF SOIL AMENDMENTS AND BRASSICA WINTER CROPS FOR MANAGEMENT OF SOILBORNE PESTS AND DISEASES IN VEGETABLE PLASTICULTURE	Seebold, K. W.	UNIVERSITY OF GEORGIA ATHENS, GEORGIA
COMBINATION OF A BIOCONTROL AGENT AND BRASSICA TISSUES AGAINST NURSERY PATHOGENS	Knudsen, G. R.	UNIV OF IDAHO MOSCOW, IDAHO
FUMIGATION MODELING, MONITORING AND CONTROL FOR PRECISION FUMIGATION OF FLOUR MILL AND FOOD PROCESSING STRUCTURES	Maier, D. E.	PURDUE UNIVERSITY WEST LAFAYETTE, INDIANA
CULTURAL AND BIOLOGICAL ALTERNATIVES TO METHYL BROMIDE FUMIGATION OF STRAWBERRIES	Hancock, J. F.	MICHIGAN STATE UNIV EAST LANSING, MICHIGAN
METHYL BROMIDE ALTERNATIVES RESEARCH-EDUCATION FOR HERBACEOUS PERENNIAL-WOODY ORNAMENTALS AND VEGETABLES IN MI, NY AND RI	Bird, G. W.	MICHIGAN STATE UNIV EAST LANSING, MICHIGAN
AN INTEGRATED PROGRAM TO REPLACE METHYL BROMIDE FUMIGATION FOR BLACK ROOT ROT CONTROL IN STRAWBERRIES	Hancock, J.	MICHIGAN STATE UNIV EAST LANSING, MICHIGAN
RESEARCH EVALUATIONS OF AND OUTREACH FOR METHYL BROMIDE ALTERNATIVES IN CONIFER SEEDLINGS AND HERBACEOUS PERENNIALS	Brown-Rytlewski, D.	MICHIGAN STATE UNIV EAST LANSING, MICHIGAN
DISTRIBUTION, EFFICACY, AND EMISSION OF CHLOROPICRIN AND MITC IN FOREST NURSERIES	Wang, D.	UNIV OF MINNESOTA ST PAUL, MINNESOTA
DEVELOPMENT, EVALUATION, AND DEMONSTRATION OF A GRAPHICAL COMPUTER PROGRAM FOR MAKING MANAGEMENT DECISIONS IN SOIL FUMIGATION	Wang, D.	UNIV OF MINNESOTA ST PAUL, MINNESOTA
DEVELOPING MYCOFUMIGATION FOR CONTROL OF SOILBORNE PLANT PATHOGENS	Jacobsen, B. J.	MONTANA STATE UNIVERSITY BOZEMAN, MONTANA
BIO-BASED MANAGEMENT AND MICROBIAL MECHANISMS OF APPLE REPLANT DISEASE	Merwin, I. A.	CORNELL UNIVERSITY ITHACA, NEW YORK
PREPLANT SOIL COMPOST AND FUMIGATION, ROOTSTOCK DISEASE RESISTANCE, AND SOIL MICROBIAL SPECIES DIVERSITY AS FACTORS IN APPLE REPLANT DISEASE	Merwin, I. A.	CORNELL UNIVERSITY ITHACA, NEW YORK
DEVELOPMENT, EVALUATION, AND EXTENSION OF INTEGRATED METHYL BROMIDE TRANSITION STRATEGIES IN VEGETABLE AND STRAWBERRY PRODUCTION SYSTEMS	Louws, F. J.	NORTH CAROLINA STATE UNIV RALEIGH, NORTH CAROLINA
INTEGRATED APPROACHES TO PEST MANAGEMENT IN METHYL BROMIDE DEPENDENT PLASTICULTURE PRODUCTION SYSTEMS IN THE SOUTHEASTERN UNITED STATES	Louws, F. J.	NORTH CAROLINA STATE UNIV RALEIGH, NORTH CAROLINA
VACUUM FOR POST HARVEST DISINFESTATION OF INSECTS FROM DURABLE AND FRESH COMMODITIES	Phillips, T.	OKLAHOMA STATE UNIVERSITY STILLWATER, OKLAHOMA
DIELECTRIC AND MICROWAVE APPLICATIONS FOR THE	Janowiak, J.	PENNSYLVANIA STATE

PHYTOSANITARY TREATMENT OF WOOD PACKING MATERIAL	J.	UNIVERSITY UNIVERSITY PARK, PENNSYLVANIA
OPTIMIZATION OF METAM SODIUM APPLICATION METHODS FOR MAXIMUM EFFICACY AND MINIMUM VOLATILIZATION LOSSES	Nelson, S. D.	TEXAS A & M UNIVERSITY KINGSVILLE, TEXAS
RADIO FREQUENCY ENERGY AS AN ALTERNATIVE TO METHYL BROMIDE FUMIGATION FOR CONTROLLING PESTS IN STONE FRUITS AND NUTS	Tang, J.	WASHINGTON STATE UNIVERSITY PULLMAN, WASHINGTON
USING SOIL SOLARIZATION TO REDUCE THE INOCULUM POTENTIAL OF VERTICILLIUM DAHLIAE AND NEMATODES IN VEGETABLE PRODUCTION SYSTEMS	Macguidwin, A. E.	UNIV OF WISCONSIN MADISON, WISCONSIN

(D) Pest Management Alternatives Program (PMAP): Descriptive Examples of Research Accomplishments

1. New Method of Managing the Apple maggot

The apple maggot is a key insect pest of apples in eastern and Midwestern North America. Attractive odor-baited pesticide-treated spheres ringing perimeters of commercial orchards offer a viable behavioral-control alternative to pesticide sprays against the apple maggot. A PMAP-funded study entitled “Refinement of Wooden Pesticide-treated Spheres for Apple Maggot Control” encompassed efforts in both research and demonstration extending over a 2-year period. The project aims to develop a superior pesticide-treated sphere that will reduce pesticide sprays by commercial orchards.

2. Managing Stored Grain Pests Using a New Low-risk Pesticide

Traditional insecticides for controlling stored-grain pests are becoming limited in availability. Consequently, this study entitled “Fate and Efficacy of Spinosad for Insect Management in Farm Stored Grain” evaluated spinosad, a relatively new, low-toxicity, fermentation-derived insecticide on wheat and corn stored on farm sites in Kansas and Indiana.

3. Development of a Non-chemical Method to Manage the Varroa Mite

The varroa mite, an obligate ecto-parasite, is one of the most devastating pests of the honey bee. The mite is becoming resistant to many pesticides. Consequently, a PMAP-funded project entitled “Field Test of an Alternative Method for Controlling the Most Serious Honey Bee Pest, the Varroa Mite” sought to determine the optimal conditions for using the ‘Mitezapper’, a device that uses electrical heat to kill mites. If proven effective, it will result in a non-chemical method for mite control that could be widely adopted by beekeepers.

(E) SBIR Plant Production and Protection area: Descriptive Examples of Research Accomplishments

1. New, Non-toxic Method to Control the Key Pest in Pecans

The last key pest preventing the pecan industry to produce organic nuts is the pecan-nutcase bearer (PNCB). PNCB is controlled using conventional pesticide applications which disrupt the orchard's ecological balance resulting in resurgence of pests. The purpose of this project was to develop a non toxic tool to economically and effectively control the PNC. First objective was to optimize the production of the non toxic, highly specific sex pheromone of PNC so that it becomes available to the industry at a competitive price. Then development of systems to manage and control PNC using our pheromone will be pursued. The result should be an efficient and safe alternative to pesticides to control this key pest of pecan.

The researchers have negotiated with a Texan organic pecan grower to test the Mating Disruption PNC formulation in 375 acres of his commercial farm and with another pecan grower to test PNC Attract and Kill in 60 acres of his farm. PNC pheromone production has been scaled up, and another chemist has been hired, in order to support these large field plots. The impact of this project to the Industry is that PNC, the key pest of Pecans will be economically and efficiently controlled with environmentally friendly, organic, sex pheromone tools, instead of the harsh pesticides currently used. EPA registration efforts are under way.

2. Flow Control and Operation Monitoring System for Individual Spray Nozzles
This project is designed to lead directly to product design. The envisioned product is a single-nozzle control and monitoring unit for agricultural spray applications. The unit will integrate well into existing Capstan products, which already provide means for nozzle control. Initially, the monitoring capabilities of the unit allow more efficient, reliable and safe agrochemical application and less driver fatigue. With further refinements, the unit will provide the highest possible spatial resolution in agrochemical application. The Impact of this work is that the device will allow individual nozzle resolution on flow rate and spray droplet size. The device will also provide, either in conjunction with control or simply as a driver-alert system, individual monitoring of proper nozzle operation. Often, drivers cannot see all spray nozzles on a large boom or they are fully engaged in driving a wide, fast-moving vehicle over rough terrain. Individual nozzle communication will be achieved using current CAN bus systems which are commercially used on spray application vehicles.

3. Sunlight Independent Crop Canopy Reflectance Sensor
Over application of nitrogen fertilizer on agricultural and commercial landscapes has resulted in contamination of ground and surface waters. This project proposed to develop a new sensor technology that will help reduce the amount of N applied to crops and turf by determining the amount of N needed by the plant via the plants reflectance characteristics. The sensing technology in conjunction with variable rate fertilizer applicators will allow precise control of N as dictated by crop requirements. Lowering N rates will help improve surface and ground water quality by reducing runoff and leaching of due to excess application.

Section 17:
Pesticide Safety Education Program (PSEP)

Relevance

17.1 Scope

The scope and mission of the PSEP is to ensure the safe and efficient use of pesticides through direct education and training. Pesticides are one of the many tools used to manage pests like insects, weeds, vertebrates, nematodes, and diseases. While pesticides may prevent or reduce the damage from pests, there are also potential risks to humans, non-target fauna and flora, and the environment if these tools are used improperly. This program provides annually pesticide safety information, approved practice recommendations, and education for farmers using restricted-use pesticides and for commercial applicators of pesticides. Farmers using restricted-use pesticides must meet certification requirements set by EPA through individual State Lead Agencies. Land grants provide program development and delivery locally. The PSEP program is more than 30 years old and originated from general farm safety programming efforts from USDA.

USDA-CSREES administers EPA pass-though funding (approximately $1,200,000 annually) to partially offset the costs of this program delivered at the local level. This is a program supported by pass-through funding from the Environmental Protection Agency (EPA) via an annually renewable Interagency Agreement. Funds are designated for all states. Funding from EPA has declined in recent years resulting in reductions in activities by some state programs. The PSEP program has increased integration locally with IPM, sustainable agriculture, refugia, biosecurity, invasive species, homeland security and other needed programming efforts at the state level through the Land Grant University personnel.

17.2 Focus on Critical Needs

The most critical needs relevant to the PSEP are to initially train pesticide applicators to use pesticides in a responsible, safe manner, and to keep certified pesticide applicators abreast of new developments by conducting recertification programs. Pesticide applicators are required to be certified before they can purchase restricted-use pesticides.

17.3 Identification of Emerging Issues

The PSEPs are among the first to recognize important emerging issues related to pest management. Excellent examples include the PSEPs development of training materials on exotic invasive species such as soybean rust, soybean aphid, emerald ash borer, and the Asian long-horned beetle. Quite often the PSEPs will address new and emerging pest issues.

17.4 Integration of CSREES Programs

The PSEP cooperates and encourages involvement with other important CSREES programs such as IPM, IR-4, and the Integrated Pest Management Centers. Some PSEPs also cooperate with Farm Safety Programs as well.

17.5 Multidisciplinary Balance/Interdisciplinary Integration

The PSEPs are by nature interdisciplinary in that the broad spectrum of pests must be addressed, including insects, weeds, and diseases. Cooperators with PSEPs include weed scientists, plant pathologists, entomologists, and nematologists, among others. Several PSEPs also involve agricultural engineers with their programs when addressing topics such as spray drift management and sprayer calibration. Where aerial applicators are an important group, the PSEP Coordinators will often participate in 'fly-ins' to cover important up-dates in aerial application technology.

Quality

17.6 Significance of Outputs and Findings

The results of PSEP initial and recertification training sessions are covered in annual reports (provided as Appendices B (2002) and C (2003)). The significance of this program is apparent in the capability to manage serious pests with pesticides that must be applied by certified applicators. Without training and certification, there would be greater damage to human health, crops, livestock, landscapes, homes, etc.

17.7 Stakeholder Assessment

Many of the PSEP Coordinators conduct surveys of the trainees to learn what they thought of the training sessions and if they will change their behavior as a result of the program. As an example, the Nebraska PSEP conducted a survey in 2003 of 1482 commercial/noncommercial applicators that resulted in 513 surveys being completed and returned. About 60% were recertification participants and 40% were in initial training. When asked "As a result of this PSEP session, I will …" applicators expressed they would "always" do the following actions: 64% will always use protective gloves, goggles, coveralls, face respirator, 56% will always check spray equipment and nozzles for wear, 55% will always use a spill kit in the event of an accidental spill, and 65% will always calibrate equipment and calculate application rates.

17.8 Alignment of Portfolio with Current Issues

As mentioned earlier, PSEPs will often address current issues even though funding is typically not provided to cover additional activities. Current issues that have been vigorously addressed by PSEPs include pesticide security (related to homeland security) and exotic invasive species such as West Nile Virus vector control, soybean aphid, emerald ash borer, Asian long-horned beetle, and soybean rust. An example is a PowerPoint presentation with a manuscript on soybean rust developed by the Iowa State University PSEP to be used for current training sessions. This presentation has been distributed to all the PSEP Coordinators as well as IPM Coordinators and the Regional Integrated Pest Management Centers. Another important issue that PSEPs have addressed is the needs of multi-cultural non-English speaking clientele.

17.9 Methodology and Use of Funded Projects

The methodology used by PSEPs is relatively uniform, with initial training addressing many of the basic principles in pesticide use such as understanding pesticide labels, wearing appropriate personal protective equipment, pest identification, calibration, and learning about the state's pesticide laws and regulations. Recertification sessions often address specific, current issues in pest management, sometimes with invited specialists.

Performance

17.10 Portfolio Productivity

During the past few years, the PSEP has utilized a web-based reporting system called the Performance Planning and Reporting System (PPRS). Table 17.1 summarizes data from the PSEPs for FYs 2002 and 2003:

Table 17.1
Data from the PSEP Performance Planning and Reporting System (PPRS) For Fiscal Years 2002 and 2003

Data Type	2002	2003
Funding		
EPA	$1,880,000	$700,000
USDA	NA	$425,000
Other Federal Funds	$999,400	$995,198
State Funding	$3,930,000	$3,853,662
Other Funding	$2,337,000	$1,971,215
TOTAL	$9,146,400	$7,945,075
EPA % of TOTAL	20.6	8.8
Staff Supported		
FTEs: EPA Funds	55	
FTEs: Other Funds	356	
Volunteers	1956	2374
FTEs: All Funds		78
Cooperators		1017
Number Trained		
Initial	114,859	104,015
Recertification	311,634	302.660
TOTAL	426,493	406,675
Non-certification	285,394	1,089,177
Educational Materials		
Printed	578	627
Electronic	315	405
Other PSEP Activities	1738	9236

17.11 Portfolio Completeness

The PSEP conducts training sessions in every state and territory, although some territories do not currently have a PSEP Coordinator. Recent visits with administrators from some of the territories will help correct these vacancies. Each state and territory is required to submit a Plan of Work for five years, and an annual report at the end of each federal fiscal year via the PPRS. If a legitimate report is not submitted by a state, funding for the next fiscal year is jeopardized. All Plans of Work and annual reports can be viewed at the PPRS website: www.pprs.info. As mentioned earlier, annual reports have been produced for FYs 2002 and 2003.

17.12 Portfolio Timeliness

It is important for the PSEPs to keep up-to-date on issues that are relevant to pesticides and applicators. This has been addressed earlier in this document (see Section 10.8)

17.13 Agency Guidance

CSREES commits a significant amount of resources to the PSEP a part of which is a National Program Leader (NPL) for Environmental Toxicology who has participated in all regional and national meetings each year. This NPL also relays current issues and updates to PSEPs via an email list and by producing a Quarterly PSEP Update. CSREES has updated its website at www.csrees.usda.gov and has a 'Pesticides' webpage covering USDA/CSREES programs, including PSEP, that address pesticide issues. CSREES has also recently supported the Spray Table Demonstration Project, the Southern Region Pesticide Safety Education Center, and the International Spray Drift Conference. In addition, CSREES administers and allocates the EPA pass-through funds but takes no indirect costs for this service. Each state's PSEP is carried out by the Cooperative Extension Service which is supported by Smith-Lever funds that are distributed to land-grant institutions in each state and territory.

17.14 Portfolio Accountability

Accountability for the PSEP is addressed by the PPRS with reports designed to satisfy the Government Performance and Reporting Act (GPRA) requirements. As stated in Section 10.11, these reports can be viewed by anyone at the PPRS website. Three examples of reports are provided as Appendices D (California), E (Maryland), and F (Nebraska). The PSEP has also recently undergone an assessment by the EPA in an effort to take a critical look at the program and recommended approaches to improve it. To accomplish this, a 14-member committee representing various stakeholders met twice during 2004. A final report on PSEP is to be released by EPA probably in early 2005.

17.15 Reference and Evidentiary Materials

See file folders of evidentiary material, which includes publications, books, journal articles, websites, etc.

17.16 Examples of Research Accomplishments

(A) APPLES
The apple maggot is a key insect pest of apples in eastern and Midwestern North America. Attractive odor-baited pesticide-treated spheres ringing perimeters of commercial orchards offer a viable behavioral-control alternative to pesticide sprays against the apple maggot. A PMAP-funded study entitled "Refinement of Wooden Pesticide-treated Spheres for Apple Maggot Control" encompassed efforts in both research and demonstration extending over a 2-year period. The project aims to develop a superior pesticide-treated sphere that will reduce pesticide sprays by commercial orchards.

(B) STORED GRAIN
Traditional insecticides for controlling stored-grain pests are becoming limited in availability. Consequently, this study entitled "Fate and Efficacy of Spinosad for Insect Management in Farm Stored Grain" evaluated spinosad, a relatively new, low-toxicity, fermentation-derived insecticide on wheat and corn stored on farm sites in Kansas and Indiana.

(C) HONEY BEES
The varroa mite, an obligated ecto-parasite, is one of the most devastating pests of the honey bee. The mite is becoming resistant to many pesticides. Consequently, a PMAP-funded project entitled "Field Test of an Alternative Method for Controlling the Most Serious Honey Bee Pest, the Varroa Mite" sought to determine the optimal conditions for using the 'Mitezapper', a device that uses electrical heat to kill mites. If proven effective, it will provide an effective, non-chemical method for mite control that could be widely adopted by beekeepers.

(D) California

During 2004, the University of California Pesticide Safety Education Program developed two new study guides for commercial applicators and totally revised an existing study guide. In addition, program staff, working with industry-specific expert panels, developed new examination question pools for three commercial categories and the private applicator certification examination. The program embarked on a new type of community-based training program for agricultural producers during 2004. Workshops were held in three locations to train agricultural employers and their employees how to better prevent offsite movement of pesticides and how to avoid water contamination from pesticide runoff. PSEP staff also worked with community groups in two major grape-growing regions of California to train instructors who in turn conducted large hands-on training workshops. Training at these day-long workshops were conducted in English and Spanish. Five workshops dealing with recognizing pesticide illnesses and injuries were conducted during 2004 for health care providers and affiliated personnel. Two of these workshops were conducted in Arizona and were focused toward Native American community health care providers. Staff from the PSEP program served on program planning committees for two major agricultural health and safety conferences, the Western Region Pesticide Conference, and the national C&T workshop. PSEP hosted on of the agricultural health and safety conferences. PSEP staff actively participated in 13 advisory groups and regional and national committees that promoted pesticide safety education and safe handling of pesticides.

(E) Nebraska

The 2004 Pesticide Safety Education Programs (PSEP)in Nebraska was a very successful year. For the three-year cycle of pesticide licensing in our State, 2004 is the second highest year of participation by both private applicators (farmers and ranchers) and by commercial / noncommercial applicators. More than 7,800 private applicators were involved and surveys indicated positive behavior changes as a result of PSEP. Nearly 2,580 categories were initially certified or recertified by our commercial / noncommercial applicators. Surveys of these applicators showed impact and significant positive change. PSEP also reached the non-traditional pesticide applicator audiences such as Master Gardeners, elementary-aged youth, electrical utility personnel, homeowners attending termite workshops, and the general public through our Pesticide Education Resources web site (http://PestEd.unl.edu). PSEP emphasized and introduced new themes this season. For private applicators, an extension entomologist colleague introduced new management options for corn soil insect control. Preliminary research results gleaned from a sprayer particle drop analyzer were presented by another extension specialist colleague to guide farmers in methods and nozzles to minimize spray drift. For the first time ever, an extension circular, the “Weed Management Guide for Nebraska” was provided to each private applicator that participated in the 2004 PSEP. Surveys indicated all of these innovations were warmly received by applicators for their excellent educational value and served as superb topics for continued discussions by Extension Educators at their local PSEP sessions across Nebraska. For all Nebraska applicators, recent changes in Nebraska pesticide regulations were presented as part of PSEP. Because the length of a pesticide license is three years, these new regulations are presented for a three-year period. For private applicators, commercial, and noncommercial applicators, a minimum age requirement of 16 years is now in effect in Nebraska before an individual may hold a pesticide license. Known as the chemical trespass law, pesticides can now only to applied to property only with the permission of the legal owner or tenant. Pesticide security and the requirements to only apply to labeled sites were especially emphasized. The importance and value of personal protective equipment (PPE) for all applicators is routinely highlighted. This audience includes pesticide mixer-loaders. The value of this point is stressed not only for the personal health of the applicator but in the recognition of required actions as outline in pesticide labels. Surveys of private applicators and commercial / noncommercial applicators provide ample evidence of the positive behavioral impact of the Pesticide Safety Education Programs in Nebraska. Through a survey of nearly 1020 private applicators from 91 counties in 2004, PSEP had definite impact. When asked “As a result of this PSEP session, I will....” applicators expressed they would “always” do the following actions. A subsequent followup survey three months later occurred of about 70 randomly selected private applicators that participated in the

2004 program. Their responses are shown in parenthesis at the end of each question. - 80% consider the time of day for glysophate applications for best weed control (55%) - 63% use IPM approaches to manage weeds, insects, and diseases (52%) - 92% wash hands after using / handling pesticides (78%) - 78% use personal protective equipment and clothing to minimize exposure (60%) - 74% consider drift reduction spray nozzles (61%) General written comments were encouraged to be provided by private applicators in this survey. More than 135 comments were received and 78% were positive and supportive of PSEP.

(F) Maryland

The objectives of the Maryland Pesticide Safety Education Program (MD PSEP) are to maximize safety and minimize adverse effects of pesticides on human health, wildlife, or the environment. Target audiences for MD PSEP include (a) private and commercial certified pesticide applicators, (b) non-certified pesticide applicators, (c) workers who may be exposed to pesticide residues on the job, (d) consumers who may occasionally apply pesticides or be exposed to pesticide residues where they live, work, do business, and play, and (e) health care providers who may treat those exposed to pesticides and/or their residues. In FY 2004, MD PSEP provided train-the-trainer sessions for Master Gardeners and for all field faculty who participate in PSEP. Consumers were educated through the Master Gardeners, and the field faculty provided training throughout the year for private and commercial applicators. MD PSEP offered 22 optional initial training sessions and 22 recertification sessions for private applicators. Regional Extension specialists and campus-based faculty offered an additional 4 sessions for recertification of private applicators and 8 major conferences for commercial pesticide applicators in agriculture, turf and ornamentals, lawn and landscape, greenhouse, nursery, public health, structural, industrial weed, aquatic, right-of-way, forest, and demonstration & research categories. In addition, MD Extension faculty and staff gave numerous presentations at recertification meetings sponsored by other organizations and businesses. In many cases, the presentations by the Extension personnel were the reason that theses non-Extension sponsored courses qualified for recertification credit. Registered employees (those working under the supervision of a certified applicator and required by Maryland law to receive training) were trained using the MD PSEP-produced video series, "Using Pesticides Safely." Approximately 70% of businesses throughout Maryland have obtained the set and use the modules to train new employees. Five new publications and 1 PowerPoint presentation were developed, and 3 publications were revised. The Pesticide Education & Assessment Program web site and the internal web site for Extension pesticide safety educators were both redesigned. The Pesticide Education web site received 67,073 successful hits in FY 2004, averaging 5590/month.

Section 18:
Biosecurity and Invasive Species

Relevance

18.1 Scope

(A) Biosecurity

The primary goal of any successful agricultural biosecurity program is to prevent entry of a pathogen or pest into a susceptible population of plants or animals. When preventive measures fail, it is imperative to have early detection, rapid and accurate assessment, and immediate implementation of various interventions that prevent spread, control the infection, and then begin the recovery phase. The current scientific status of diagnostic methods for either plants or animals does not meet these criteria for many pathogens or pests.

Rapid, specific, and low-cost diagnostic methods are still a rarity in agriculture, compared with those available for human health problems. This is due in part to the lack of necessary information about the genomic makeup of the agents to permit use of time- and cost-effective modern techniques such as Rapid or Real Time Polymerase Chain Reaction (RTPCR). In other instances, some of the needed scientific information is available, but the methods have not been fully validated, laboratories lack the resources to purchase the equipment needed to perform these tests, or the funding for initial developmental work has not been available.

Building on existing work in genomics and the commonality of host-pathogen interactions among the phyla of animals, insects, and plants, CSREES will expand research and educational programs – both resident and outreach – to develop the knowledge and expertise required to ensure biosecurity of our agricultural and rural communities and a secure and safe food supply. Many pests or pathogens are potential weapons for use by terrorist groups, and we need to be prepared for emerging threats – either accidental or deliberate. The program will focus on agents that are easily spread, have high infectivity at low infective dose levels, or have high economic consequences. It is important to note that additional focus and funding in this area will also spin off technologies helpful in controlling domestic diseases or pests.

Genomics
Genomics is the study of an organism's entire nucleic acid (genetic) sequence, structure, and function. It is a blueprint for understanding how the organism functions and how it adapts to changes in diverse environments. Genomics – including genome sequencing, functional genomics, and bioinformatics – provides a basis for examining biological phenomena in ways that were previously not possible. The continued development of this technology holds great potential to provide innovative strategies for solving production problems in agriculture while at the same time increasing our ability to defend the nation's food supply from intentional introductions of diseases and pests.

The continued development of genomic research is essential to establish a CSREES foundation for future progress in dealing with these issues and to provide a foundation for the development of new products. Because of the broad implications and importance of this research area, it is vital that the public sector fund and support genomic research to ensure that the results are available in the public domain and are broadly accessible to those interested in improving agricultural production systems. Some genomic research will be of little interest to the private sector but may be critical to certain agricultural and environmental areas. Further, educators and extension specialists need access to this information to enhance educational efforts directed at end users, producers, and consumers.

There is a fundamental need to sequence the genomes of plants, as well as their pathogens and pests. This information is really only valuable if the initial research is followed by what is commonly referred to as functional genomics or proteomics. This latter area of research will provide information about the specific virulence factors of the pathogens, resistance, and susceptibility factors in the host and will enable the development of diagnostic techniques and preventative and control strategies, such as pesticides and biocontrol agents.

There is a significant advantage in considering the mechanisms of pathogenesis and virulence factors in both animal and plant pathogens in collaborative research programs. Similarly, we expect that we will achieve greater progress in understanding host defense systems if we consider plants, animals, and insects in a coordinated manner. In animals, the information on zoonotic diseases such as anthrax, brucellosis, and tuberculosis can make significant contributions to solving both agricultural and public health problems. There are also plant pathogens that represent significant public health issues (see Vidaver and Tolin, in Fleming and Hunt, *Biological Safety Principles and Practices*, ASM Press, pp 27-33, 2000). Thus, this plant protection portfolio also bridges to the animal protection portfolio (Goal 3, Objective 3.2B) also being reviewed.

Detection, Rapid Assessment and Control
Should an organism slip through the prevention system, early detection is an absolutely essential component of a biosecurity system. An example of what can happen when detection is absent is the case of the Chinese soybean aphid. This insect was introduced into North America, became established, and spread throughout the Midwestern soybean production area before it was first detected. Had this insect been intentionally introduced, perhaps carrying a highly virulent viral pathogen, the consequences for American agriculture could have been dire.

Detection must operate on many levels. Intensive production systems, where the farmer or rancher has more direct contact with the production units, require different detection systems than are needed in extensive production systems, where a single individual may work with thousands of production units. Similarly, there are different detection needs for small land area operations vs. large land area operations.

In intensive and small land area operations, the development of technology that the producer can use to assess plant health before the development of symptoms is essential. Equipment currently under development, such as hand-held or easily portable infrared sensing equipment, must be made available. Intensive and small land area operators need to be trained to recognize symptoms once they appear. They need to be informed about procedures to contact the National Plant Diagnostic Network, which is currently in the process of becoming fully functional and operational, to verify their preliminary assessment.

For extensive and large land area operations, the continued application of geo-spatial technology in the form of remote sensing must be a priority. The collaborations that comprise the AG 20/20 program, which currently involves CSREES, NASA, the National Corn Growers Association, the National Cotton Council, the United Soybean Board, and the National Association of Wheat Growers, should be expanded to include more producer groups. Ranchers as well as farmers should be involved. Additional research is needed to define how healthy plants appear in satellite imagery and the different appearances that are induced by challenges from biotic (insects and pathogens) vs. abiotic stress factors (water, nutrients, etc.). APHIS has successfully used the concept of “sentinel plants” to detect early outbreaks of new infestation of citrus canker in Florida. Based on the information gained through genomics research, it may be possible to produce genetically engineered organisms that respond to low doses of plant pathogens and react in ways that can be easily detected before symptom development.

In addition to the need to monitor managed systems, it is also important to determine the health of natural systems as well. Many diseases and pests of crops are also diseases and pests of native flora. A surveillance system that only monitors agricultural areas will be easily breached and is doomed to failure. This fact clearly demonstrates the enormity of the task and the need to engage a broad-based cadre of support.

Once a potential biotic challenge has been detected, rapid and accurate assessment is the next step in agricultural biosecurity. As mentioned previously, a rapid diagnostic network is being developed as part of a separate initiative. The genomics research proposed in this document will provide this network with new ways of assessing pathogens and pests rapidly and accurately. Many of these assessments will be made at the production site using new tools developed as a result of the genomics research. Early detection may enable easy management and control. However, despite early detection, control may still be difficult and could require several years of research to discover best control procedures, e.g., resistant varieties or biological control agents.

Education and Outreach

Detection and assessment systems must be operative at multiple levels to be effective. However, the number of skilled observers and diagnosticians is limited. The regional Rapid Detection and Response Centers for plant diagnostics can assist in this effort as they begin to develop their programs. On-campus and outreach educational programs will be essential to expand the capacity of these few individuals.

The science of genomics and the downstream application of functional genomics are in their infancy. There is a need to train a future generation of scientists who will have the skills and capacity to move the science forward. Programs are needed to encourage colleges and universities to create multi-disciplinary programs with the goal of training such individuals to provide the fundamental knowledge needed to ensure agricultural biosecurity. Educational programs are also needed at colleges and universities to attract and train competent individuals in the skills of detection, epidemiology, and risk assessment.

There is also an urgent need to retrain and retool currently established researchers in genomics technology through training programs such as short courses and sabbaticals. It is critical to ensure that agricultural scientists have access to state-of-the-art equipment and other resources to rapidly translate genomic information into practical applications.

Outreach programs, such as train-the-trainer programs, are needed to provide an adequate number of individuals who can recognize changes from the normal appearance of plants and animals and are in regular contact with production sites. These include farmers and ranchers, state and county extension specialists, master gardeners, crop consultants, pesticide applicators, and others.

In the face of a deliberate attack on the nation’s food production systems, there are not enough people currently involved to meet the challenge of independent on-site verification and make preliminary assessments of purported detection events. A volunteer training program is needed to provide a workforce that can be rapidly mobilized and directed to specific sites to make initial determinations of potential bioterrorist acts. This volunteer force can also be utilized in routine surveillance and monitoring activities so that deliberate acts, as well as naturally occurring events, can be detected as rapidly as possible. The involvement of consumers in the security of the food and fiber production system will enhance their awareness of intentional or unintentional food adulteration and contribute to a safer food supply as well.

The program must be flexible and ensure cooperation between private and public sector personnel. Because of its historic role as the leader in educational programs through the Cooperative Extension System, CSREES will provide leadership to develop the needed educational programs in consultation with sister agencies, especially the Agricultural Research Service, the Animal and Plant Health Inspection Service, and the US Forest Service. Once in place, education and extension efforts must be coordinated with state and local authorities, local educators, and other local service personnel, such as the police, by Land Grant University System personnel.

Expected Outcomes
Successful implementation of this program will lead to the following outcomes:

- Rapid, on-site diagnostic tests to detect new diseases and pests
- Informed communities that assist in surveillance and detection of pests/diseases
- Reduced pesticide chemical use and new biocontrol systems for plant diseases
- Enhanced safety and security of the food supply
- Prevention/control of outbreaks of devastating pests and diseases in plants
- Trace back potential to site(s) of origin of pest/disease

(B) Invasive Species

Invasive species are defined as organisms that are non-native to an ecosystem, and whose introduction causes economic, social, or environmental harm. Nearly every terrestrial, wetland, and aquatic ecosystem in the United States has been invaded by nonindigenous species (Lee and Chapman 2001); economic losses have been estimated at $137 billion per year (Pimentel et al. 2000). Invasive species constitute one of the most serious economic, social, and environmental threats of the 21st century.

The Formosan termite causes an estimated $300 million in property damage annually in New Orleans alone. The Asian longhorned beetle is causing the destruction of valuable city trees and is currently threatening natural forests. Soybean aphid is causing millions of dollars in annual losses to the soybean industry, and the recent introduction of soybean rust threatens countless more.

In addition to their negative impacts on endangered species and biodiversity, invasive plants such as leafy spurge, yellow starthistle, spotted knapweed, purple loosestrife, and saltcedar cause billions of dollars in lost revenue and control costs each year. Terrestrial invasive plants typically crowd out more desirable and nutritious plant species, cause soil erosion, and are toxic to some livestock and wildlife species. They reduce habitat for native and endangered species, degrade riparian areas, create fire hazards, and interfere with recreational activities. Aquatic invasive plants clog lakes and waterways and adversely affect fisheries, public water supplies, irrigation, water treatment systems, recreational activities, and shipping.

Farmers, ranchers, scientists, State officials, private citizens and others have urged the Federal Government to consider invasive species issues a priority and to develop a coordinated national effort to address the problem. In response, President Clinton issued Executive Order 13112 on Invasive Species in February 1999. The Order established the National Invasive Species Council (Council) Co-Chaired by the Secretaries of Agriculture, Commerce, and Interior; and includes the Secretaries of State, Treasury, Defense, Homeland Security, and the Administrator of EPA. The Order directed the Council to form a non-federal Invasive Species Advisory Committee (ISAC) to advise the Council in addressing invasive species issues. The purpose of the Council is as follows: to provide national leadership on invasive species; see that their Federal efforts are coordinated and effective; promote action at local, State, tribal and ecosystem levels; network to document and monitor invasive species; develop a web-based information network; provide guidance on invasive species for Federal agencies to use in implementing the National Environmental Policy Act, and develop a National Invasive Species Management Plan (Plan). The Plan consists of a number of elements including leadership and coordination, prevention, early detection and rapid response, control and management, restoration, international cooperation, research, information management, and education and public awareness.

18.2 Focus on Critical Needs

CSREES has been responsive to critical issues and the needs of the nation, such as in addressing the economic and ecological impacts of invasive species. This has been accomplished through leadership in the implementation of the National Invasive Species Management Plan, through funding from the Section 406 Pest Management Programs and the National Research Initiative, through establishment of the National Plant Diagnostic Laboratory Networks, Hatch funding of Agricultural Experiment Station Projects, participation in the USDA Invasive Species Budget Crosscut process (with other USDA Agencies involved in invasive species - ARS, APHIS, NRCS, ERS) and through the administration of special grants concerning invasive species.

Leadership
A CSREES National Program Leader for Bio-Based Pest Management, serves as Co-Chair of the Control and Management Working Group for the National Invasive Species Council. This working group recently developed draft guidelines for ranking invasive species projects in natural areas. These guidelines will help invasive species managers prioritize invasive species projects, including those for invasive weed species. The guidelines will be available on the "www.invasivespecies.gov" site once they are approved by the National Invasive Species Council. CSREES has established an Invasive Species Working Group within the agency and CSREES is represented on the following committees: the USDA Coordinating Committee on Invasive Species; FICMNEW (Federal Interagency Committee for the Management of Noxious and Exotic Weeds); NASA-USDA Working Group on Invasive Species; ITAP (federal coordinating committee for the Management of Invasive Terrestrial Animals and Pathogens); and the Technical Advisory Group (TAG) for the Biological Control of Weeds. Thus, CSREES has a strong voice in all aspects of invasive species issues at the national level.

CSREES and our LGU partners are supporting and playing a leadership role in early detection and rapid response systems. A CSREES National Program Leader for Horticulture serves as Co-Chair of the Early Detection and Rapid Response Working Group for the National Invasive Species Council. This working group has developed general guidelines for the establishment and evaluation of invasive species early detection and rapid response systems (see following url: www.invasivespecies.gov/council/GuidelineCommunication.doc).

CSREES also has established two national networks of existing diagnostic laboratories to rapidly and accurately detect and report plant and animal pathogens of national interest, and provide timely information and training to state university diagnostic labs. A CSREES National Program Leader for plant pathology has been instrumental in facilitating the development of the national plant diagnostic network. The National Plant Diagnostic Network (NPDN) is led by five regional labs (Cornell, Florida, Michigan State, Kansas State, and California at Davis) and one support lab (Texas Tech). It is anticipated that the role of these NPDN's will broaden in the future to include invasive arthropods, invasive plants, and other organisms.

The NPDN System in collaboration with the Regional IPM Centers has developed what appears to be a successful system for monitoring, early detection, and rapid response for sudden oak death and soybean rust and is currently developing such a system for the pink hibiscus mealybug, facilitated by CSREES and APHIS National Program Leaders, with collaboration among the Regional IPM Centers, the National Plant Diagnostic Networks, Land Grant Universities, and federal and non-federal entities. The establishment and implementation of such early detection and rapid response systems increases the likelihood that new invasions will be addressed successfully while populations are still localized and not too large to be contained or eradicated.

18.3 Identification of Emerging Issues

CSREES engages in continuous feedback with stakeholders and partners to ensure that new emerging issues are being addressed. This is accomplished through feedback from multi-state committees, input from federal and nonfederal partners in the development of RFA's, feedback from professional societies, and a budget crosscutting process that identifies critical issues of shared interest across federal agencies. A number of emerging issues have been identified by our stakeholders and partners. These include the need to develop early detection and rapid response systems for invasive species; the need to develop better models to predict the invasiveness of an organism; the need to develop ecological niche models to better predict the potential geographic and ecological range of current and potential invaders; the need to develop risk analysis methods for determining potential risks from invaders; the need for better collaboration between the Regional IPM Centers and the National Plant Diagnostic Networks (NPDN); and the need for the NPDN's to expand beyond plant pathogens, to also address arthropod, invasive plant, and vertebrate pest species.

18.4 Integration of CSREES Programs

CSREES has made some marked improvements in the integration of Programs. CSREES NPL's and Program Specialists from PAS, NRI, and Competitive Programs are now invited to participate in the NRI RFA planning process, and Integrated Competitive Program Discussions. Similarly, PAS NPL's have invited input from NPL's from NRI and Competitive Programs regarding development of RFA's for the Integrated Research, Education, and Extension Competitive Grants Program: Integrated Pest Management.

18.5 Multidisciplinary Balance/ Interdisciplinary Integration

The biological, ecological, and environmental complexities associated with invasive pest species necessitate that an interdisciplinary approach be used to help solve our pest problems. The Risk Avoidance and Mitigation Program, the Crops at Risk Program, and the IFAFS (Initiative for Future Food and Agricultural Systems) Program are excellent examples where interdisciplinary research has been conducted and management approaches implemented to address pest complexes, often across a number of states, regions and crop commodities.

CSREES has funded a number of large-scale/regional, bio-based pest management projects that address multiple crops and pest complexes. These include projects in the Risk Avoidance and Mitigation Program (RAMP) and IFAFS Program. These multi-state, multi-agency, multi-disciplinary, integrated (involving research, education, and extension) projects are funded at levels that enable the researchers to address very complex pest problems on a grand scale, while still delivering applied pest management information to the growers. CSREES has also participated with other USDA Agencies in the development of joint white papers on research (e.g., Bio-based Pest Management, and Invasive Species; federal partner: ARS), and a budget-crosscut for invasive species (federal partners: APHIS-PPQ, ARS, ERS, NRCS, and USFS), which will emphasize integrated pest management.

Quality

18.6 Significance of Outputs and Findings

(A) USDA *Phytophthora ramorum* Educate to Detect (PRED) Program
Outreach and screening for homeowner plant samples with symptoms of *Phytophthora ramorum*, cause of Sudden Oak Death and other diseases

Issue: in spring 2004, potentially infected ornamental plants were shipped throughout much of the United States The plants came from a few nurseries that inadvertently shipped containerized rhododendron, camellia and other plants that may be infected with *Phytophthora ramorum*, cause of Sudden Oak Death and other diseases. Since *P. ramorum* is a quarantine pathogen, inspections were conducted and infected plants recovered and destroyed at over 160 sites in 21 states. However, many plants were sold prior to inspections, this project aims to reach out to homeowners so they report suspicious plants in their homes landscapes.

Background on Sudden Oak Death: Sudden Oak Death is a forest disease caused by the quarantine plant pathogen *Phytophthora ramorum*. This pathogen has caused widespread dieback of tanoak and several oak species (coast live oak, California black oak, and others) in California's central and northern coastal counties and in Southwest Oregon. It has also been found to infect the leaves and twigs of numerous other plants species. While many of these "foliar hosts", such as camellias and rhododendrons do not die from the disease, they do play a key role in the spread of *P. ramorum*, acting as breeding ground for innoculum, which may then be spread through wind-driven rain, water, plant material, or human activity. For more information see www.suddenoakdeath.org.

Project Objective: Early detection of ornamental plants infected with *Phytophthora ramorum*

Program overview and status:
1. State cooperators and others were briefed on purpose, need and desired outcomes.
2. National training in detection and screening of potentially infected plants was accomplished.
3. States developed programs asking the public to notify Master Gardeners and others if they have symptomatic, potentially infected plants on their property.
4. Master Gardeners or agriculture departments analyzed samples to determine if *P. ramorum* was present.
5. If positive plants are identified quarantine procedures will be implemented by state and federal regulatory officials. (Pending, if needed)

The training program for master gardeners and other ornamental support staff, created by a national panel of experts consisted of web-based materials, fact sheets and a national teleconference which occurred on October 26th, 2004. CSREES worked with State departments of agriculture and the land-grant universities to develop individual, state-specific plans for public education, detection and handling of homeowner landscape plants that might be infected by P. ramorum. State and land-grant university plant disease clinics helped in the effort through the National Plant Diagnostic Network.

Cooperators: USDA-Cooperative State Research, Education and Extension Service (CSREES), USDA-Forest Service and USDA-Animal and Plant Health Inspection Service (APHIS), National Plant Diagnostic Network (NPDN), USDA Regional Integrated Pest Management Centers, Extension Service Master Gardener programs, Pesticide Safety Education Program, state forestry departments, state department of agriculture, state universities and others.

(B) Early Detection and Rapid Response System for Soybean Rust

CSREES in collaboration with the IPM Centers, National Plant Diagnostic Networks, Land Grant Partners, other federal agencies, and others is facilitating the development of an early detection and rapid response system for soybean rust, which was first detected in Louisiana soybeans in 2004, and has since spread to a number of states in the U.S. Two fungal species, *Phakopsora pachyrhizi* and *P. meibomiae*, cause soybean rust. *P. pachyrhizi* infects more than 90 species of legumes. Principal hosts include soybean, wild soybean, the weed kudzu, jicama or yam bean, snap and dry bean, yellow lupine, and cowpea. Kudzu is widespread in the U.S. and likely will serve as a reservoir for the soybean rust pathogen. The broad host range of the fungal pathogen increases the likelihood of widespread economic impact on legumes in the U.S. unless early detection and rapid response measures can be successfully implemented.

(C) Development of an Early Eetection and Rapid Response System for the Pink Hybiscus Mealybug

The successful system for monitoring, early detection, and rapid response developed for sudden oak death and soybean rust is currently being developed to address the pink hibiscus mealybug, facilitated by CSREES and APHIS National Program Leaders, with collaboration among the Regional IPM Centers, the National Plant Diagnostic Networks, Land Grant Universities, and federal and non-federal entities.

The pink hibiscus mealybug (PHM), *Maconellicoccus hirsutus* (Green), is an exotic pest species that invaded California in 1999 and Florida in 2002. Worldwide, PHM has been recorded from over 300 host plant species, including citrus, ornamentals, and vegetables. Despite federal (USDA-APHIS) and state (FDACS-DPI) efforts to regulate and control the spread of PHM to other susceptible states, a nursery in Homestead, FL, accidentally shipped 900,000 hibiscus plants from potentially infested stock to 36 states in the U.S. from January through July 2004. According to USDA-APHIS personnel, 11 of the states that received plant shipments are climatically suitable for establishment of the mealybug. Of these plant shipments, which went to retail outlets in the 36 states, PHM was confirmed from plant material in Kansas, Louisiana, and North Carolina. Given the broad host range of PHM, the climatic suitability for its establishment in 17 southern states, and its potential for persistence in more temperate climatic regions on nursery stock in glasshouses, etc., it has been estimated that this pest species could potentially cause economic losses of $750 million per year in the U.S. alone (APHIS-PPQ 2004). Hence, it is critical that an early detection and rapid response system be developed for this insect pest as well.

Performance

18.7 Reference and Evidentiary Material

See file folders of evidentiary material, which includes publications, books, journal articles, websites, etc.

18.8 Examples of Research Accomplishments

(A) Ecological, Area-Wide Management of Weeds in the Western Region

CSREES is part of the Saltcedar Biological Control Consortium which is a federal, state, and private organizational group working to improve natural and agricultural ecosystems by controlling exotic invading species, including saltcedar (*Tamarix spp.*), yellow star thistle (*Centaurea solstitialis*), and giant reed (*Arundo donax*).

Saltcedar, yellow starthistle, and giant reed are a nuisance in several western states. They out-compete beneficial vegetation and often form dense monotypic (one-of-a-kind) stands. They provide poor habitat for other flora and fauna, are excessive water consumers, increase fire risk, and alter ecosystems that further their growth and development over desirable species.
These weeds threaten the economic viability of agriculture and the sustainability of many natural habitats. This consortium project supports research and demonstration activities to address the following tasks:

- Development of new benefit/risk evaluation methods for biological control agents used to combat invasive plant species in sensitive environments.
- Area-wide and ecosystem level research on the impact of the target weeds, and optimizing the effects that biological and other integrated methods of control have on beneficial flora, fauna, and physical aspects of the environment.
- Area-wide assessments of invasive species impacts, implementation of biological control release and evaluation, natural enemies impact assessment, and evaluation of other weed control methods, as well as revegetation technologies.

This CSREES-funded effort is using a team approach that includes scientists, land managers, economists, and risk assessors from state, federal, and private groups. The consortium provides expertise across disciplines and methodologies from basic research to area-wide implementation and evaluation. The program is using a combination of institutional planning, consortium oversight, and Cooperative Extension System facilitation of project deliverables. Overall, this project will develop control options for invasive plants that will be implemented on government, private, and Native American lands.

The leaf-feeding beetle *Diorhabda elongata* has been introduced and established at a number of saltcedar sites in the West. Adults and larvae of the beetle have caused spectacular levels of defoliation of saltcedar at a number of release sites. Additional biological control agents are being evaluated for potential introduction into the United States against saltcedar.

Biological control is being integrated with other bio-based management approaches in hopes of achieving area-wide management of saltcedar in the future with minimal impacts on wildlife and the environment.

(B) IFAFS Project - Invasive Plant Atlas of New England

The Invasive Plant Atlas of New England is a multi-faceted project designed to provide comprehensive and up-to-date information about invasive plants in New England. The goals of the project are to facilitate education and research leading to a greater understanding of the dynamics of plant invasions, and to support the early detection of new invasions, which will enable rapid management responses.

The project includes a web-accessible atlas with images and descriptive information for the invasive and potentially invasive plants in New England. Collection databases constructed from herbarium specimens and current field records document the dates and locations of invasive plant occurrences, making it possible to generate maps that depict the distribution and spread of invasive plants across New England. The intent is to provide public access to an online interactive resource that can act as an effective tool for students, researchers, land managers, conservationists, scientists, government agencies, the green industry, and the interested public. The project is actively creating a network of trained volunteers who inventory habitats throughout New England for the presence and absence of invasive plant species. The data collected by our professionals and volunteers is used to continually update the collection databases, and plays a central role in our goals of academic research and early detection.

The project is supported by a grant from the USDA. Partners involved in the project include: the Ecology and Evolutionary Biology Department of the University of Connecticut, the University of Connecticut Libraries, the University of Connecticut Center for Geographic Information and Analysis, the Silvio O. Conte Refuge of the U.S. Fish & Wild life Service, and the New England Wildflower Society.

(C) Exotic Pests and Diseases, CA Special Grant

The UC Statewide IPM Program and the UC Center for Invasive Species Research (CISR), through a special grant from the U.S. Department of Agriculture (USDA), CSREES, support projects that address exotic pests and diseases, and invasive species in agricultural, urban, and natural environments. The pests include insects, mites, mollusks, nematodes, bacteria, fungi, viruses and other microorganisms, vertebrates, and weeds. Administered by the UC IPM Program and launched in 2001, this program funds projects designed to develop and promote basic and applied research and extension programs.

The introduction of exotic pests and plant diseases threatens California's agricultural, urban, and natural environments. Agriculture has suffered immensely from such exotics as cottony cushion, black, red, and San Jose scales; mealybugs; whiteflies; and aphids. Threatening the state's urban areas are the Formosan termite, German yellow jacket, and the Africanized honey bee.

The long-term goal of this special grant program is to develop: systematic methodology for dealing with exotic pests in risk assessment; early detection; and rapid development of control or eradication measures leading to improved IPM practices through biological, microbial, genetic, and chemical practices. An important role is to foster cooperation and coordination of research efforts among the UC campuses, USDA, the California Department of Food and Agriculture (CDFA), and the agricultural industry.

Scientific review panels review proposals in these three research areas:

- Agricultural systems
- Urban systems
- Natural systems

For more information on this grant program, see www.ipm.ucdavis.edu/EXOTIC/aboutexotic.html. In the Reference and Evidentiary Material for Section 16 are the 2002, 2003, and 2004 annual reports for this special grant

Section 19: Sustainable Agriculture and Organic Agriculture

Relevance

19.1 Scope

(A) Sustainable Agriculture

This area focuses on production and marketing methods and systems that improve sustainability, i.e. profitability, environmental stewardship, and quality of life for farmers, rural communities, and society. Sustainability in CSREES is addressed primarily through two cross-cutting areas, Sustainable Agriculture Research and Education (SARE) and the Organic Agriculture program. Plant protection issues include improved understanding of ecologically based pest management, reduced reliance on agrichemicals, and the integration of sustainable pest management into broader management systems—including soil, water and nutrient management, livestock management and crop/livestock systems, and also marketing methods that capture consumers' willingness to pay for more sustainable production (e.g. organic and eco-labeling).

Sustainable agriculture is addressed by CSREES most comprehensively through its Sustainable Agriculture Research and Education (SARE) program, and also in an integrated approach through a variety of other funding sources which address aspects of sustainability in varying ways.

SARE offers competitive grants through four regions through Land Grant Host institutions for projects that address production and marketing methods that improve profitability, environmental stewardship and quality of life. For the years 1998 to 2002 the SARE program funded 149 projects with some degree of emphasis on plant protection. The total sum of the investment was $9,139,964, which represents about 12% of the total number of SARE projects and 22% of the funds.

The projects were funded from four different programs, *Research and Education* (54 projects, total funds $7,047,693), *Farmer/Rancher* (60 projects, total funds $253,823), *Graduate Student* (12 projects, total funds $116,913) and *Professional Development* (23 projects, total funds $1,436,639). Research and Education, Farmer/Rancher, and Professional Development grants are offered by all four SARE regions, while the newer Graduate Student awards are offered only by Southern SARE and North Central SARE.

Since "sustainable agriculture" is not a category for coding within CRIS, it is impossible to discretely separate out projects funded by sources other than SARE. A number of projects voluntarily identify their work with the keyword "sustainable agriculture," however, including 38 projects in PA 211, 63 in PA 212, 32 in PA 213, 47 in PA 215, and 60 in PA 216 from 1998-2002 (some of these are the same project recurring in several PAs). Many of the projects so identified are similar to SARE-funded projects in their emphasis on ecologically-based methods and a systems approach. Others are more traditional but indicate a clear interest in linking the research and education to the future viability of agriculture. The most common source of funding for these projects is Hatch, followed by Special Grants and Other, with a few funded by NRI and SBIR. Interviews with NPLs in 2004 by the CSREES internal sustainability working group indicated that many NPLs believe that their programs address sustainability more broadly that this voluntary keywording would suggest.

(B) Organic Agriculture

Organic agriculture became one of the fastest growing segments of U.S. agriculture during the 1990s. According to USDA statistics, organic acreage in the United States has doubled, and consumption of organically produced products has increased 20 percent per year for the past decade. Today, 80 percent of organic products purchased on the market are fresh fruits and vegetables. The potential consumer demand for other organic products, like meat and processed foods, is wide open. Organic agriculture's importance was further solidified when the USDA implemented the first nationwide organic standards--the National Organic Standards--in 2002. Organic agriculture research and extension is addressed by CSREES most comprehensively through its organic agriculture program. CSREES addresses organic agriculture through formula funds and competitive funding, such as the Integrated Organic Program, which includes both the Integrated Research, Education, and Extension Program--Organic Transitions Program and the Organic Agriculture Research and Extension Initiative.

19.2 Identification of Emerging Issues

The SARE programs are administered regionally by Land-Grant University Host Institutions (University of Vermont, University of Georgia, University of Nebraska and Utah State University) and steered by regional Administrative Councils that include various stakeholders (farmers and ranchers, agribusiness, non-profit organizations, government and university representatives) who set program priorities and oversee the selection of projects for funding. Projects are encouraged to show farmer and rancher involvement in problem selection and project implementation, which further ensures that stakeholder priorities will be met. Furthermore, small grants are offered to individual producers and small groups of producers to conduct their own on-farm research and share the results with other farmers and scientists, and the review of these proposals keeps the SARE regions in close contact with farmers' ideas and priorities. Administrative Councils are charged annually with setting research and education priorities important to the region for funding. Technical Review Panels convened by the Host Institutions under the auspices of the Administrative Councils ensure the technical merit of projects selected for funding.

Areas of work addressed in SARE projects funded from 1998-2002 driven by local interests include: Allelopathy, biological control, biorational pesticides, botanical pesticides, chemical control, competition, compost extracts, cultural control, disease vectors, economic threshold, eradication, flame, field monitoring, genetic resistance, IPM, killed mulches, living mulches, mating disruption, mechanical control, physical control, plastic mulching, precision cultivation, precision herbicide use, prevention, row covers, sanitation, soil solarization, smother crops, traps, trap crops, vegetative mulching, weather monitoring, and weed ecology.

Organic agriculture works closely with the SARE program for identification of emerging issues emerging at the regions. CSREES consults with members of the National Organics Standards Board and with others in the organic industry on ways of RFA improvement and emerging needs and issue.

19.3 Multidisciplinary Balance/ Interdisciplinary Integration

Sustainable agriculture requires, by definition, integration of multiple disciplines and perspectives to achieve the multiple goals of profitability, stewardship and quality of life. This integration is reflected in the projects funded by SARE, and by many of the projects funded in-part by other CSREES funding lines such as IPM, CAR, RAMP, Organic Transitions, SBIR and higher education. SARE regionally has also cooperatively funded interdisciplinary priority research and education projects nation-wide with shared funding from EPA and The National Agroforestry Center.

All but a few of the SARE Professional Development projects (key educator training) that addressed pest management did so as a component of a broader education and training program. Many of the Research and Education projects also dealt with pest management as a component of a larger research effort. Farmer/rancher and graduate student projects, being smaller, are more likely to be more narrowly focused. Thus most SARE projects use multiple strategies to address pest management in a systems approach, often involving nutrient management and other aspects of farm management, and, somewhat less often, crop/livestock integration, and consideration of both production and marketing.

Interdisciplinary integration is apparently in many of the Hatch and Special Grants keyworded "sustainable agriculture," although some are more specific to one or two disciplines.

In organic agriculture during 2004, CSREES consulted with members of the National Organics Standards Board and with others in the organic industry on ways to improve the 2005 RFA and the program in general. Based on recommendations from NAREEAB, CSREES has provided a web site url on the RFA that leads to a document detailing research and extension needs for organic animal production.

Quality

19.4 Significance of Findings and Outputs

CSREES-SARE funded projects focusing on sustainable agriculture and organic agriculture have resulted in numerous high-impact publications. Many SARE sponsored publications are published and made available at no cost to the public through the Sustainable Ag Network (SAN) and the SARE website at sare.org. SARE has also supported graduate student training in sustainable agriculture and organic agriculture in two regions. See evidentiary file of graduate student awards.

Interest in organic agriculture has grown dramatically over the last decade in US agriculture. CSREES responds to inquiries and issues related to organic agriculture and have recently hired in 2005 an individual to serve on a 12-month Interagency Personnel Agreement for leadership in organic agriculture.

19.5 Stakeholder Assessment

SARE and organic agriculture actively seeks stakeholder input with regard to portfolio composition, program direction, and research and education priorities. Examples of activities soliciting stakeholder input are as follows:

(A) Stakeholders are involved in every aspect of SARE, IPM, and NPDN Center management, planning and program delivery. SARE seeks active farmer and rancher input on Administrative Councils and Technical Review Committees. Often a farmer or rancher chairs the Administrative Councils. SARE and the IPM Centers work to connect a diverse array of people who have an interest in pest management policy, sustainability, and implementation throughout the region. These include pest management users (farmers, nurserymen, park and turf managers, building superintendents, pest control operators, homeowners, gardeners, organic growers, and others), consumer and environmental groups, governmental regulatory agencies, researchers, and educators. SARE and IPM Centers network these groups both through its internal organization (Advisory Committee, Stakeholder groups, State Project Leaders) and through development of electronic communications structures such as email lists, online bulletin boards, and web pages.

(B) *Plants and Pest Biology stakeholder workshop,* Crystal City, VA, November 14, 2002 Provided a forum for stakeholders to review and contribute feedback on the agency's research priority issue areas that CSREES is considering multi year funding. The issue areas are: (1) Agricultural and Environmental

Quality, (2) Agricultural Security, (3) Genomics and Food and Fiber Production, (4) Obesity, Human Nutrition and Food Security, (5) Food Safety, and (6) Rural and Community Development. Feedback from this workshop helped to focus CSREES portfolios including the Plant Protection portfolio.

(C) National Organic Standards Board interactions

19.6 Alignment of Portfolio with Current Science

Peer review of submitted proposals, Host Institution review, and NPL expertise assure that funded SARE and organic projects are aligned with the current state of science-based knowledge.

19.7 Methodology and Use of Funded Projects

This portfolio leads to solutions to National plant protection problems, improved economic performance for producers and long-term protection of the nation's food and plant Biosecurity while helping ensure long-term economic viability, increased environmental stewardship, and adoption of appropriate social responsibilities by farmers and ranchers.

Performance

19.8 Portfolio Productivity

(A) USDA Awards $4.5 Million In Grants for Organic Agriculture Projects
The USDA awarded $4,614,980 in grants for 11 projects in six states that will strengthen the Integrated Organic Program (IOP). These awards provide information to assist farmers and ranchers increase the production of high quality products while decreasing costs. The IOP supports research, Extension and higher education programs to help organic farmers incorporate new technologies into their operations and to develop innovative marketing strategies. USDA's Cooperative State Research, Education, and Extension Service (CSREES) manages the IOP in collaboration with partners at universities, non-profit organizations and the organic industry through its many state partners.

The 2004 grants were awarded to the following:

ARKANSAS: University of Arkansas, $305,015, for slow-growing broilers in organic production: an alternative to supplemental methionine and a marketing opportunity.

CALIFORNIA: University of California, Santa Cruz, $571,902, for improving fertility and pest management strategies for organic crop production and strengthening researcher/grower network. To University of California, Davis, $297,814, for nutrient dynamics, soil biota, and functional biodiversity at an organic farm. To University of California, Davis, $186,624, for the activity and suppression of soil-borne pathogens and pests in organic vs. conventional plots with conservation vs. conventional tillage.

MASSACHUSETTS: Tufts University, $197,768, for strengthening the scientific foundation of organic standards on animal health and welfare.

MINNESOTA: University of Minnesota, $463,645, for soybean aphid suppression using a fall-seeded rye cover crop.

NEW YORK: Cornell University, $518,306, for the transitioning dairy: identifying and addressing challenges and opportunities in milk quality and safety. Cornell University, $894,450, for the organic seed partnership. Cornell University $575,028, for building on the best: a research and education partnership for increased competitiveness of organic grain and vegetable farms.

VERMONT: University of Vermont, $301,161, for profitability and transitional analysis of northeast organic dairy farms.

WASHINGTON: USDA's Agricultural Research Service Tree Fruit Laboratory in Wenatchee, $303,267, for use of resident biological resources for the management of replant disease in organic tree fruit production systems.

(B) Organic Agriculture

In 2004, eleven proposals were funded with $4,614,837 in available monies. There was an unusually short application period for applicants: 8 weeks. Communication efforts involving stakeholder groups, most notably the Organic Farming Research Foundation, resulted in 111 applications for funding (requesting $51,879,946) received by the deadline, with 104 (requesting $47,614,033) considered eligible for funding. This was an increase of 75 proposals compared to fiscal year 2003 before the Integrated Organic Program was created. Of those applications considered eligible for funding, 86 (83%, requesting just over $42 million) were deemed by the peer review panel to merit funding. Program priority breakouts of funded projects (Table 19.1) are shown where the most submitted proposals were in crops and which category received the most awards. Table 19.2 shows that most requests were in agronomy and horticulture and where award success rate ran from 6-10%. Table 19.3 illustrates the distribution of the awards by region where the majority were awarded to the Western and Northeastern regions.

Table 19.1
Analysis of Fiscal Year (FY) 2004 Funding Recommendations

Program Priority	Amount Requested	Amount Awarded	# Funded/ # Submitted	Success Rate
Crops	$37,488,560	$3,292,730	7/73	10%
Animals	$5,540,804	$823,321	2/12	17%
Economics	$5,470,817	$301,018	1/14/	7%
Organic Standards	$947,769	$197,768	1/3	33%
Other	$2,458,996	$0	0/2	0%
TOTAL	$51,906,946**	$4,614,837	11/104*	11%

Table 19.2
FY 2004 Funding Recommendations by Discipline

Discipline	Amount Requested	Amount Awarded	# Funded/ # Submitted	Success Rate
Agronomy	$26,555,336	$2,417,561	5/49	10%
Horticulture	$14,568,145	$875,169	2/33	6%
Other	$10,783,465	$1,322,107	4/22	18%
TOTAL	$51,906,946**	$4,614,837	11/104*	11%

Table 19.3
FY 2004 Funding Recommendations by Region

Region	Amount Requested	Amount Awarded	# Funded/ # Submitted	Success Rate
North Central	$15,548, 862	$463,645	1/33	3%
Northeastern	$11,796,543	$2,486,570	5/27	18%
Southern	$8,731,772	$305,015	1/20	4%
Western	$15,829,769	$1,359,607	4/24	16%
TOTALS	$51,906,946**	$4,614,837	11/104*	11%

The states from which successful applications were submitted are: Arkansas (1), California (3), Massachusetts (1), Minnesota (1), New York (3), Vermont (1) and Washington (1). *111 applications were received but 7 were deemed ineligible so 104 applications were actually reviewed for funding by a peer review panel. **The total amount requested ($51,906.946) reflects 111 applications submitted for funding consideration. 7 were deemed ineligible. The 104 eligible applications accepted for funding consideration requested $47,614,033.

19.9 Reference and Evidentiary Material

See file folders of evidentiary material, which includes publications, books, journal articles, websites, etc.

19.10 Examples of Research Accomplishments

SARE places strong emphasis on communicating the results of its research in practical publications for farmers and educators, through its national outreach and communications arm, the Sustainable Agriculture Network. SAN published a 20-page bulletin “A Whole Farm Approach to Managing Pests,” for educators and farmers, and has distributed more than 40,000 copies in two print editions and about 500 per month more in electronic form (see www.sare.org/publications/farmpest.htm). Other SAN publications address pest management as a component of related topics, such as the bulletins “Diversifying Cropping Systems,” “Transitioning to Organic Production” (17,000 distributed in print and 900 per month electronic) and handbooks such as “Managing Cover Crops Profitably” and “Building Soils for Better Crops.” A SAN handbook on ecological pest management of insects is under development, which may lead to a series of handbooks on ecological pest management. A review of SARE projects that address weed management – a top priority of producers – is underway, and is expected to lead to one or more educational resources.

(A) Examples of SARE Research and Education Projects

The primary purpose of **SARE’s Research and Education** grants is to advance knowledge and adoption of production and marketing methods that improve profitability, environmental stewardship, and quality of life. In the area of plant protection, top priorities include reducing reliance on agrichemicals, improving understanding of ecologically based production methods, and developing marketing methods that reward producers for their stewardship. Projects are generally carried out by teams of producers, researchers, and educators from universities and/or non-profit organizations, and generally take a systems approach to production and marketing systems, including but not limited to pest management.

(1) Reduced Reliance on Pesticides in Muskmelon
Muskmelon, a key high-value crop in the North Central region, relies heavily on costly synthetic pesticides and fertilizers. A SARE-funded scientist at Iowa State University investigated innovative tactics to reduce or replace them using field trials studying 1) mass trapping augmented by trap crops, 2) row covers, 3) neem and kaolin clay to deter bacterial wilt transmission and 4) feeding injury by cucumber beetles. Another field experiment evaluated control of anthracnose, gummy stem blight, and Alternaria leaf blight by *Bacillus subtilis*, potassium bicarbonate, and the Melcast disease-warning system, which allows growers to time fungicide sprays efficiently. Finally, the ISU team assessed the suitability of a hairy vetch-winter rye mulch to replace synthetic herbicides and fertilizers to manage weeds and N fertility. Growers learned about the most promising control methods – such as fabric row covers, which decreased the incidence of bacterial wilt, indicating that they protected the plants from cucumber beetles; and the Melcast disease-warning system, which saved four to eight sprays without an increase in foliar damage or a decrease in yield – through on-farm trials, field days, a website, newsletter articles, press releases, and an Extension bulletin.

(2) Managing Habitat for Beneficial Insects in Pear Orchards
To help tree fruit growers who are seeking alternatives to broad-spectrum pesticides, SARE-funded researchers in Washington tested managing orchard habitats to control insect pests. Specifically, the project tested mowing frequency in pear orchards. Researcher Dave Horton ran trials at three orchards and varied mowing frequency (weekly, monthly and just once a season) to change the ground cover composition. He found that mowing once a month rather than the more typical two or three times a month creates alluring habitats that attract beneficial insects, setting them up to control pest populations. The natural enemies moved into the ground cover in greater numbers, likely attracted to the pollen and nectar newly available from flowering plants as well as more abundant prey, such as aphids and thrips. Horton found more lacewing larvae, spiders, ladybug beetles, damsel bugs, parasitoids and minute pirate bugs. Questions remain whether the predators migrate from the ground cover into the pear trees to attack orchard pests, although evidence supports that some predators, especially spiders, appeared in higher numbers in pear trees in the less frequently mowed plots, good news for pear growers. (SARE Research and Education grant SW99-011)

(B) <u>Examples of SARE Professional Development Projects</u>

SARE's Professional Development Program, funded via Smith-Lever 3(d), offers competitive grants, state grants, and regional coordination for educational opportunities for Extension educators and other agricultural professionals such as field personnel of USDA's Natural Resources Conservation Service. Projects are encouraged to take a systems approach and to involve farmers and educators in their design and implementation. Priorities are to extend the findings of SARE's Research and Education grants and to meet the expressed needs of Extension educators and other agricultural professionals, which are assessed through SARE's state coordinators in developing their plans of work and through regional surveys of Educators in the North Central and Western regions.

(1) Hawaii and Pacific Islands Pest Management Education
To spread the word about pest control methods suitable for fragile tropical island ecosystems, a SARE professional development grant recipient in Hawaii set up an extensive program that included a two-day training program in Hawaii, extension materials and demonstration sites. Some of the topics covered included "living" mulches, sustainable plant disease and nematode control, and organic pest management strategies. Organizers set up video teleconferencing to broadcast segments from the training module to colleagues throughout the American Pacific. Extension agents, NRCS staff, and agricultural professionals teamed together to install 10 demonstration sites that tested sustainable pest techniques. Subsequent field days hosted by the participating ag professionals showcased the pest control methods.

(2) Florida Pest Management Education
Using a SARE professional development grant, educators at the University of Florida delivered practical training in biological control and IPM as preferred pest management strategies to ag educators. The program – conducted statewide via satellite teleconferencing – improved knowledge in biological control techniques and IPM protocols for conventional and organic growers, Master Gardeners and other pest consultants. Sixty participants attended the in-service training at six teleconferencing sites around the state. Twelve videotape copies of the in-service presentations were distributed after the training for use in individual or group extension in-service education.
The program developed educational materials for training extension professionals and producers on the biology and appropriate use of natural enemies and antagonists, and it furnished demonstration projects in the proper use of biological control agents.

(3) Multistate Organic Ag Training in Northeast
A team from eight states planned a SARE-funded professional development conference, "Working with Organic Farmers: Enhancing Agency Involvement," held in September 2002. The conference featured 40 presentations, including 15 by experienced, successful organic farmers,

on a broad range of production issues. The conference brought 159 participants from across the Northeast. The conference went beyond the basics by providing detailed, relatively advanced information about organic agriculture, and to allow sufficient time for participants to process the information through interaction. Some of the content included:

- Soil Health and Organic Soil Fertility
- Planting Systems and Weed Management in Organic Strawberries
- Insect Management: Managing Beneficial Habitats, Using Organic Insecticides
- Weed Management on Organic Vegetable Farms

(C) Examples of SARE Producer Projects

SARE offers grants directly to producers to conduct their own on-farm research and share the results with researchers, educators, and other producers. These grants engage producers by meeting their immediate needs, tapping their creativity, and providing practical examples to others. They also keep SARE leaders in touch with producers' concerns and ideas.

(1) Organic Vegetables as a Replacement for Tobacco

A SARE-funded producer grant recipient in North Carolina tested growing organic, "identity-preserved" vegetables as a profitable alternative to burley tobacco. Charles Church used biologically based integrated pest management to raise organic broccoli under an "Appalachian grown" label, relying on use of timed sprays of *Bacillus thuringiensis*, planting border areas with plants that provide a habitat for beneficial insects, monitoring pest and natural enemy populations and releasing natural enemies. With several years' work, Church and other developed a market their certified organic product.

(2) Reducing Insects, Disease, Weeds and Deer in Apples

To test a low-chemical apple production system while maintaining a high-quality fruit, a SARE-funded producer grant recipient in Michigan adopted several pest control methods: 1) trapping apple maggot flies by using sticky red spheres combined with volatile apple esters in place of insecticide cover sprays; 2) controlling apple codling moths with a rotation of organophosphate insecticide spray and pheromone disruption through degree day calculation; 3) using a disease resistant cultivar to control apple scab; 4) applying fungicide sprays only after a tree developed an infection; managing fireblight with antibiotic cover sprays and inoculum removal during the orchard's dormancy and copper-based spray applied at the silver tip stage; 5) controlling weeds with herbicides and a mechanical tiller; and 6) installing nine-strand, high-tensile steel wire high-voltage fences to deter deer grazing. The many measures proved effective, especially in managing apple maggot fly and apple scab. Moreover, weed control was excellent. Finally, deer fencing provided exceptional control, even during the high pressure season of late winter and early spring.

(3) Reducing Weeds with Cover Crops

A SARE producer grant recipient in Ohio who raises corn and soybeans experimented with planting a cereal rye cover crop to manage weeds like wild onion and garlic grasses. He broadcasted seed at different rates on experimental plots, leaving one as a control. Onion grass species were already established in the corn stubble. In the spring, the producer bush-hogged the rye at the flowering stage and left it to mulch for 30 days, at which time he no-tilled soybeans into the field. Comparing his plots, he found that most of his fields planted with rye decreased wild onion populations, while up to nine wild onion plants grew per square yard in the control plot.

(D) Examples of SARE Graduate Student Projects

The structure of SARE allows its regions innovate in program development and delivery. In addition to the core R&E, PDP, and Producer grants that all four regions share, three regions have developed small grant programs for on-farm research led by agricultural professionals, modeled after SARE's producer grant program. Southern SARE is collaborating with the Southern Regional Rural Development Center in offering community innovation grants. Southern

SARE and North Central SARE offer grants to graduate students to support the costs of their thesis and dissertation projects, and to encourage the next generation of sustainable agriculture researchers and educators.

(1) Tackling Tomato Diseases
A team of graduate students and researchers in Tennessee tested a variety of pre-plant treatments to combat blight in plasticulture tomato production. The group tested compost-based treatments, which they found effective at both increasing yields and decreasing the incidence of Southern Blight. Biofumigation treatments also favorably influenced crop production although they were not as effective as synthetic fumigants. Low-dose chemical fumigation, when combined with organic amendments, proved to be a feasible alternative to full dose fumigation. Finally, the team tried solarization treatments during the spring and found that they did not significantly suppress soilborne diseases.

(2) Understanding Plant Responses to Attack
Plants play an active role in the interactions taking place in their ecosystem, including chemical defense mechanisms – such as volatile substances – triggered by herbivore and/or pathogen attack. A graduate student worked with other researchers at the University of Florida to study those chemical defenses, which can directly modify the development and survival of the attacking organism. The team investigated the production of volatile compounds by plants under pathogen attack and evaluated the effect on the pathogen or herbivore. They found that uninfected, undamaged control plants released small amounts of volatiles compared to those released by white mold-infected or peanut plants damaged by beet armyworms. Data confirm that peanut plants release chemical signals in response to infection by the white mold fungus. “We present conclusive evidence that the volatile profile emitted by these plants differs qualitatively and quantitatively from those from healthy plants and from those emitted in response to BAW damage,” they stated. “The significant quantitative difference in the volatile profile of peanut plants attacked by either the fungus or the insect, added to the fact that emission of compounds was not suppressed when both organisms were simultaneously attacking the plant, provides a clear indication that the activation and regulation of plant biosynthetic pathways is dependant upon the type of threat perceived by the plant.”

Section 20:
IPM and NPDN Centers

Relevance

20.1 Scope

In the year 2000, the USDA announced the creation of Regional Integrated Pest Management Centers (RIPMCs), to help focus research and extension efforts on developing and delivering alternative and safer pest management strategies to farmers and ranchers. It was envisioned that these centers would help strengthen the connection between production agriculture, research, and extension programs, and agricultural stakeholders throughout the United States and would play a key role in USDA's efforts to work with Environmental Protection Agency (EPA) on the continued implementation of the Food Quality Protection Act (FQPA). The centers bring together university research and extension specialists in each region of the country. Four regional Centers were created to work in cooperative partnerships that involve colleges, universities, and crop production experts from states within each region. The centers focus their efforts on pest management issues that are common to agricultural production within a region and across state boundaries. A key objective of the centers is the formation of a responsive pest management network that is able to inform public and private sectors about emerging issues and to identify farmer needs and priorities. The Pest Management Centers currently work with USDA and a large number of cooperating institutions. While Centers are regionally based, inter-regional collaboration that crosses parochial boundaries is an important component of the program's success. RIPMCs provide the USDA with the capability to:

- Increase the effectiveness of public investments by enhancing the coordination of research and outreach efforts,
- Bolster interdisciplinary and multi-organizational IPM research and outreach efforts,
- Provide timely and high-quality information on IPM practices and use patterns to government agencies and agricultural stakeholders,
- Organize responses to emerging regional and national issues, and
- Foster a high level of stakeholder involvement and support for public research and outreach IPM programs.

In the North Central Region, Michigan State University and the University of Illinois leads a multi-state coalition. Similar coalitions are established in other areas. Pennsylvania State University and Cornell University are the lead institutions in the Northeast. In the South and West, North Carolina State University and the University of California at Davis are the lead institutions.

The IPM Center's most basic function is to develop and maintain a pest management information network that will contribute to environmentally and economically sound pest management decisions. The network serves two major purposes: to facilitate communication among key groups of people, and to provide these groups with broad access to pest management information. A key objective of the centers is the formation of a responsive pest management network that is able to inform public and private sectors about emerging issues and to identify farmer needs and priorities. The RIPMCs work in conjunction with USDA and cooperating institutions, extending their research, education and extension networks and services to 50 States and 5 Territories and ultimately to the end-user, through the Land-Grant University System.

The National Plant Diagnostic Network (NPDN) Centers were established by the Secretary of Agriculture through a cooperative effort of the CSREES and the Animal and Plant Health

Inspection Service (APHIS). The purpose of these networks is to link plant and animal disease diagnostic facilities across the country. The NPDN provides support and extends the effectiveness of the Land Grant University plant disease and pest diagnostic facilities from across the United States.

The mission of the NPDN is to enhance national agricultural security by quickly detecting introduced pests and pathogens. This is achieved by creating a functional nationwide network of public agricultural institutions with a cohesive, distributed system to quickly detect deliberately introduced, high consequence, biological pests and pathogens into our agricultural and natural ecosystems by providing means for quick identifications and establishing protocols for immediate reporting to appropriate responders and decision makers. The network will allow Land Grant University diagnosticians and faculty, APHIS personnel, State Regulatory personnel, and first detectors to efficiently communicate information, images, and methods of detection throughout the system in a timely manner. Lead universities were selected and designated as Regional Centers to represent 5 regions across the country. Regional Centers are located at Cornell University (Northeast region), Michigan State University (North Central region), Kansas State University (Great Plains region), University of Florida at Gainesville (Southern region), and University of California at Davis (Western region). The National Agricultural Pest Information System (NAPIS) located at Purdue University was designated as the central repository for archiving select data collected from the regions. The establishment of the network will provide the means necessary for ensuring all participating Land Grant University diagnostic facilities are alerted of possible outbreaks and/or introductions and are technologically equipped to rapidly detect and identify pests and pathogens.

20.2 Focus on Critical Needs

The Public Health Security and Bioterrorism Preparedness and Response Act instructs APHIS to maintain a list of “select agents” that are of critical national interest. These are agents that have not yet become firmly established in the United States and represent significant consequences if endemic. The NPDN is focused on these select agents identified by APHIS and selected other high consequence pathogens. Below are a few examples of select agents:

Soybean Rust: Potential Economic Loss **-** Total losses to consumers and other sectors of the US economy are forecast to exceed $7.2 billion/year, even with a conservative estimate of potential damage, should the disease become established (Kuchler et al., 1984). This disease has been found in Louisiana, Mississippi, Florida, Georgia, Alabama, Arkansas, Missouri, South Carolina, and Tennessee.

Citrus Greening: Potential for Economic Loss **-** In southwestern Saudi Arabia, practically all mandarin and sweet orange trees were destroyed by the disease, but the more tolerant Mexican lime (Citrus aurantifolia) trees managed to survive despite heavy infestation with Diaphorina citri. In India, the disease is widespread (Bové and Garnier, 1984).

Philippine Downy Mildew: Potential for Economic Loss **-** The disease is a major problem in the Philippines where losses in maize were estimated at 8% nationally in 1974-75 (Exconde, 1976). One yield loss study showed losses of 100% (Exconde and Raymundo, 1974). The disease is generally less severe in India, but losses of up to 60% have been reported (Bonde, 1982; Payak, 1975).

Plum Pox: Potential Economic Loss - Virus infection can lead to considerable yield losses (on stone fruit), reaching 83-100% in highly susceptible varieties (Kegler and Hartmann, 1998; Nemchinov et al. 1998a; Waterworth and Hadidi, 1998).

Striped Mildew – Potato Wart: Potential Economic Loss - Wart disease of potato is so important that quarantine and domestic legislation has been in force globally for more than 65 years to prevent its spread and dissemination. In the 1950s and 1960s numerous EPPO publications were devoted to the disease. Once the pathogen has been introduced to a field of potato cultivation the whole crop may be devastated and unmarketable. Moreover, introduction into the soil not only renders the crop unusable but the soil itself cannot be used for further crop production due to the longevity of the fungus.

The RIPMCs, while mindful of the aforementioned threats, are more keenly focused on threats that are emerging or have already become established in the United States. The foci of their efforts are regionally identified by a wide cross section of stakeholders.

20.3 Identification of Emerging Issues

The RIPMC program identifies emerging issues through their system of stakeholder advisory committees. The NPDN identifies emerging issues through a close working relationship with APHIS and steering committee representation by certified crop advisors, national plant board members, and seed trade association officials. The two programs have mutual steering committee members and CSREES leadership crossover.

20.4 Integration of CSREES Programs

The RIPMC efforts are integrated with other agency activity in the following manner:

- CSREES and the RIPMCs work closely with the EPA office of pesticide programs (OPP) to identify emerging needs of pesticide use and usage information. A member of the EPA-OPP staff was assigned to a temporary duty assignment in 2003 and remains a key advisor to the RIPMC program.
- CSREES and the RIPMCs cooperate with the USDA Office of Pest Management Policy (OPMP) by providing data to promote informed pesticide regulatory decision making and sharing stakeholder feedback on priorities.

NPDN efforts are integrated with other USDA agency activity in the following manner:

- CSREES works closely with APHIS/PPQ in the development of a system of expert and triage laboratories for the ten APHIS/PPQ program plant diseases. Not only does this decrease the overall time of a first diagnosis and speed regulatory response, it provides an increased and geographically distributed set of diagnostic capabilities that dramatically increases surge capacity in the event of an agroterrorist incident.
- The network is currently being utilized by APHIS/PPQ manage the Phytophthora Ramorum (Sudden Oak Death) outbreak.
- NPDN is currently running several multi-state plant disease outbreak simulations in cooperation with APHIS/PPQ, state governments, the grower community.
- The network is currently working with the USDA Forest Service to educate potential first detectors of sudden oak death disease.
- NPDN provides equipment funding, training, and educational resources to all land grant university diagnostic laboratories in an effort to raise diagnostic capabilities nationwide.

20.5 Multidisciplinary Balance/ Interdisciplinary Integration

These 2 sets of Centers provide a complementary continuum of support from the pest surveillance, detection, diagnostics, reporting, to grower education and integrated pest management. All plant protection disciplines are represented by the activities of both the IPM and NPDN Centers since surveillance, detection and management must be for insects, mites, nematodes, plant diseases, weeds and mollusks.

Quality

20.6 Significance of Outputs and Findings

USDA Integrated Pest Management Centers have been instrumental in developing Crop Profiles and Pest Management Strategic plans which are used by EPA, USDA and other governmental and non-governmental groups and organizations to assess needs and determine gaps in pest management tools and practices available to farmers and ranchers, nation-wide. These documents are used to prioritize research needs and justify development and use of new strategies for pest management. The Plant Diagnostic Network has developed rapid response procedures to interdict introduction and spread of new potentially damaging plant pests and diseases, utilizing a coordinated, responsive network of experts.

20.7 Stakeholder Assessment

Stakeholders are involved in every aspect of IPM and NPDN Center management, planning and program delivery. The IPM Centers work to connect a diverse array of people who have an interest in pest management policy and implementation throughout the region. These include pest management users (farmers, nurserymen, park and turf managers, building superintendents, pest control operators, homeowners, gardeners, and others), consumer and environmental groups, governmental regulatory agencies, researchers, and educators. IPM Centers network these groups both through its internal organization (Advisory Committee, Stakeholder groups, State Project Leaders) and through development of electronic communications structures such as email lists, online bulletin boards, and web pages.

20.8 Alignment of Portfolio with Current Issues

Under the sponsorship of Senator Patrick Leahy of Vermont, the US General Accounting Office (GAO) conducted an audit of the USDA IPM program during 2000-2001. The purpose of the audit was to determine if USDA had met the goals of the 1994 IPM Initiative. The overall goal of the initiative was to foster adoption of IPM practices on 75% of US planted cropland by the year 2000. An anticipated outcome of reaching the adoption goal was a reduction in pesticide use.

From 1994 through 2000, IPM adoption on US cropland increased from some 40% to around 71%, according to a farmer survey designed and administered by USDA, nearly reaching the stated goal. However, total pesticide use, measured as pounds active ingredient, increased approximately 4%. Therefore, GAO concluded that even though the adoption goal was nearly reached, the desired outcome was not obtained because pesticide use did not decrease. During interviews with GAO, USDA and others explained that the use of pesticides listed as most risky by EPA had been reduced by 14% during the same timeframe, and thus pounds of pesticide use may not be the most appropriate measure of success of IPM programs in reducing pesticide risks. Nevertheless, GAO concluded:

“The IPM initiative is missing several management elements identified in the Government Performance and Results Act that are essential for successful implementation of any federal effort. Specifically, no one is effectively in charge of federal IPM efforts; coordination of IPM efforts is lacking among federal agencies and with the private sector; the intended results of these efforts have not been clearly articulated or prioritized; and the methods for measuring IPM’s environmental and economic results have not been developed. Until these shortcomings are effectively addressed, the full range of potential benefits that IPM can yield for producers, the public, and the environment is unlikely to be realized.”

The report went on to recommend that the Secretary of Agriculture:

- Establish effective department-wide leadership, coordination, and management for federally funded IPM efforts;

- Clearly articulate and prioritize the results the department wants to achieve from its IPM efforts, focus IPM efforts and resources on those results, and set measurable goals for achieving those results;
- Develop a method of measuring the progress of federally funded IPM activities toward the stated goals of the IPM initiative; and
- If the Secretary of Agriculture determines that reducing the risks of pesticides to human health and the environment is an intended result of the IPM initiative, we also recommend that the Secretary collaborate with EPA to focus IPM research, outreach, and implementation on the pest management strategies that offer the greatest potential to reduce the risks associated with agricultural pesticides.

In the required Statement of Action in response to specific recommendations in the GAO report, the Secretary of Agriculture wrote:

GAO Recommendation #1: Establish effective department-wide leadership, coordination, and management for federally funded IPM efforts.

Departmental Response: Fiscal responsibility and program management for IPM is vested in several departments and agencies because IPM includes such sectors as crop production, food safety, environmental quality, public facilities, and workplace and residential environments. Currently, the Office of Pest Management Policy coordinates USDA pest management activities. Over a decade ago USDA embarked on a program of regionalizing IPM. In 2000, USDA created four regional centers through a competitive process. These Regional Pest Management Centers effectively merged the Regional IPM programs with the Regional Pesticide Impact Assessment Program (PIAP). Vesting Regions with program management responsibilities has significant potential for moving IPM to the next level. IPM practice and implementation is site specific and, therefore, it is logical that regionalizing and moving the management and resources to the problem area is a viable approach. Coordination and oversight of each Center is provided by a “board” comprised of representatives from federal and state agencies and relevant stakeholder groups. USDA is committed to a continuing dialog with stakeholders to identify and implement improvements in IPM. The Department will engage the appropriate individuals from other departments and agencies as well as outside stakeholders in a workshop to address the future of IPM programs including priority needs, management, coordination, and funding.

GAO Recommendation #2: Clearly articulate and prioritize the results the department wants to achieve from its IPM efforts, focus IPM efforts and resources on those results, and set measurable goals for achieving those results.

Departmental Response : We have already begun this effort by formulating a draft strategic plan for pest management for the next decade. This draft plan will be submitted for comment to a wide range of IPM experts across the country and a workshop to finalize the plan is being organized for early 2002. As soon as results of the workshop can be summarized, the new plan will be implemented through all USDA agencies and land grant university partners. Crop-specific pest management strategic plans have been completed for a number of commodities and more are under development through the Regional Centers. These plans rely on the input of growers to establish priority pest management needs and have helped target competitive grant funding and IPM implementation. USDA believes that grower-driven crop-specific pest management planning at the local, state, and regional level should remain a key element of any future IPM strategic plan.

GAO Recommendation #3: Develop a method for measuring the progress of federally funded IPM activities toward the stated goals of the IPM initiative.

Departmental Response: IPM is a global concept that is developed, implemented, and practiced at a site specific, local level, which may be at the field, crop, production system, watershed, landscape, or ecosystem level. Each IPM program will have unique objective(s) and projected outcomes. Measurement of accomplishments should be targeted primarily to the specific program objectives. USDA is committed to identifying resources for innovative approaches to assessing the continuum of IPM implementation. The PAMS evaluation process, which identifies four components in IPM (prevention, avoidance, monitoring, and suppression), is one approach to measuring the degree of bio-based IPM implementation. In IPM systems, biological information is the basis for decision and action in prevention, avoidance, and monitoring components. Therefore, these components should be credited in bio-based IPM activity and receive equal weight with bio-based strategies for pest suppression. In an ideal situation, a highly successful bio-based IPM program would only rarely be expected to require incorporation of suppression tactics. USDA will attempt to differentiate and credit all relevant elements of IPM. Regarding pesticide use in IPM, USDA will seek innovative approaches to quantify risk reduction as contrasted with total pounds of pesticide used or acres treated." This National Roadmap for IPM has been developed with extensive and inclusive stakeholder and Federal and State agency input as part of the Federal response to the recommendations of the GAO report. It is intended to provide strategic directions for research, implementation, and measurement activities needed to insure that the full benefits of IPM adoption are realized. Because the Roadmap provides both the vision and the direction for the future of this Plant Protection portfolio. The current Roadmap can be found in Evidentiary Materials, in its entirety.

National IPM Program Leadership and Coordination
The National IPM Program is a broad partnership of governmental institutions working with many stakeholders on diverse pest management issues. Leadership, management, and coordination of these IPM efforts will occur at several levels to more completely address the needs of program stakeholders. At the Federal level, the IPM program is a multi-agency effort that demands coordination and collaboration. The Federal IPM Coordinating Committee will provide oversight of the federally funded programs. This committee will be made up of representatives of the major participating Federal agencies and departments. The role of the committee will be to establish overall goals and priorities for the program. To achieve this, the Federal IPM Coordinating Committee will require a dynamic system of information flow and feedback that provides an up to date, accurate assessment of the status of IPM and the evolving requirements of numerous IPM programs. Stakeholder input to the Federal IPM Coordinating Committee will occur through the USDA Regional IPM Centers. The USDA IPM Coordinator will be responsible for preparing an annual report documenting the status and performance of the IPM program nationally and distributing the report to Congress, Federal and State IPM partners, and the general public. USDA Regional IPM Centers will play a major role in gathering information concerning the status of IPM, and in the development and implementation of an adaptable and responsive National IPM Road Map. These Centers will have a broad, coordinating role for IPM and they will invest resources to enhance the development and adoption of IPM practices.

Performance

20.9 Portfolio Productivity

Evidence of the productivity of these two crosscutting programs in the plant protection portfolio can be seen through evidentiary material provided or through an examination of the web-based outputs from the IPM Centers (www.pmcenters.org) or through the NPDN web site (http://npdn.ppath.cornell.edu/). Evidentiary material includes examples from:

(A) Crop profiles
Crop Profiles are descriptions of crop production and pest management practices compiled on a state basis for specific commodities. They are also searchable.

(B) Crop Timelines
Crop Timelines are descriptions of generalized crop phenology, pest occurrence and human activity for specific crops by state. This is a new activity and timelines are expected to be eventually incorporated into Crop Profiles. All Timelines posted here have been reviewed by EPA.

(C) Pest Management Strategic Plans

The USDA Office of Pest Management Policy (OPMP) is facilitating the production of Pest Management Strategic Plans (PMS Plans) which are developed by growers, commodity associations, land-grantspecialists, food processors, crop consultants, and EPA. These plans address pest management needs and priorities for individual commodities. Each plan focuses on commodity production in a particular state or region. The plans take a pest-by-pest approach to identifying the current management practices (chemical and non-chemical) and those under development. Plans also state the commodity's priorities for research, regulatory activity, and education/training programs needed for transition to alternative pest management practices.

(D) First detector training

Technical training on plant biosecurity issues is provided through The National Pest Diagnostic Network's *First Detector* Training and Certification Course. The course goals are to:

- Raise awareness of national plant biosecurity issues.
- Provide information on specific high risk pests and pathogens.
- Increase proficiency in the detection and identification of new pests and pathogens.
- Provide instruction on proper sampling and response protocols when a suspect sample is encountered.

Those who receive at least two hours of training and complete the three core NPDN First Detector training modules will receive an NPDN First Detector Certificate and will be registered with NPDN as a First Detector.

(E) SOD National Training

A training program for Master Gardeners and other horticultural crop support staff, created by a national panel of experts was conducted consisting of web-based materials, fact sheets and a national teleconference scheduled held on October 26, 2004. A panel of experts was available at the end of the presentation to answer questions. Individual states had the option of holding state-specific break out sessions immediately after the national session. The USDA CSREES worked with State departments of agriculture and the land-grant universities to develop individual, state-specific plans for public education, detection and handling of homeowner landscape plants that might be infected by *P. ramorum*. State and land-grant university plant disease clinics supported the effort.

(F) Diagnostician Training

National taxonomic specialists interactively lead participants through family, genus, and species level identification of key pest and disease organisms. Specialists serving as instructors generally provide brief, overview presentations to pest and disease groups. The majority of participant time in these training opportunities focuses on hands-on identification of specimens.

20.10 Portfolio Accountability

Outcomes and Outputs

The ultimate outcome for the NPDN is an *expanded national preparedness and response capacity* to rapidly and accurately detect high consequence plant diseases. The contributing intermediate outcomes, their evidence for achievement, and programming outputs making them possible are described in Table 20.1 (found on page 204).

Table 20.1

Outputs	Intermediate Outcomes Contributing to Preparedness & Response Capacity	Condition Outcome Evidence
• Plant Diagnostic Laboratories in 41 states received funding to upgrade equipment and facilities, • Plant Diagnostic Laboratories in all states and US Territories received diagnostic training	Increased diagnostic capacities for high consequence pathogens	Laboratories provided triage diagnostics for over 130,000 samples that were potentially infected with P. ramorum, the pathogen that causes sudden oak death, preventing it's nationwide distribution through marketing channels
• Outbreak scenario training exercises were conducted in 23 states • Outbreak scenarios will be completed for all states in the continental US by May, 2005	Improved cooperative response capabilities among CSREES, APHIS, State regulatory officials, LGU scientists and extension professionals	First detected soybean rust outbreak in the United States (Louisiana): Digital sample submitted through NPDN lab to APHIS expert Mary Palm; in less than 24 hours a morphological diagnosis was derived followed by a PCR molecular confirmation. This facilitated a rapid response to the outbreak.
• Trained 10,000 first detectors nationwide • Trained 1500 first detector trainers nationwide • First detector resources were made available through the NPDN and RIPMC website	Educated and capable set of first detectors in every state	With a few weeks after soybean rust was first detected in Louisiana, private interest disease surveillance activities were conducted by first detectors. Samples submitted to diagnostic laboratories, as a result of these first detectors, identified soybean rust in Mississippi, Florida, Georgia, Alabama, Arkansas, Missouri, South Carolina, and Tennessee.

Outcomes from the activities of the IPM Centers are demonstrated through the identification of priority issues by Centers stakeholders and Directors in conjunction with CSREES and science-based faculty throughout the Land Grant University system. The interaction of these groups both facilitates and maximizes the use of resources to attack emerging pest and disease problems in a timely manner. Key examples are the response to soybean aphid, soybean rust and sudden oak death. Documentation of the multi-agency response to these issues is presented in evidentiary materials available.

20.11 Reference and Evidentiary Material

Selected examples of the activities listed below are included for examination. More complete examination is accessible through the National IPM Center and National Plant Diagnostic Centers web sites.

- Crop profiles
- Pest Management Strategic Plans
- NPDN Center Description (slick)
- WPDN and IPM Center Site Visit
- IPM Center (slick)
- Review of the SPDN sponsored Homoptera Diagnostics Workshop

20.12 Examples of Center and Network Accomplishments

- Review of the SPDN sponsored Homoptera Diagnostics Workshop

- Pest Management Strategic Plans
- Crop profiles
- Pest Alerts
- CSREES Key Programmatic Contacts http://www.ipmcenters.org/contacts/index.cfm
- Find Your Local Expert by County from the National Pesticide Telecommunications Network
- Pest Management in the News
- Pest Management Newsletters
  www.ipmcenters.org/Public/news.cfm?USDARegion=National%20Site&site=Producers
- IPM Centers' Search Engine on Production Information

BOOK V:

CONCLUSION

Conclusions on Relevance, Quality and Performance of the Plant Protection Portfolio

A. Relevance

(1) Scope

Plant protection research, education and extension develops and disseminates knowledge and tools for the purpose of managing enormously valuable crops, forests and urban plantings from the depredations caused by undesirable pathogens and pests. The intent of this portfolio is to work toward the development of a healthy and sustainable food and fiber production systems for the present and future generations. These program areas (PAs) within this portfolio are closely related in ecological management sense and also in federal legislation. Research and extension activities which protect crops and recreational areas from pests and plant diseases with minimal adverse effects on the environment and human health remains one of the most important issues of the day. Fundamental and applied research-based knowledge is being used to develop specialized methods for plant protection in both urban and rural settings that reflect needs and opportunities created by modern societal and agricultural developments. In a very real sense, activities in these PAs impact most of the American landscape (forest, range, agricultural, urban) and directly affect the lives of almost all citizens.

The primary topical themes and programs covered by Goal 3.2A (covered in Sections 13-20 of the self study) crosscut two or more of the Goal's problem areas and illustrate where CSREES is contributing to timely, relevant research directed at solving critical problems of national significance. Prominent among these are issues related to ecosystem sustainability, human and environmental safety, plant biosecurity, economic viability and quality of life.

The Goal 3.2A portfolio is funded by a number of separate times of resources in the CSREES budget.. Major components come from Hatch Research, Smith-Lever Extension and CSREES Competitive grant lines of funding. Over the five-year review period, increasing contributions have come from competitive grants, chiefly the National Research Initiative and Integrated 406 programs; moreover, Special Grants allocated by Congress have become an important and growing part of the portfolio.

In terms of CSREES research funding provided to partners, significant progress and growth for this goal occurred during the five years which this portfolio review covers. The Goal 3.2A portfolio expended $64.8 million in FY 1999 which increased to $81 million in FY 2003; a growth of 24.9% over the five years. Funding for the several program areas representing emerging national priorities especially increased. Support for arthropod, disease, weeds, and IPM systems research increased annually by 21%, 21%, 20% and 66%, respectively. Moreover, the leveraging power of CSREES support increased during this period. In 1999, every CSREES research dollar was matched with about $4 from other sources, and as of 2003, this leverage has remained at approximately $4 from other sources (Table 6.1, found on page 49).

Extension activities and educational materials and programs provide additional examples of significant progress during this period. These include pest and disease management and control guides, web-based informational services, web-based decision support tools and web-based educational programs.

(2) Portfolio Ability to Remain Focused on Critical Needs of the Nation

State partners utilize stakeholder inputs and other relevant information to identify critical needs which may be addressed by application of formula research and extension funds. State processes for critical needs identification and development of appropriate activities and programs are reported to CSREES in mandated 5-year plans of work and in annual reports. CSREES peer review of these reports as well as review of individual formula-funded research proposals ensures that state programs and activities supported by CSREES funds focus on relevant and scientifically critical areas. The requirement that states engage in multi-state research, coordinated through regional associations of agricultural experiment station directors, further encourages attention to critical issues that are of regional and often national importance. In some cases of extreme emergency or importance, national research projects are established through the regional experiment station system. National extension planning activities also help to guide state Extension programming to contribute to meeting regional and national needs.

The CSREES competitive grants review process especially encourages innovative ideas that are likely to open new research approaches to enhancing agricultural and natural resources management. A proven mechanism for stimulating new scientific research, the process increases the likelihood that investigations addressing relevant topics of the highest importance are using well-designed and well-organized experimental plans. Each year, panels of scientific peers meet to evaluate and recommend proposals based on scientific merit, investigator qualifications, and relevance of the proposed research consistent with the mission and goals of USDA. Review panels and CSREES staff constantly provide input to competitive grant program managers that results in evolution of program foci that reflect critical needs for new research-based knowledge.

(3) Identification of Emerging Issues Relevant to the Portfolio

The Agricultural Research, Education, and Extension Reform Act of 1998 (AREERA) formally requires that formula-funded projects reflect stakeholder priorities. Setting priorities is an important means of facilitating the scientific and technological advances needed to meet the challenges facing U.S. agriculture and natural resources management. Congress sets the budgetary framework by providing funds to CSREES. Members of Congress also make recommendations for the scientific and programmatic administration through appropriation language and through their questions and comments during Congressional hearings. Input into the priority-setting process is also sought through various input channels from a variety of customers and stakeholders. The scientific community provides direction through the competitive grant proposals it submits each year as well as through the proposal evaluation and funding recommendations provided by individual peer-review panels (see Evidentiary Materials).

Participation by NPLs in review panels for competitive programs, federal interagency working groups, stakeholder workshops, and NASULGC programs are important mechanisms for CSREES to identify emerging issues for Goal 3.2A PAs. NPLs also attend professional and scientific meetings to stay current on scientific trends that are reflected in CSREES programs and in the coordination of priority setting with other federal agencies. NPLs also participate in meetings with state research and Extension personnel or multi-state committees, with representatives of the land-grant university community, and with officials of non-governmental citizen organizations. Through such meetings, NPLs learn of current priorities, and solicit comments and suggestions on ways that CSREES can assist in meeting their needs. Both IPM Centers and IR-4 programs receive formal stakeholder input from Advisory boards and liaison groups which meet to prioritize research and extension educational needs.

(4) Integration of CSREES Education, Research, and Extension Efforts in the Portfolio

Integration refers to the inter-linkage of the several CSREES' mission areas of research, education, and extension into coordinated programs and activities. The intent of program integration is to produce products which reach a wide variety of audiences in appropriate formats. That might otherwise be disjoint and more narrowly defined. Although CSREES is dedicated to integrative efforts in all its programming areas, there are some challenges to accomplishing this, caused chiefly by outside factors. For example, some legislative authorizations are so specifically defined that they preclude meaningful integration. Moreover, some CSREES stakeholders have interests which are similarly fixed on single purposes. Such situations require that NPLs must often take the initiative to stimulate and accomplish integration in otherwise focused program areas. While this has been somewhat problematic in the past, significant progress has been made through the years covered in this review. CSREES also has competitive grant programs, such as the 406 Integrated Grants program, that specifically require or encourage integrated programming. I addition, the NRI, is now authorized to allocate up to 20% of its annual funding for appropriate integrated projects and certain programs are identified as appropriate for this.

(5) Multidisciplinary Balance of the Portfolio

Both mission-linked research and fundamental research are supported by CSREES formula- and competitively-funded research. Mission-linked research targets specific problems, needs, or opportunities. Fundamental research involves the quest for new knowledge about important organisms, processes, systems, or products and opens new directions and opportunities for mission-linked research. Both mission-based and fundamental research is essential to the sustainability of agriculture and renewable natural resources of forest and rangelands. Review of Hatch funded projects in the Goal 3.2A portfolio reveals that the vast majority typically combine both fundamental and applied approaches. Although single-investigator projects are common increasingly these types of research are taking multidisciplinary and multi-investigator forms since the Request for Applications of CSREES competitive grant programs are encouraging multidisciplinary research. Moreover, CSREES requires that 25% of the research base funding that it provides to states be devoted to multi-state activities, which promotes multidisciplinary approaches to problem solving. In turn, the regional agriculture experiment station systems use the funds to support multi-state research projects and committees. The multi-state committees which have objectives related to Goal 3.2A are listed in Tables 6.9 (found on pages 59-60).

From the Extension perspective, multidisciplinary and sustainability approaches are common in "Master" and "Train the Trainer" programs that are well-established in most states. Examples given in the Goal 3.2A portfolio include such titles as Master Gardener. At the national level, the web-based training such as that led by the NPDN is a prime example of "one-stop multidisciplinary educational shopping" available to stakeholders (see Evidentiary Materials for examples).

B. Quality

(1) Significance of Portfolio Outputs and Findings

At the Agency level, all federal funds are leveraged at least by a ratio of $2 of non-federal funds for every $1 of federal funding. This leveraging provides expanded fiscal resources to address programs that have been decreed as important and relevant by CSREES stakeholders.

CSREES investment in plant protection research is highly effective and beneficial. One example of this is a study that demonstrates the impacts of CSREES-funded research is deer damage research at the University of Georgia. White-tailed deer damage management research will provide economic benefits and ecological benefits to citizens in Georgia and the U.S. This research project is developing and testing new methods to minimize deer-vehicle collisions and reduce damage from deer browsing to agricultural and household plantings. Nationwide, there are about 1.5 million deer-vehicle collisions in the U.S. each year, with an average vehicle repair cost of $1,500, for a total economic loss of more than $1 billion. Thus, new methods that reduce the number of deer-vehicle collisions could lead to a significant economic savings, as well as, the decreased potential for loss of life and human suffering. Furthermore, each year deer browsing in the U.S. causes an estimated $100 million in damage to agricultural productivity, $750 million in damage to timber productivity, and $250 million in damage to household plantings. Wildlife scientists and graduate students are investigating and evaluating non-traditional deer management strategies, based on current knowledge of deer social ecology, as a means of minimizing deer-human conflicts in localized areas. Working on these projects provides students with valuable training and field experience in resolving real world deer herd management problems.

Hatch, Smith-Lever and competitive grant supported research projects at North Carolina State University and the University of Nebraska developed weed management decision support tools which are now widely used.

Results of research on plum curculio (PC) in Massachusetts have given rise to an entirely new, inexpensive and efficient way of monitoring PC using perimeter-row trap trees baited with grandisoic acid and benzaldehyde. Once action levels based on percent fruit with fresh injury are destablished sampling to determine need to spray against PC can be confined to examination of fruit for fresh injury on a few strategically located perimeter-row trap trees.

Researchers at Colorado State found that carbon dioxide given off by corn attracts western corn rootworm larvae. They developed a formulation of granules that produces the gas to lure the pests away from the corn. The technique also is proving effective in attracting and trapping termites.

The above are examples from the wide array of projects conducted each year with Hatch Act funding. Research studies are geared to the needs of all stakeholders: farmers, ranchers, urban residents, policy makers, and just about every person in this country. The benefits accruing from this research investment are exceedingly large and often can be multiplied by coordination with other funding lines.

An assessment of the quality of outputs and outcomes can only be made on a state-by-state basis. There is no national extension teaching curriculum since every state that conducts programs on topics that are specifically relevant to their needs. In fact, at the state level, the topics are customized even further based on county or regional issues. The result, when viewed nationally, is a diverse portfolio of programs with different goals and objectives that necessitate different outputs which result in different outcomes. Examples of state-level outputs and outcomes were previously described in each Problem Area within this document.

The assessment of the quality of outputs and outcomes for research programs can only be made on a state by state, project by project, basis. There are no national research questions, approaches, and data collection and analyses conventions that provide national answers. Each state and project formulates research questions based upon their specific needs, the expertise of their research scientists, and the capacity of the institution to carry out the proposed scientific inquiry. Examples of research outputs and outcomes have been highlighted in each Problem Area throughout this document.

(2) Stakeholder/Constituent Assessment of the Portfolio

CSREES National Program Leaders have effective networks and mechanisms that assist them in recognizing and establishing priorities and assuring program relevancy.

The 1998 Agricultural Research, Education and Extension Reform Act (AREERA) requires recipients of formula funds (Hatch, Evans-Allen, McIntire-Stennis and Smith Lever) to collect stakeholder inputs every year and describe the process used to identify individuals or groups as stakeholders. Also each institution needs to describe how these inputs relate to their plans of work, priority setting, immediate needs and long-term goals, guidance on monitoring, and proposed research activities.

(3) Alignment of Portfolio Projects with the Current State of Science-based Knowledge and Previous Work

Alignment of research/education and extension programs with current and emerging science is being implemented through both competitive and merit funding lines comprising this portfolio's programs (Figure 6.4, found on page 47).

Integrated Pest Management, or IPM, is a long-standing, science-based, decision-making process that connects and overarches the PA components of this portfolio. IPM identifies and reduces risks from pests and diseases, by coordinating and using the pest's biology, environmental information, and available technology to prevent unacceptable levels of damage while posing the least possible risk to people, property, resources, and the environment. A strategic plan for pest and disease management for the next decade has been developed as the National IPM Roadmap. This plan was developed through a 2 year nationally based facilitated process and then submitted for comment to a wide range of IPM experts across the country and at the National IPM Workshop, which was held in early 2002. Results of this workshop were summarized, and the new National IPM Roadmap is currently being implemented through USDA agencies and land grant university partners.

Crop-specific pest management strategic plans detailing the current state of plant protection science and identifying high priority needs have been completed for a number of commodities and more are under development through the Regional Centers. These plans rely on the input of growers to establish priority pest management needs and have helped target competitive grant funding and IPM implementation. CSREES believes that grower-driven crop-specific pest management planning at the local, state, and regional level should remain a key element of this and any future IPM strategic plan.

(4) Appropriate Methodology of Funded Portfolio Projects

The quality of experimental results is significantly influenced by experimental methodologies. Appropriate methodology correspondingly produces appropriate results. Appropriate procedures should produce data suitable for statistical analysis. From 1999 to 2003, plant protection research was principally funded through the Hatch Act, SARE, SBIR, integrated 406 Program, Pest Management Alternatives Program, the discontinued IFAFS Program, and NRI. Projects funded by the Hatch Act are peer reviewed by each institution and must agree with the Plans of Work that are approved by CSREES (see Evidentiary Materials).

Congressionally designated Special research grants are reviewed through a merit review process by first the designated project Liaison, then by a unit reviewer who has expertise in the proposed subject of investigation and finally merit by an independent reviewer. All concerns of reviewers must be addressed before a special project is recommended for funding.

NRI, Integrated 406 Program, Pest Management Alternatives Program Regional IPM Program and IFAFS projects are/were rigorously reviewed by individual experts and Peer Review Panels for scientific merit, innovation, impact, national significance, and potential for success. SARE and SBIR proposals are likewise reviewed by panel processes that are similar to NRI.

C. Performance

The performance of the programs funded in this portfolio can be assessed in several dimensions, which, when combined, suggest that overall, the programs are advancing the knowledge and application of agricultural science through research, education and extension programming.

(1) Portfolio Productivity

Assessing the overall portfolio productivity is a difficult task for several reasons:

1) Specific measures of productivity have not yet been established. Without established criteria to measure against, current productivity and the amount of change in trends over time cannot be tracked,

2) Assessing the productivity of competitively funded programs is relatively straightforward, in that annual and final reports are required. The assessment is more difficult with formula programs, particularly extension, in that states exercise wide latitude in what they report. This is based, in part, on the fact that CSREES is a minority funder in most states. Thus, some states report only those programs "touched" by CSREES funds, while others report the entire state program. In both cases the amount and quality of annual reports vary widely from state to state. The result is that at the national level, there is a very mixed and incomplete picture of the results that emerge from CSREES-funded programs,

3) State extension annual reports most often report only program inputs, audiences reached, and outputs. Evaluating outcomes requires more resources, particularly time, professional evaluation expertise, and money. If program evaluation efforts are not budgeted for, they are unlikely to occur. If evaluation specialists are not available at the universities to assist in the design and execution of evaluations, many extension educators are left to do what they can without the benefit of experts.

Despite these limitations, several observations and conclusions can be drawn from a review of the work that is accomplished by the university partners (See "Outcomes" in the Problem Area descriptions):

1) The portfolio can be assessed by examining the sum of its parts. Each Problem Area previously described demonstrates various research, education and extension outputs and outcomes, which represent productivity.

2) Research productivity can be measured, in part, by the number of publications that are produced (Output), the number of patents developed (Output), and the actual or estimated economic impact when new practices are adopted (Outcome).

3) Through the mechanism of CSREES Program Reviews led by National Program Leaders, the Portfolio 3.2 Team members have observed and studied programs at universities and have documented the quality and productivity of the programs (partially funded by CSREES) in Program Review Final Reports (see Evidentiary Materials).

(2) Portfolio Completeness

Programs in this portfolio meet their intended outcomes at both the individual project level as well as at the state and institution level. In the case of formula funds where broad guidelines are provided to states, "completeness" is largely evaluated by stakeholders who provide input as to what the extension programs need to address. Competitively funded projects result from funding recommendation from Peer Review Panels which make selections on a proposal by proposal basis and do not necessarily consider "completeness" in the suite of proposals recommended for funding. In the case of competitively funded programs, NPL's who serve as Program Directors are responsible for reviewing final reports and comparing the proposed objectives against what was actually accomplished.

(3) Portfolio Timeliness

Assessing the timeliness of the work in this portfolio is largely done by monitoring the submission of final reports or requests for renewal, extension, or budget carryover. These determinations are relatively easy to track for competitive grants and special projects where formal proposals and annual reports are due. Assessing the timeliness of the work accomplished through formula programs, particularly extension programs, has inherent challenges. Research projects have discreet start and completion dates; extension education programs will have start dates, but often do not have a completion date, due to the nature of life-long learning. What can be assessed, in place of timeliness, is extension program evolution. As issues change and new knowledge is gained, extension programs are continually evolving to in order to incorporate new discoveries and curricula. This is monitored, in part, through the state Annual Reports which are reviewed by the CSREES National Program Leaders and staff.

(4) Agency Guidance Relating to the Portfolio

The agency provides guidance in the conduct and assessment of program through several mechanisms:

- Requests for Proposals - Project Directors of funded projects are expected to fulfill the project objectives and to provide annual progress reports and final reports. The requirements that must be fulfilled by the Project Director are clearly spelled out in the Terms and Conditions of the award document that is sent to the performing institution. In this way, CSREES ensures that funding recipients clearly understand their obligations.
- Post-Award Management – CSREES NPLs provide post-award management through reviews of program reports; leadership of program, department and institutional reviews; and their interest and intellectual inputs into reporting systems such as CRIS, CREEM and REEIS.
- Program of Research - All Hatch and McIntyre-Stennis Research proposals require CSREES approval prior to the institution being permitted to draw the funds. National Program Leaders review the proposals and for funding approval or deferral until deficiencies are addressed. At the beginning of the fiscal year, each institution receives a listing of its approved projects; this serves as the institution's Program of Research which has been reviewed and approved by CSREES.
- NPL Management and Leadership - NPL's are responsible for portfolios of work within specific disciplines, funding sources and functions. Within their sphere of influence, NPL's interact with multi-state research committees, ad hoc program committees, strategic planning efforts and other venues with the university community. Part of this interaction involves conveying agency needs and expectations regarding the funding that is provided. This is usually more relevant to formula-funded programs, as competitive grant recipients have formal obligations to complete project objectives for which they were funded.
- Plan of Work Guidance – CSREES provides guidance for the preparation and annual updating of extension plans of work. To ensure that the guidance is followed, these plans are reviewed by two-person teams of NPL's. If plans are deficient, they are deferred until the deficiencies are corrected.

Examples of the various forms of agency guidance are contained in the Evidentiary Materials.

(5) Portfolio Accountability

The work accomplished in this portfolio is monitored by NPL's who are either program directors for competitive grant programs, agency contacts for special grants, stakeholders thought the land-grant systems, and state annual report reviewers. The CRIS system is an informational resource that allows NPL's to track the progress of research and, more recently, education programs. Though not designed to fulfill accountability purposes, CRIS is accessed by NPL's to determine if projects were completed as funded, requests for extensions and budget carryovers are justified and progress reports submitted prior to approving requests for renewals. Extension formula-funded programs are evaluated on a state-by-state basis by the two-member NPL Review Team. These reports are examined for completeness, evidence of impacts, and stakeholder involvement. A written assessment is completed and returned to each institution.

CSREES is designing new processes and tools, particularly monitoring and evaluation systems and will train the agency's partners in their use. In an environment in which funding support at all levels is becoming tighter, activities that strengthen accountability and impacts will have greater funding support. This is true of the President's Management Agenda and OMB results-based budgeting processes.

Acronyms

Acronyms Appearing in the Portfolio

AA	Administrative Advisor
AAFC	Agriculture and Agri-Food Canada
AES	Agricultural Experiment Station
AMV	Alfalfa mosaic virus
APHIS	Animal and Plant Health Inspection Service
APS	American Phytopathological Society
AREERA	Agricultural Research, Education and Extension Reform Act
ARPA	Agricultural Risk Protection Act
ARS	Agricultural Research Service
BPI	Budget Performance Integration
Bt	Bacillus thuringiensis
CAR	Crops at Risk
CES	Cooperative Extension Service
CEW	Corn Earworm
CDLI	Congressionally Designated Line Item
CP	Competitive Programs
CRGO	Competitive Research Grants Office
CRIS	Current Research Information System
CSREES	Cooperative State Research, Education and Extension Service
CSRS	Cooperative State Research Service
CYFAR	Children, Youth, and Families at Risk
ECB	European Corn Borer
ECS	Economic and Community Systems
EFNEP	Expanded Food and Nutrition Education Program
EIRP	Extension Indian Reservation Program
EPA	Environmental Protection Agency
EPS	extra-cellular polysaccharide
ERS	Economic Research Service
ESCOP	Experiment Station Committee on Organization and Policy
FFDCA	Federal Food, Drug, and Cosmetic Act
FIFRA	Federal Insecticide, Fungicide and Rodenticide Act
FQPA	Food Quality Protection Act
FS	Forest Service
GAO	General Accounting Office
GIS	geographic information system
GPRA	Government Performance and Results Act
GPS	Global Positioning System
HSI	Hispanic Serving Institution
IFAFS	Initiative for Future Agricultural and Food Systems
IFPRI	International Food Policy Research Institute
IMPACT	International Model for Policy Analysis of Agricultural Commodities and Trade
IOP	Integrated Organic Program
IPM	Integrated Pest Management
IR-4	Inter-regional Project 4
IRM	insect resistance management
ISE	International Science and Education
LAI	Leaf Area Index
MBT	Methyl Bromide Transitions
MRF	Multi-state Research Funds

MRL	Minimal Risk Level
NAREEAB	National Agricultural Research, Education and Economics Advisory Board
NAFTA	North American Free Trade Agreement
NASA	National Aeronautics and Space Administration
NASS	National Agricultural Statistics Service
NC	North Central
NDVI	normalized difference vegetation index
NGO`	Non-Governmental Organization
NIFSI	National Integrated Food Safety Initiative
NIMSS	National Information Management Support System
NPDN	National Plant Diagnostic Network
NPAL	National Planning and Accountability Leader
NPL	National Program Leader
NRCS	Natural Resources Conservation Service
NRE	Natural Resources and Environment
NRI	National Research Initiative
NSF	National Science Foundation
OMB	Office of Management and Budget
PA	Problem Area
PART	Program Assessment Rating Tool
PAS	Plant and Animal Systems
PI	Principal Investigator
PMA	President's Management Agenda
PMAP	Pest Management Alternatives Program
PMRA	Pest Management Regulatory Agency (Canada)
POW	Plan of Work
PPQ	Plant Protection and Quarantine
PPRS	Performance Planning and Reporting System
PSEP	Pesticide Safety Education Program
PREP	Portfolio Review Expert Panel
RAMP	Risk Avoidance and Mitigation Program
R&D	Research and Development
REE	Research, Education and Economics
RFA	Request for Applications
RFP	Request for Proposals
RIPMC	Regional Integrated Pest Management Centers
RMA	Risk Management Agency
RME	Risk Management Education
RREA	Renewable Resources Extension Act
RRF	Regional Research Funds
RTPCR	Rapid or Real Time Polymerase Chain Reaction
SAN	Sustainable Agriculture Network
SAES	State Agricultural Experiment Stations
SARE	Sustainable Agriculture Research and Extension
SBA	Soybean Aphid
SBIR	Small Business Innovation Research
SERD	Science and Education Resources Development
SMV	Soybean Mosiac Virus
SRG	Special Research Grant
TWG	Technical Working Group
USDA	United States Department of Agriculture
USFWS	United States Fish and Wildlife Service
USFS	United States Forest Service
WSFR	Warnell School of Forest Resources

Tables *Guide*

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Executive Summary

In response to a directive from the Office of Management and Budget (OMB), the USDA Cooperative State Research, Education, and Extension Service (CSREES) prepared a set of self-review documents on the Relevance, Quality, and Performance of Research, Education, and Extension programs that support the Agency's strategic goals. The purpose of these self-review documents is to provide concise yet comprehensive insight into activities so that the Panel may assess whether CSREES is fulfilling OMB's requirement for relevance, quality, and performance. This is one of three self-review documents addressing Goal 3 (Enhance Protection and Safety of the Nation's Agriculture and Food Supply) prepared by national program leaders. The Plant Protection Portfolio within Goal 3 was prepared by national program leaders from four different units of CSREES, namely: Plant and Animal Systems (PAS), Competitive Programs (CP), Natural Resources and Environment (NRE), and Economic and Community Systems (ECS). The program leaders and staff of these units develop and deliver science-based information and technologies to reduce the number and severity of agricultural pest and disease outbreaks. The total Goal 3 Program Portfolio includes all of the agency's programs, functions, and funding related to Objectives 3.1 (Reduce the Incidence of Food-borne Illnesses and Contaminants Through Science-based Knowledge and Education) and 3.2. (Develop and Deliver Science-based Information and Technologies to Reduce the Number and Severity of Agricultural Pest and Disease Outbreaks). Objective 3.2 encompasses both plant (3.2A) and animal (3.2B) pests and diseases. This report specifically focuses on work supporting CSREES Strategic Objective 3.2A. The report's timeframe is 1999-2003. The self-review documents on Portfolio 3.1(Food-borne illnesses and contaminants) and 3.2B (Animal pests and diseases) have also been prepared by CSREES and will be reviewed by other panels.

CSREES-sponsored research, education, and extension work is funded from multiple authorities and funding sources. To fully appreciate this integrated, mission-focused work, portfolios of topically-linked issues are aligned with the five USDA Strategic Goals, and fourteen CSREES Strategic Objectives. The portfolio and its related Problem Areas (PAs) demonstrate the complementary nature of research, education, and extension to solve national problems and to ensure that public investment is effective and efficient. The portfolio report provides detailed descriptions of PA activities.

The conclusion of this self-review document is that CSREES' efforts under Portfolio 3.2A are relevant, of high quality, and high performance in addressing the national problems, needs, and concerns identified. The remarkable aspect of this effort is that so many separate funding lines (23) and authorities have been put together to form a suite of synergistic programs to address high priority stakeholder needs. The resounding theme of all descriptions of work in Problem Areas in Portfolio 3.2A is that CSREES is engaged, through a unique partnership with Federal and State Agencies, academic institutions, and the private sector, in solving plant protection problems. The predominant partnership is the CSREES-land grant university partnership that supports agricultural research, extension, and education programs at these institutions.

Work in this portfolio has benefited agricultural production systems Nation-wide, both urban and rural environments, the natural resource base, landowners, producers and consumers, and the general public. Examples of the productivity of the Plant Production Portfolio are demonstrated throughout the self study document and in the supplementary evidentiary materials that are provided at the site review.