Portfolio Annual Report 2008:
Plant Systems

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

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Portfolio Annual Review

Section I: Portfolio Overview

Portfolio Planning

Plant Systems Portfolio Mission
To provide strong research, extension, and educational programs that promote the efficiency of plant production and protection systems that are economically competitive, environmentally sound, and produce high quality and safe products for the American consumer and international markets.

Plant Systems Portfolio Vision
A sustainable, globally competitive, consumer driven 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, extension, and regulatory programs of the Department.

Plant Systems Portfolio Functions
Integrated program functions for the Plant Systems Portfolio include:

- Increase fundamental knowledge and understanding from basic research at the frontiers of the biological, physical, and social sciences relating to plant production and pest/disease management in plant agriculture.
- Produce, apply, and adopt applied research-based knowledge in innovative ways to address problems and issues in plant systems.
- 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.

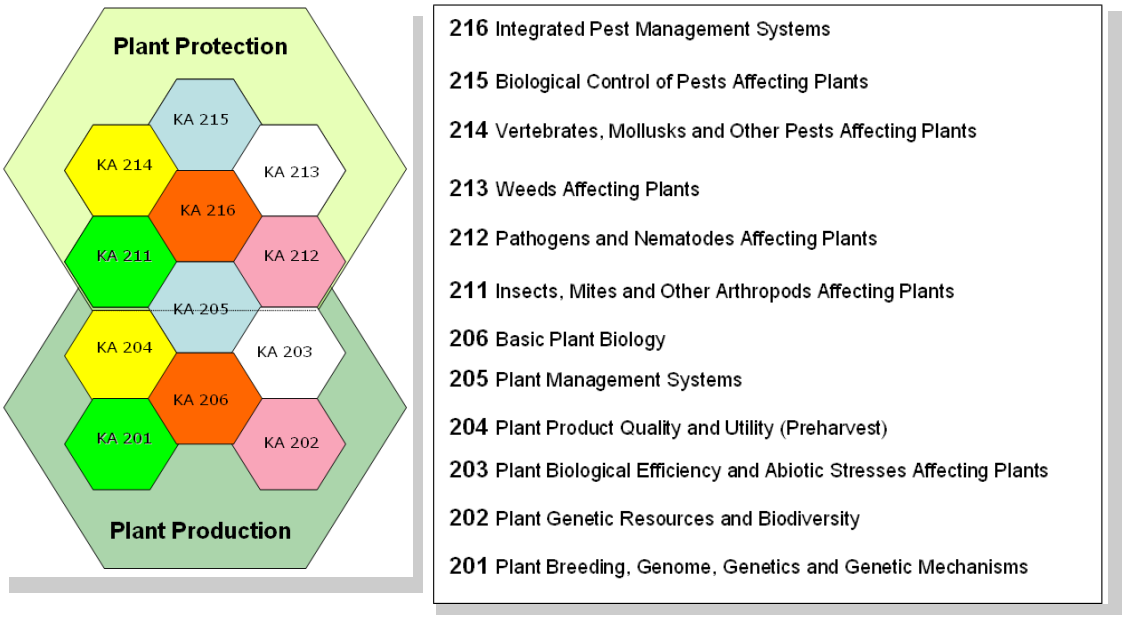
Plant Systems Portfolio Roles
Integrated program roles for the Plant Systems Portfolio include:

- 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.

Plant Systems Portfolio Introduction
This portfolio represents a major component of the CSREES-supported full portfolio of programs at 1862, 1890, 1994, and other institutions. Plant systems focuses on most of the key factors relating to plant production, and to the 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 twelve (12) Knowledge Areas (KAs). The USDA strategic goals that are pertinent to this portfolio include: Goal 2, Enhance the Competitiveness and Sustainability of Rural Farm Economics; and Goal 4, Enhance Protection and Safety of the Nation's Agriculture and Food Supply.

The CSREES Plant Systems Portfolio (**Figure 1**) encompasses Plant Production and Plant Protection**.** Plant Production programs have been arbitrarily defined as research, extension, and education programs aligned with six knowledge areas related to the efficiency of plant production systems. Formerly, Plant Production was reviewed as a separate Portfolio in an earlier portfolio review held in 2004. Plant Protection has been defined to include new, emerging, and reemerging plant pests and diseases, plant agricultural security, biosecurity, and toxicology aligned with knowledge areas to the efficiency of plant protection systems.

Figure 1. Knowledge Areas of the Portfolio



An integrated systems approach is utilized in planning, developing, and implementing programs. The CSREES National Program Leadership Team for Plant Systems recognizes that the production and protection 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 program areas such as product quality (post harvest), food safety, engineering, waste management, marketing, and economics.

The Plant Systems Portfolio is diverse in terms of commodities covered and includes research and extension activities directed at plant production and 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 Systems Portfolio encourages multi-disciplinary approaches to address the needs of plant agriculture and the American consumer.

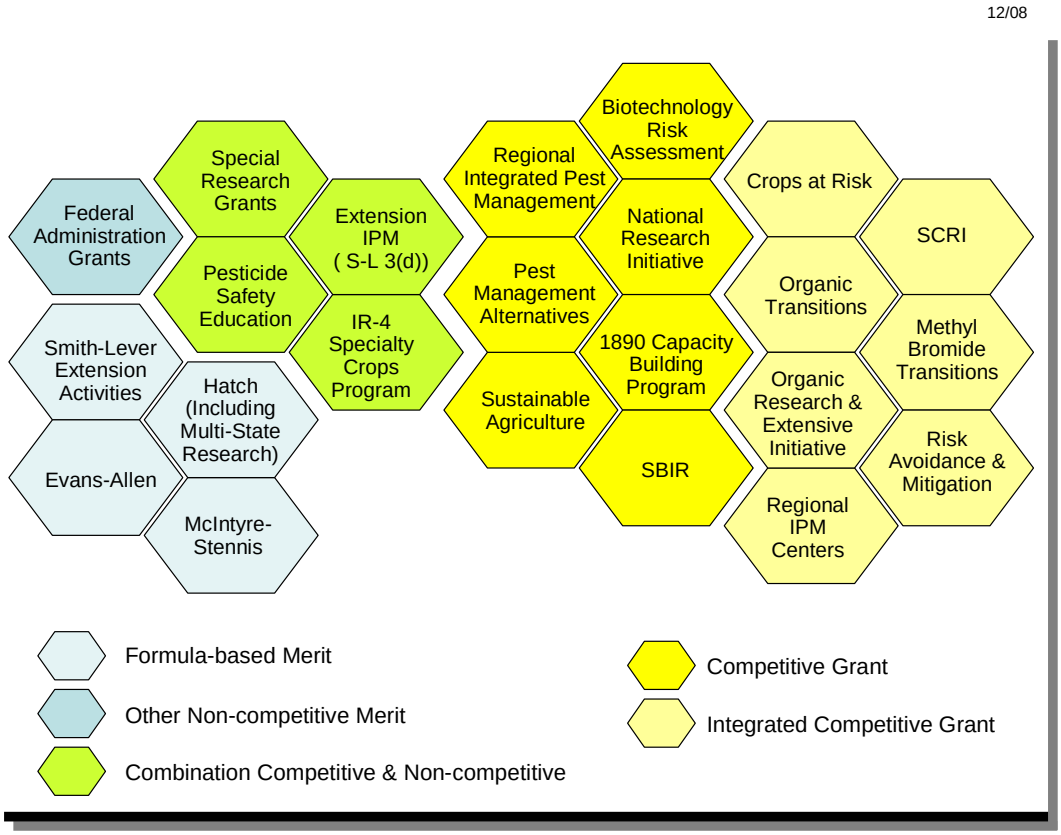
The portfolio contains a balance of discipline-based components including all major plant production systems and groupings of pests affecting plants and the integration of these into plant production and protection management systems. Program integration may occur at a commodity-based system level (e.g., 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 components are highly integrated and not always evident as a separate effort.

The long-term 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. This portfolio represents a major component of CSREES funding and likewise a major part of the programming reported by partner institutions.

The scope of this portfolio is restricted to the specific issues covered under the 12 KAs as listed in Figure 1. In many cases research and extension efforts are supported by one or more of the KAs included in other portfolios (e.g., Natural Resources and Environment). Therefore, the total CSREES resource allocation directed to Plant Systems is actually greater than depicted in this portfolio.

Twenty-three funded programs comprise the Plant Systems Portfolio (**Figure 2**). The 12 KAs are embedded within, and cut across the integrated structure as seen in the figure. Program activities in plant systems 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, page 13). Funding support is through *Competitive Grants, Integrated Competitive Grants* and Formula-based *Merit Programs.* Considerable integration and cross cutting approaches take place through the 23 funded programs of the Plant Systems Portfolio.

Figure 2. Plant Systems Funding Authorities



The integration and impacts of the Plant Systems Portfolio are enhanced through the partnership and interaction with KA 205 (Plant Production Management Systems) and KA 216 (Integrated Pest Management Systems). The KAs do not work in isolation, but rather in a direct relationship to both KA 205 and KA 216 in discovery and outreach. Recurring communication and feedback provide new program direction, coordination, alteration and ultimate impacts across the KAs.

Plant systems programs, like most program areas supported under CSREES strategic goals, are funded from a wide range of the funding sources depicted in **Figure 2**. Major support for the plant systems portfolio comes from competitive programs, Congressionally directed special grants and formula funding.

Linkage to CSREES Strategic Plan

Supported CSREES Strategic Goals. This portfolio supports strategic goals "Enhance the Competitiveness and Sustainability of Rural and Farm Economies" (Goal 2) and "Enhance Protection and Safety of the Nation's Agriculture and Food Supply" (Goal 4).

The Agency's strategic goal "Enhance the Competitiveness and Sustainability of Rural and Farm Economies" supports numerous research and extension activities to enhance the competitiveness and sustainability of rural and farm economies, ranging from the development of new products to improvements in productivity and financial management. Education programs strengthen the foundation for this goal by building capacity in the agricultural research and extension system and training the next generation of scientists and educators.

The Agency's strategic goal "Enhance Protection and Safety of the Nation's Agriculture and Food Supply supports the development and distribution of scientific-based information, technology and practices to producers, manufacturers, the work force and regulatory agencies to help ensure the safety of agriculture and the food supply to domestic and global consumers. Education programs strengthen the foundation for this goal by building capacity in the agricultural research and extension system and training the next generation of scientists and educators.

Supported CSREES Objectives. This portfolio supports objectives "Provide Research, Education, and Extension to Increase the Efficiency of Agricultural Production and Marketing Systems" (Objective 2.2) and "Develop and Deliver Research, Education, and Extension to Reduce the Number and Severity of Agricultural Pest and Disease Outbreaks" (Objective 4.2).

The Agency's objective entitled "Provide research, education, and extension to increase the efficiency of agricultural production and marketing systems" supports research, education and extension programs to develop and transfer technology, practices, and skills to support economically viable farms and ranches of various size and scale. This work reduces per unit and overall production costs, improves quality and yields, reduces environmental impacts, improves marketing and management decisions, develops new products and uses for by products, and finds new ways of adding value to traditional crops and products. Research ranges from using genomics to develop hybrids requiring fewer chemical inputs, to systems for more informed decision making, to new precision technology and nanotechnology to improve management of crops and animals.

The Agency's objective entitled "Develop and deliver research, education, and extension to reduce the number and severity of agricultural pest and disease outbreaks" supports research, education and extension activities on pest, disease and plant production systems that impact the food and fiber system. CSREES sponsors work on the investigation, understanding and control of plant pests and diseases, which results in methods and practices to prevent or control outbreaks of exotic, native and foreign pests and diseases, including invasive pests.

CSREES Strategic Plan Performance Measures Progress Table

The following key long-term outcomes and performance measures coordinate with the strategic goals and objectives that are both supported by this portfolio and its areas of emphasis.

Objective: Provide Research, Education, and Extension to Increase the Efficiency of Agricultural Production and Marketing Systems

Key Long-Term Outcome: Increased efficiency of agricultural production system by: 1. Expanding information to model feed utilization for animal species; 2. Releasing new or improved varieties or germplasm with enhanced pest or disease resistance; 3. Further understanding of the biological role of gene sequences in plants, animals, microbes and insects; 4. Strengthening masters degree level courses in the food and agricultural sciences, particularly at minority-serving institutions; 5. Increasing the number of minority students participating in the workforce by funding minority-serving projects at Hispanic serving institutions, 1890 institutions, 1994 institutions, Alaska-Native Serving institutions, Native-Hawaiian service institutions; and 6. Increasing the number of socially disadvantaged minority farmers and ranchers who are knowledgeable, eligible, and participating in USDA farm programs.

Performance Measure: Cumulative number of new crops that have been developed and used commercially.

Performance Criteria:

- Develop fundamental information and improve understanding of plant genetics and plant breeding technology
- Identify, preserve, characterize and develop genetic resources for plant production or protection
- Understand and improve plant productivity and quality as affected by reduced inputs, or stresses
- Improve biological quality before harvest
- Develop and implement comprehensive plant production management systems
- Improve understanding of fundamental processes and mechanisms basic to plant life

Actionable Strategies:

- Expand the knowledge base and provide information to enable producers and policymakers to make informed production, management and marketing decisions to increase the profitability and competitiveness of agriculture
- Increase outreach and education supporting the broad view of agriculture from the rural community to the consumption of products, thereby gaining communication and input from all stakeholder groups in agriculture

- Support the recruitment, retention, training, graduation, and placement of the next generation of research scientists, educators, and practitioners in the food and agricultural sciences
- Sponsor science-based work to increase producers' knowledge and understanding of the disciplines involved in providing products that strengthen the rural community, support the sustainability of plant and animal production and create a richer variety of products for the health, welfare and satisfaction of consumers
- Sponsor efforts to preserve, conserve, characterize, and make available genetic resources for further research and development, including plant variety development
- Integrate new science-based knowledge, technologies, decision-support systems and best-management practices to optimize efficient, economical and environmentally sustainable production systems appropriate in size and scale
- Sponsor analyses of the benefits and costs of agricultural and environmental policies to compare the effects of alternative production and management systems
- Support research, education and extension to 1) better understand and address consumer needs, tastes and preferences, 2) inform consumers, 3) provide continuing professional development throughout the agricultural and foods system
- Sponsor research and extension efforts to use plant, animal and microbial genomic sequences in addition to population approaches to improve the efficiency, quality, and sustainability of plant and animal production

Objective: Develop and deliver research, education, and extension to reduce the number and severity of agricultural pest and disease outbreaks

Key Long-Term Outcome: Expanded science-based information and technologies and reduced number and severity of agricultural pest and disease outbreaks through: 1. Connection and data exchange among national plant and animal disease diagnostic networks; 2. Increased resource efficiency and decreased economic risk regarding the adoption of sustainable pest management tactics; 3. Developed capacity to minimize or mitigate occupational and non-occupational human health risks associated with pest management; and 4. Increased capacity in minimizing or mitigating environmental risk associated with pest management.

Performance Measure: The number of high-consequence pest and disease threats detected and diagnosed by integrating the National Plant Diagnostic Network and the National Animal Health Laboratory Network Diagnostic labs.

Performance Criteria:

- Reduce adverse impacts of indigenous and exotic pathogens, toxins, plants and pests on plant yield and quality
- Reduce adverse impacts of indigenous and exotic bacteria, fungi, nematodes, viruses and other pathogens on plant yield and quality
- Reduce adverse impacts of competition from indigenous and exotic weeds, including aquatic weeds and parasitic plants, on plant yield and quality
- Reduce adverse impacts of indigenous and exotic vertebrate pests (including birds and mammals), mollusks (including slugs and snails) and other plant pests on plant yield and quality

- Improve and enhance the use of natural enemies, including microbial biological control agents, to manage plant pests
- Develop and improve integrated control tactics and systems to manage plant pests or pest complexes in an economically, socially and environmentally sound manner
- Increase knowledge and impact of insects, ticks, mites, and other pests that are a threat or annoyance to human health and develop safe, effective and economical control measures

Actionable Strategies:

- Assist the Animal and Plant Health Inspection Service in supporting the development, validation, and deployment of new identification devices and tests that:
  - are operationally robust;
  - can rapidly detect pathogens, toxins, and other contaminants that threaten livestock poultry, plant/crops and food; and
  - can be used by producers, processors, veterinarians, diagnosticians, and regulatory agencies
- Sponsor research, education, and information transfer on the transmission and epidemiology of animal and plant diseases to rapidly develop and apply strategies for controlling disease outbreaks
- Intensify research, education, and extension efforts to rapidly identify pests and diseases that enter the United States
- Support development and increase capacity and capability of national diagnostic laboratory networks for crops and livestock that can rapidly detect pathogen outbreaks, and support work with APHIS to more effectively prepare for, prevent, respond to, and recover from animal and plant disease outbreaks
- Support an increase in scientific monitoring for a broader array of emerging agricultural pests and diseases
- Support the strengthening of surveillance systems for plant and animal pests and diseases to minimize spread beyond the original area of introduction and minimize economic and environmental risk
- Sponsor research, education, extension, and the dissemination of results on:
  - The role of genes, proteins, and nutrients in the immune systems of animals and plants;
  - Microorganisms, pathogens, and toxins that can contaminate foods;
  - Advanced, rapid, accurate, and cost effective diagnostics, protections, treatments, and monitoring technologies; and
  - The development of practices to improve the management, control, and prevention of pests and diseases
- Sponsor research, education, and extension on effective real-time cleaning and disinfecting technologies to limit or contain the spread of infectious materials, and isolate and contain potential outbreaks

- Sponsor research using traditional breeding and biotechnology to develop new or enhanced varieties and germplasm with enhanced pest resistance
- Support the recruitment, retention, training, graduation, and placement of the next generation of research scientists, educators, and practitioners in the food and agricultural sciences
- Sponsor research and dissemination of science-based information on:
  - the efficacy of chemical usage to fight pests and disease
  - the development of strategies to minimize the need for chemical pesticides that negatively affect the environment and human health
  - the development of knowledge to support approval and registration by the Environmental Protection Agency of safe and effective disinfectants and pesticides
- Sponsor research and education on the use of antimicrobial agents in the food production chain and their effects on the development of antimicrobial resistance

This portfolio has one performance measure that indicates the portfolio's progress toward its mission. This performance measure was carefully developed by portfolio team members. This performance measure was not developed for the purpose of aligning with the Agency's strategic plan, but this measure along with those identified in the strategic plan broadly support the mission of the Agency and the portfolio. The performance measure is reported to the Office of Management and Budget annually, as well as other portfolio performance measures, to indicate progress toward the Agency's mission.

Performance Measure Description: High Consequence Plant and Animal Pests and Diseases

Explanation of Measure: The number of high-consequence pest and disease threats that affect animal, plant and human health and impact the national economy that the integrated National Plant Diagnostic Network and the National Animal Health Laboratory Network diagnostic labs are prepared to detect and diagnose.

Baseline (FY 2002): 6	**Target**	**Actual**
Fiscal Year 2003	3	3
Fiscal Year 2004	9	9
Fiscal Year 2005	12	12
Fiscal Year 2006	14	14
Fiscal Year 2007	15	15
Fiscal Year 2008	17	17
Fiscal Year 2009	18	
Fiscal Year 2010	20	
Fiscal Year 2011	21	
Fiscal Year 2012	22	

Plant Systems Logic Model

Plant Systems

Situation	Inputs	Activities	Outputs	Outcomes		
				Knowledge	Actions	Conditions
- New agricultural production and plant protection methods are needed to improve upon agricultural products, the environment, human health and well being and the communities. - Value and usefulness of plants produced and plant protection methods need improvement. - Plant production yield & yield stability Need improvement. - Plant production and plant protection efficiency needs improvement. - Environmental friendliness, benefits, and sustainability of plant production and plant protection methods need improvement. - Plant biosecurity needs improvement.	Funds: - **Federal** - **State** - **S**ome provide funding that contributes to research Human Capital: - NPLs - Extension personnel - Faculty - Researchers - Paraprofessionals - Stake holders (Industry, etc.) - Volunteers	Problem Areas: 201, 202, 203, 204, 205 & 206; 211, 212, 213, 214, 215 and 216 -- Proposals & Plans of Work: - solicited - reviewed. - funded - Research conducted - Experiments conducted - Training/ Education provided - Extension provided	- Research, education and extension findings vetted by scientists - Research, education and extension findings submitted to CSREES Research findings disseminated - Publications - Citations - Patents - Best management practices - Curricula - Undergraduate and graduate education training provided to producers - Germplasm - Plant varieties	- Expanded knowledge base - Plant production methods - Products - Plant Protection methods - Trained workforce - Sharing knowledge - Exchanging experience among producers	Changes in: - knowledge - attitudes - skills - motivation - decisions regarding: - new discoveries - new plant production and protection approaches & methods Changes in: - behavior - practices - management Use of input that: - improves plant production and protection, plant products, and economic performance - change the way producers live and work	- Improved economic performance of producers - National plant production and protection-related problems solved - Long term protection of food and plant biosecurity

Assumptions - CSREES has the funds, personnel and facilities to facilitate plant production and plant protection efforts. There is a need to collaborate with lateral partner organizations and agencies.

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.

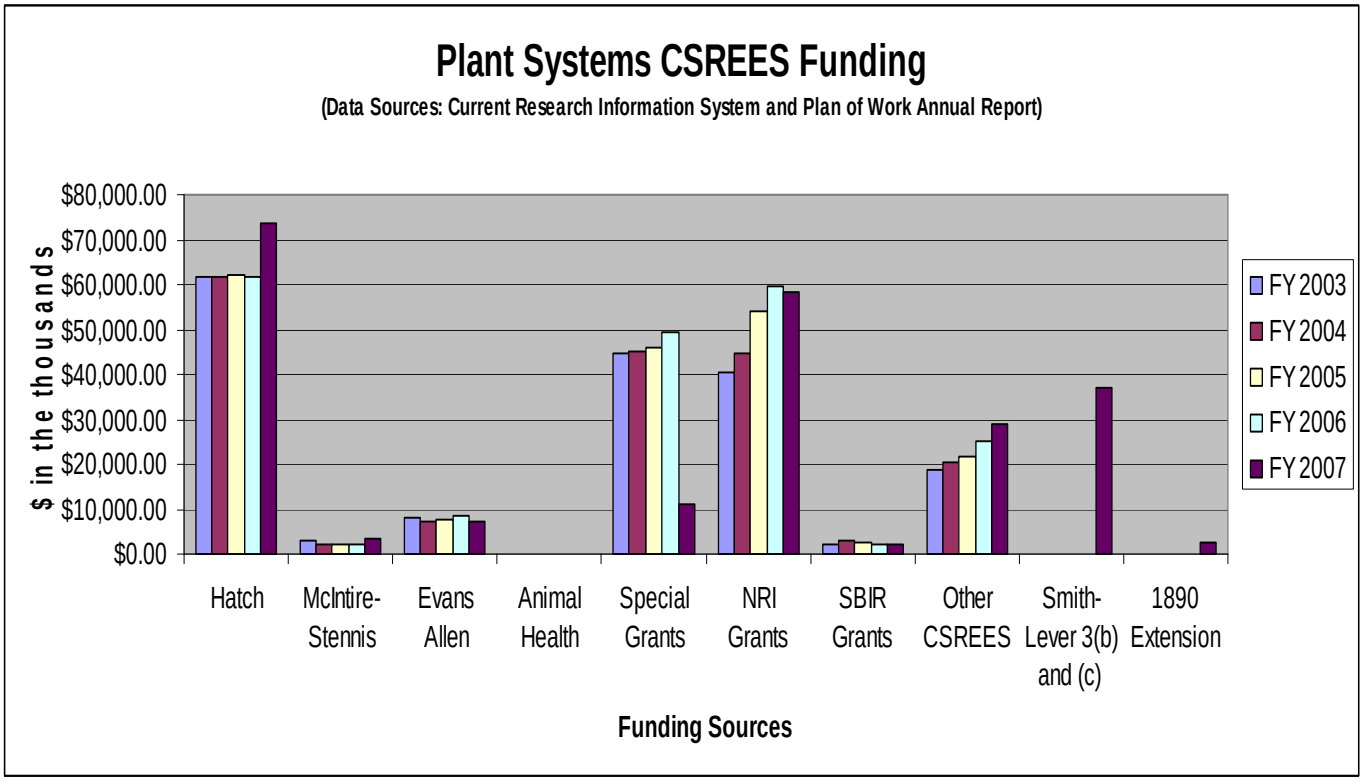
Portfolio Inputs

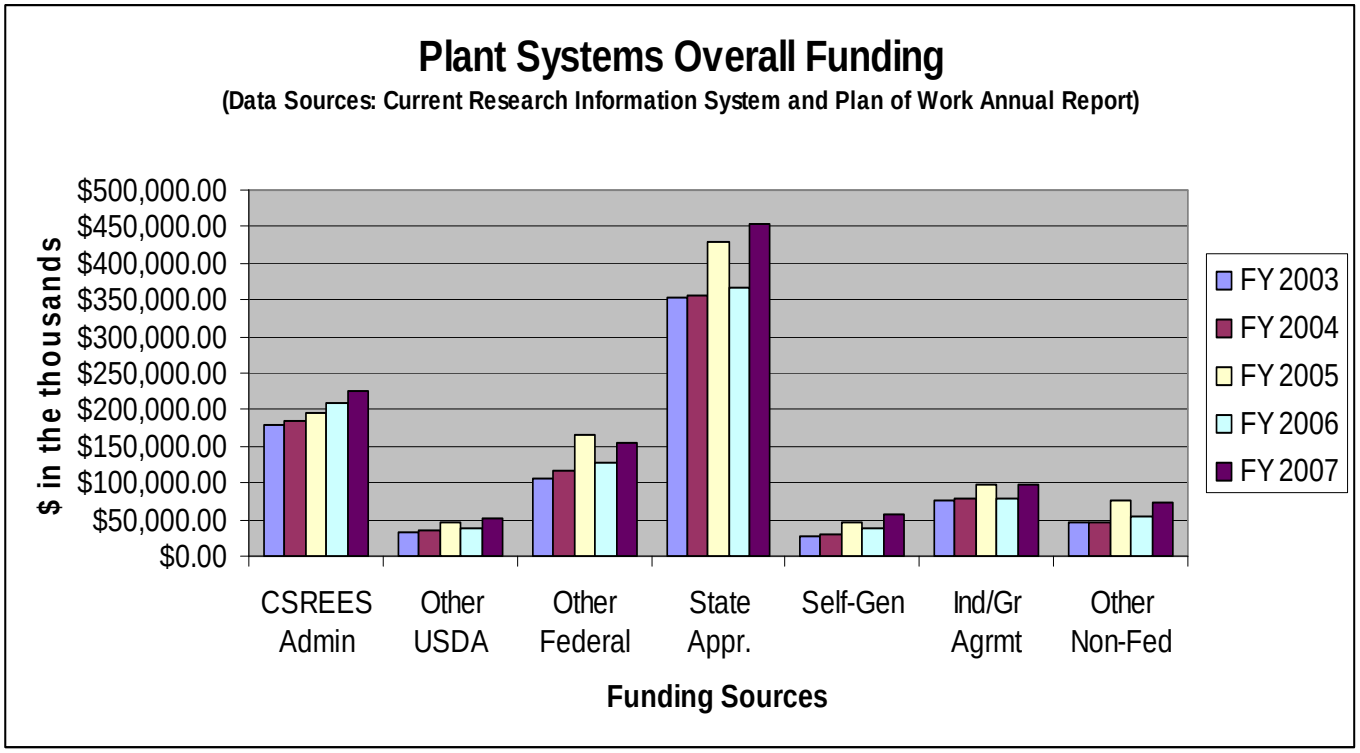
Agency funding data for fiscal year 2007 was collected from the Current Research Information System (CRIS) and the Plan of Work (POW) annual report. Fiscal year 2007 funding data includes Smith-Lever 3(b) and (c) and 1890 extension funding, which were not otherwise accounted for in FY 2003 – 2006. Agency funding data for fiscal years 2003 through 2006 were collected from CRIS only.

Portfolio Level Funding Table and Bar Chart

Table 1: Plant Systems Portfolio Summary Funding Table
Combined Research and Extension Funding

Funding Sources	($ in the Thousands)					
	FY 2003	**FY 2004**	**FY 2005**	**FY 2006**	**FY 2007**	**Grand Total**
All CRIS Reported CSREES Funding	$178,847.00	$183,993.00	$195,917.00	$208,418.00	$184,799.00	**$951,974.00**
All Extension Funding Reported in POW	n/a	n/a	n/a	n/a	$39,847.49	**$39,847.49**
All non-CSREES Funding	$637,813.00	$664,165.00	$863,890.00	$700,975.00	$886,980.66	$3,753,823.66
Total Funding	$816,660.00	$848,158.00	$1,059,807.00	$909,393.00	$1,111,627.16	$4,745,645.16
Percentage of CSREES Funding	22%	22%	18%	23%	20%	21%


Plant Systems CSREES Funding
(Data Sources: Current Research Information System and Plan of Work Annual Report)
$ in the thousands
$80,000.00
$70,000.00
$60,000.00
$50,000.00
$40,000.00
$30,000.00
$20,000.00
$10,000.00
$0.00
Hatch
McIntire-Stennis
Evans Allen
Animal Health
Special Grants
NRI Grants
SBIR Grants
Other CSREES
Smith-Lever 3(b) and (c)
1890 Extension
FY 2003
FY 2004
FY 2005
FY 2006
FY 2007
Funding Sources


Plant Systems Overall Funding
(Data Sources: Current Research Information System and Plan of Work Annual Report)
$ in the thousands
$500,000.00
$450,000.00
$400,000.00
$350,000.00
$300,000.00
$250,000.00
$200,000.00
$150,000.00
$100,000.00
$50,000.00
$0.00
CSREES Admin
Other USDA
Other Federal
State Appr.
Self-Gen
Ind/Gr Agrmt
Other Non-Fed
FY 2003
FY 2004
FY 2005
FY 2006
FY 2007
Funding Sources

Discussion of changes in funding

A shift of earmarked funds to Hatch Formula Funding in 2007 resulted in an approximate $13 million increase in Hatch dollars devoted to plant systems research activities. Slight increasing trends in funding from 2003-2007 were seen for special grants (except for 2007, where special grants funds were generally not appropriated), National Research Initiative (NRI) grants, other CSREES funds, CSREES administrative funds, other USDA funds, other federal funds, state appropriations, self-generated funds, individual grant agreements, and other non-federal funds.

Portfolio Results

Plant Systems Portfolio Outcomes

Plant Production

New Test Kits Help Manage Farm Nitrate Levels
A company in Michigan, with support from the CSREES SBIR program, developed a series of test kits that allow farm managers to see how nitrate is accumulating and moving in the farm ecosystem. The company conducted a market research study to determine how to most effectively inform Michigan farmers about the latest nitrate management strategies and tools available. In addition, scientists tested the accuracy of the test kits and published the results of their study in peer-reviewed scientific journals.

New Technology Improves Native Grass Seed Harvest
A company in Montana, with support from the CSREES SBIR program, developed new equipment to efficiently harvest grass seed. The company developed and patented a system of counter-rotating combs and brushes to effectively dislodge seed from difficult-to-harvest grass species. Using an integrated dislodgement and conveyance mechanism mounted on a tractor, the system uses air flow along with brushes and combs to thrust dislodged seed into a collection hopper. This design was developed in 2007 and it is particularly appropriate for tall grass species such as switchgrass.

Tree Wound Healing and Formation of Wood Grain
Scientists in Massachusetts, with support from CSREES/NRI, determined how the plant growth hormone auxin forms a gradient around wound sites in trees. The auxin gradient triggers the reorientation of wood-forming cells thus directing water and nutrient conducting tubes of newly formed wood around the wound. This work will help scientists to improve the resistance of trees to drought conditions, develop trees with consistent wood grain patterns that result in stronger lumber, and develop specialized wood grain patterns for ornamental purposes.

Plant Protection

Biological Control Agents Instrumental in Reducing Mole Cricket Levels in Florida
Exotic pests continue to pose threats to American agriculture and well being, making continued efforts in importation biological control relevant and necessary. With support from Hatch

funding, establishment of three biological control agents released in the 1980s against pest mole crickets was documented by a 25-year monitoring effort that ended in summer 2004. The data showed a long-term decline in populations of pest mole crickets over this 25-year period to just 5 percent (in 2000-2004) of their average numbers observed during the 1980s. The emphasis in that part of the program is now to spread the biological control agents everywhere in Florida, to encourage county extension faculty to adopt their use in integrated pest management programs, and to make these biological control agents available to collaborators in other states (Alabama, Georgia, Louisiana, and Texas, and potentially others) and Puerto Rico.

Egg Parasitoids Reduce Corn Earworm levels in corn

Trichogramma species present in Hawaii, and attacking eggs of the corn earworm, *Helicoverpa zea* in seed corn production in Hawaii, were collected, identified and mass reared in laboratory colonies with support from Hatch funding. Two species, *T. achaeae* (new record for Hawaii) and *T. papillionis*, were mass reared and experimental augmentative releases were conducted in seed corn plots to determine which of these species had the greatest potential to suppress *H. zea*. Outreach efforts resulted in increased seed corn grower awareness of the effects of egg parasites of the corn earworm in their crops. Promising results were obtained, with *T. papillionis* providing the highest levels of field parasitism following augmentative releases. As a result, pesticide applications for *H. zea* control in seed corn were reduced by approximately 90 percent.

Countering Insect Resistance with Designer Bt Toxins

Researchers at the University of Arizona, with support from CSREES/NRI, determined that resistance to Bt toxin in bollworms occurs when mutations inhibit the binding of a gene product called cadherin to the toxin. The researchers designed and created a modified toxin and showed that resistant bollworms were killed by the modified toxin. The results suggest that modified toxins may be useful for countering or delaying resistance to standard Bt toxins in caterpillar pests. The impact of Bt toxins for pest control with the threat of resistance mounting is that the modified toxins could help to protect the nation's food supply and promote sustainable, environmentally friendly agriculture.

Researchers Unmask How Harmful Soybean Parasite Operates

Scientists at the University of Missouri and Iowa State University, with support from CSREES/NRI, have uncovered the mechanisms of the soybean cyst nematode for weakening the host plant's defense system. The nematode injects secretions into plant root cells that create specialized feeding cells necessary for growth and development of the nematode. The scientists screened 35,611 soybean genes and found 1,765 soybean genes that underwent altered expression within two days of formation of the special feeding cells for the nematode. The researchers studied interactions between plant hormones and found that a decrease in the production of a plant hormone called jasmonic acid may suppress the plant defense response which allows the nematode to survive and thrive. These findings should provide scientists the key to decipher which genes play essential roles in the induction, formation, and function of the special feeding cells for the survival and growth of cyst nematodes.

Bioengineering Root-Knot Nematode Resistant Plants

Scientists at the University of Georgia, with support from CSREES/NRI, have discovered the molecular tools used by root-knot nematodes to infect plants. The scientists identified a

parasitism gene in the root-knot nematode essential for the nematode to infect crops. Using a technique called RNA interference (RNAi), the researchers have effectively turned the nematode's biology against itself. The scientists genetically modified the plants to produce a double-stranded RNA that silences or shuts down the specific parasitism gene when the nematode begins to feed on the plant's roots. This disrupts the nematode's ability to infect the plant and renders the plant resistant to the nematode. The resistance gene is effective against the four most common species of root-knot nematodes.

Plant Systems Portfolio Leadership and Management

CSREES works closely with stakeholders who have interests in issues impacting plant systems including plant production and plant protection. Both formal and informal mechanisms are used to obtain stakeholder input. These may include stakeholder workshops, symposia, technical reviews, peer panel recommendations, presidential directives, interagency agreements, and strategic plans for plant systems. CSREES and its educational partners conduct stakeholder listening sessions in order to assess program effectiveness and directions and to identify new and emerging issues.

Stakeholder Interaction

Plant systems programs at CSREES have been developed and updated using extensive stakeholder input. CSREES sought stakeholder input for its plant systems programs through a variety of mechanisms. Recent examples include:

Plant and Pest Biology Stakeholder Workshop 2007. CSREES sponsored a workshop in November, 2007, on stakeholder priorities in the area of plant and pest biology in Alexandria, Virginia. The workshop -- attended by scientific societies, commodity groups, and other organizations -- allowed stakeholders to present their research, education, and extension priorities.

Rosaceae Specialty Crops Planning Workshop, 2007. A workshop was held at Michigan State University in June, 2007, to develop a strategy for the integration of genomics science and crop breeding in Rosaceae fruits. Breeders, growers, and scientists representing genomics, plant physiology, plant pathology, pomology, and extension identified key steps for addressing current knowledge gaps in fruit crop breeding.

Engineering Solutions for Specialty Crop Challenges Workshop. CSREES co-sponsored a workshop on "Engineering Solutions for Specialty Crop Challenges," April 24-25, 2007, in Arlington Virginia. Representatives from various specialty crop industries and from several federal agencies planned and organized the meeting. Attendees included federal program managers, specialty crop industry producers and representatives, and researchers, educators, and outreach specialists from numerous universities.

International Wheat Genome Sequencing Consortium, 2008. CSREES participated in a workshop of the International Wheat Genome Sequencing Consortium at the Plant and Animal Genome XVI Conference in San Diego, California, January 2008. Discussion included

information on agricultural research for wheat production and utilization using DNA-based tools and resources.

Workshop on the ARS Overseas Biological Control Laboratories (OBCL), 2008. CSREES participated in an ARS Stakeholder Workshop in Miami, Florida, on May 19, 2008, to examine the programmatic and personnel management of the ARS Overseas Biological Control Laboratories (European Biological Control Laboratory, France and satellite laboratories; South American Biological Control Laboratory, Argentina; Australian Biological Control Laboratory, Australia; and Sino-American Biological Control Laboratory, China). Discussion topics included: National Program Staff oversight of foreign labs; managing the overseas labs; ARS laboratory in Panama: a model for the OBCLs; increased stakeholder understanding of OBCL services; funding; determining goals and improving linkages with U.S. partners; and project coordination and prioritization of target pests.

NP 304 Crop Protection and Quarantine National Program Workshop. CSREES participated in an ARS Stakeholder Workshop in Miami, Florida, May 20-23, 2008 to initiate the next 5-year cycle of the Crop Protection and Quarantine National Program (304). Stakeholder participants learned about the current national program structure and focus, and provided inputs for its refinement; developed a better understanding of crop protection and quarantine issues relating to insects, mites and weeds important to customers, stakeholders, and partners; identified and prioritized areas for increased research emphasis, emerging issues and critical gaps as well as those issues that may be de-emphasized; and strengthened professional and interpersonal relationships with other meeting participants.

Conservation of Insect Genetic Resources. CSREES participated in an ARS briefing in Washington, DC, on September 12, 2008, to learn more about current activities related to conserving insect genetic resources. Topics of discussion included: vulnerability of insect genetic resources; a summary of the conservation status and risk poised by not protecting insect genetic resources; storage technology for insect genetic resources; the status and research needs for cryopreserving insects; transgenic resources; population status and vulnerability; repository for insect collections; and facility and database needs for developing useful insect collections.

Plant Systems Programmatic or Management Shortcomings

Duplication of effort and activities across agencies. Several agencies are involved in the early detection and rapid response to plant pests and disease. These include the Animal and Plant Health Inspection Service/Plant Protection and Quarantine, the Agricultural Research Service, the CSREES/land grant university partnership, the U.S. Forest Service, and the U.S. Geological Survey. Interagency committees of the National Science and Technology Council could address the issue of duplication of effort and activities across agencies.

Lack of coordination of research, education and/or extension activities across units and programs within CSREES. Formation and organization of the National Institute of Food and Agriculture provides an opportunity to improve coordination of research, education, and extension activities. Closer attention to communication, balance and integration between

programs in basic and applied research is necessary before integration of research with extension can meaningfully occur.
Lack of strategic planning for research across federal agencies. This is a separate issue from detection and response activities mentioned above. Systems biology and metabolic engineering of plants are examples of growing fields that could have significant impacts on food, agriculture, medicine, bioenergy, and the environment. Revival of currently inactive subcommittees within the Committee on Science of the National Science and Technology Council could address this issue.

Lengthy timeframe for review and approval of requests for applications (RFA). The duration and timing of RFA reviews seems to be driven by factors other than service to the scientific and educational communities. This can lead to shortened notification periods for research/education/extension solicitations and result in lower quality proposals. Options for expediting RFA review and approval could be explored and implemented in the transition to the National Institute of Food and Agriculture.

Key Future Activities and Changes in Direction

Specialty Crop Research Initiative
Specialty crops are defined in the Specialty Crops Competitiveness Act of 2004 (Public Law 108-465, and modified in the Food, Conservation, and Energy Act of 2008, Pub. L. 110-246) as "fruits and vegetables, tree nuts, dried fruits, horticulture, and nursery crops (including floriculture)." One of the findings of the Act is that "a secure domestic food supply is a national security imperative for the United States." Furthermore, three out of five components of USDA's food pyramid included specialty crop foods, so they represent a critical portion of the recommended nutritional program for U.S. citizens. Without a strong and viable specialty crop industry in the United States, a significant portion of our nation's nutritional base would be reliant exclusively on foreign markets. This puts readily available and affordable health-conscious foods at risk for U.S. citizenry. Specialty crops are also a significant and important part of the U.S. agricultural economy. As a percentage of total agricultural production, specialty crops represent a substantial revenue stream for many states and counties. Recognizing the importance of specialty crops, the 2004 act established a permanent specialty crop committee on the National Agricultural Research, Extension, Education, and Economic Advisory Board (NAREEEAB) and charged the committee to prepare an annual report to counsel USDA on research, extension, and economics programs related to specialty crops. Two reports have been published to date (http://NAREEEAB.ree.usda.gov).

The Specialty Crop Research Initiative (SCRI) is authorized by Section 7311 of the Food, Conservation, and Energy Act of 2008, which establishes a specialty crop research and extension initiative to address the critical needs of the specialty crop industry by developing and disseminating science-based tools to address needs of specific crops and their regions. This legislation calls for mandatory expenditures of $230 million over fiscal years 2008-2012 across the following five focus areas:

1. Research in plant breeding, genetics, and genomics to improve crop characteristics;

2. Efforts to identify and address threats from pests and diseases, including threats to specialty crop pollinators;
3. Efforts to improve production efficiency, productivity, and profitability over the long term (including specialty crop policy and marketing);
4. New innovations and technology, including improved mechanization and technologies that delay or inhibit ripening; and
5. Methods to prevent, detect, monitor, control, and respond to potential food safety hazards in the production and processing of specialty crops, including fresh produce.

Specialty crop industry problems (and their solutions) must be viewed, and treated, as systems of interrelated processes, participants, institutions, collaboration, and technologies in a comprehensive manner. This vision of a systems-based approach consists of a hierarchical taxonomy of systems, which, in total, define a "producer-to-consumer" system. The primary specialty crop systems – crop production, processing and distribution, and consumers and markets – appear at the highest level, with specific subsystems found within each. Emphases would be placed on efforts that focus on an entire primary system of where two or more of the primary systems overlap/intersect. At the most specific level of the hierarchy, one finds traditional, disciplinary research, development, and application efforts (i.e., more narrowly focused investigation), which would also be envisioned as part of this initiative. With sustainability as an umbrella goal for the industry, the principles of systems thinking, trans-disciplinary scientific approaches (bridging biological, physical, and socio-economic disciplines), and effective outreach are essential for meeting stakeholder needs.

Organic Research

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. CSREES addresses organic agriculture through formula funds and competitive funding, such as the Integrated Research, Education, and Extension Program--Integrated Organic Program; the Integrated Research, Education, and Extension Program--Organic Transitions Program; and the Organic Agriculture Research and Extension Initiative.

Energy Research

USDA energy programs range from basic scientific research to the development and commercialization of new technologies. From more efficient farming techniques, wind farms, and ethanol plants to biochemical and genomics research, USDA is deeply involved in the nation's quest for energy security. CSREES supports research on plant feedstock genomics for bioenergy and improved plant feedstock production. Future production challenges include production of ethanol from a variety of plant feedstocks, lowering production costs of cellulosic ethanol, and increasing conversion technology options. Future research foci include improved sugar recovery and conversion, reduction of enzyme costs, faster fermentation times, and improved yield of ethanol per ton of plant feedstock.

Climate Change Research
One of the most pressing issues faced by plant producers is to adapt to the ever-changing conditions and impacts of global change and climate on their crops. Another critical issue is the need for scientific information that producers can use to plan and make decisions to ensure economic viability. CSREES-supported global change and climate projects are addressing these issues through research, extension, and education activities.

Conservation of Biodiversity
CSREES works in partnership with the National Institutes of Health, the National Science Foundation, and the Department of Energy, in supporting biodiversity research through the International Cooperative Biodiversity Groups (ICBG). This organization was established to address the interdependent issues in biodiversity exploration for applications in health, agriculture, and energy while supporting the sustainable use of these resources and enhanced economic growth. Sustainable agriculture goals include the discovery and development of new crop protection or animal health agents from natural products, or the production of biobased products, such as ethanol for bioenergy. Sustainable agriculture goals also include promoting the preservation of the environment and the long term profitability of farming.

Bio-Based Pest Management
The ability of the United States to produce, store, ship, and trade agricultural products is limited by the degree to which pests can be controlled. Although vital to the health of agriculture, pest control using synthetic pesticides can have adverse effects. Harm to humans and the environment can occur as a result of chemical contamination from these pesticides. Biobased management is the control of pests using one or more of five major tactics: 1) biological control--suppression of pests by using natural enemies (predators, parasites, competitors, and diseases), 2) microbial pesticides, 3) behavior-modifying chemicals, 4) genetic manipulation of pests, and 5) host plant resistance. CSREES supports research in biobased pest management, which has the goal of providing safer and more effective methods of controlling pests while reducing our reliance on synthetic pesticides. Other agronomic or exclusionary tactics, such as date of planting, crop rotation, intercropping, and early maturing varieties, are based on knowledge of the interactions among pests, beneficial organisms, and crops. These tools may further enhance the success and implementation of biobased pest management approaches.

Conservation of Ecosystem Goods and Services
Agricultural production is dependent on many ecosystem services, such as nutrient cycling, pest control, and pollination. Management of agroecosystems can enhance or degrade the ability of these systems to provide ecosystem services, such as clean water and air, habitat and food sources for biodiversity, soil conservation, carbon sequestration, disease and invasive species suppression, and climate regulation.

The future viability and long-term sustainability of agriculture depends on how effectively we understand and manage the social, economic, ecological, and policy elements of agricultural ecosystems. The future of agriculture is dependent on acquiring a more balanced approach to the management of these systems, one that optimizes the production of agricultural goods and services. Fundamental questions need to consider human design and engineering of ecological processes in whole ecosystems, emergent behavior, and the dynamics on interacting agricultural,

natural, and socioeconomic systems. A research portfolio directed toward conservation of ecosystem goods and services would allow for collaborative management of ecosystem services topics at multiple levels—from specific services (e.g., clean water, species habitat, and nutrient flows) to complex multiple service systems.

Invasive Species

Invasive species constitute one of the most serious economic, social, and environmental threats of the 21st century. Nearly every terrestrial, wetland, and aquatic ecosystem in the United States has been invaded by non-native species, with economic losses estimated at $137 billion per year. Detections of invasive species are increasing annually and highly damaging species are rapidly extending their range across the country. Global climate change will continue to further exacerbate the spread of invasive species.

CSREES is actively engaged in the battle against invasive species 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 the IPM Centers; establishment and operation of the National Plant and Animal Diagnostic Laboratory Networks and the Integrated Pest Management - Pest Information Platform for Extension and Education (ipmPIPE); Hatch funding of Agricultural Experiment Station Projects; and through the administration of special grants concerning invasive species.

In April 2007, members of the CSREES Invasive Species Working Group prioritized research, education and extension activities identified in the 2008-2012 National Invasive Species Management Plan (**http://www.invasivespeciesinfo.gov/council/mpdraft07.pdf**) that would strengthen our Agency's efforts to address invasive species on a more comprehensive front. These included:

- Improve and support recruitment and training of volunteers for early detection and rapid response efforts at the local level, utilizing existing programs and infrastructure (e.g., Master Gardeners, Master Naturalists, National Wildlife Refuge "Friends" Groups, 4-H Groups, and National Park Support Groups).
- Engage risk assessment experts to provide authoritative and timely assessments of current or potential invasions.
- Develop and evaluate the use of predictive models to forecast the spread of specific invasive species.
- Improve economic modeling of control and management actions to determine their costs and benefits.
- Develop and provide portal and reference information, as well as public access to federal research information, as appropriate and consistent with applicable law.
- Work with existing educational organizations to enhance invasive species information delivery to primary and secondary educators.
- Improve federal research capacity and coordination to address a broader array of invasive species issues.

The magnitude of the problem and ever increasing threats of invasive species to the economic, social, and environmental well-being of U.S. agriculture, human/animal health, and natural

resources necessitates that CSREES increase its investment in research, education and extension activities in the future relative to invasive species.

Nanotechnology

Nanotechnology is the science of studying and producing materials and devices of nanometer size--about the size of a small molecule or individual atom. It enables the development of future inventions across a vast array of fields. By 2015, the global impact of products where nanotechnology plays a key role will be approximately $1 trillion annually and will require a highly trained workforce of two million. CSREES' involvement in nanotechnology includes four grant programs that fund nanotechnology research projects. CSREES also participates as a USDA and agency representative on the Nanoscale Science, Engineering, and Technology Subcommittee of the White House National Science and Technology Council and as a member agency in the National Nanotechnology Initiative. Many federal agencies are working together through this initiative to develop a comprehensive research, education, and outreach approach to this relatively new scientific field.

What Others Are Doing in Plant Systems

Plant Genome Interagency Working Group

Interagency Working Group 5 -Year Plan, National Plant Genome Initiative: 2003 – 2008.

The Interagency Working Group on Plant Genomes, under the auspices of the Committee on Science of the National Science and Technology Council (NSTC), along with the Office of Science and Technology Policy (OSTP), coordinates activities, guidance, and oversight of the National Plant Genome Initiative (NPGI). Participating agencies include the USDA (CSREES, ARS and FS), NSF, DOE, NIH, USAID, OSTP, and OMB. Each agency contributes to the development of the NPGI plans and participates in its activities in a manner consistent with its specific mission and based on available resources. The IWG on Plant Genomes continues to provide strong leadership and stewardship for NPGI activities, ensuring continued world-class research and training as reliance on plants increases for materials, energy and fuels. Exciting new discoveries include: the finding that genetic variants of tropical corn have novel sugar composition with potential uses for biofuel production; new opportunities for improved agricultural practices in peanut breeding; fruit tree cultivar development; as well as breeding of disease resistant and salt tolerant plants; advances in the development of innovative technology to enable automated, high-throughput analysis of plant growth and development; and a novel X-ray system to analyze root development. Continued advances in both biological discovery as well as technology development serve as a key resource for plant systems research to address the challenges of increasing population, decreasing agricultural land area, and the impacts of climate change.

***National Science Foundation* - Plant Genome Research Program (PGRP)**
http://www.nsf.gov/pubs/2006/nsf06581/nsf06581.htm

The Plant Genome Research Program supports basic research in plant genomics

- Utilizes knowledge gained to explain fundamental biological processes in plants with a focus on plants of economic importance and plant processes of economic value.

Plant Sciences, Inc. http://www.plantsciences.com/index_flash.html

Plant Sciences, Inc. is an agricultural consulting, research, and production company

- Programs include breeding and propagation of fruit and vegetable varieties, development of crop management practices, and applied biotechnology techniques.

Donald Danforth Plant Science Center http://www.danforthcenter.org/default.asp

The Danforth Plant Science Center is a non-profit research institute that focuses on providing research with a global impact.

- Research focus areas are as follows: developing new materials and products in plants, adapting plants for environmental stresses, enriching the nutritional value of foods, and controlling plants pests and pathogens.

United States Department of Agriculture – Agricultural Research Service (ARS)
Plant Science Institute http://www.ars.usda.gov/Main/site_main.htm?modecode=12-75-00-00

The Plant Sciences Institute research programs seek to:

- Improve pest management systems, crop quality, and production efficiency; support research which will lead to new varieties
- Improve food quality and food safety; improve conservation of natural resources and environmental quality; support regulatory and action agencies
- Respond to research needs identified by farmers and other customers and stakeholders; and contribute to advances in biotechnology and other areas of plant science with societal benefits.

Section II: Primary Knowledge Areas

Knowledge Area 201: Plant Genome, Genetics, and Genetic Mechanisms

KA 201 Introduction:
This area focuses on development and dissemination of fundamental information in plant genetics and plant breeding technology with the purpose of making plant breeding more efficient and productive, and includes related technologies such as genomic database management. Areas of work include but are not limited to genome sequencing and mapping; genetic structure, organization, and function; comparative and translational genomics; gene identification and manipulation; genetic markers and marker assisted selection for breeding; quantitative trait loci (QTL) analysis; genetic structures and mechanisms; inheritance of traits; and bioinformatics and databases.

KA 201 Logic Model:

KA 201: Plant Genome, Genetics, and Genetic Mechanisms

Situation	Inputs	Activities	Outputs	Outcomes		
				Knowledge	Actions	Conditions
Genomic, genetic and breeding knowledge and techniques accelerate the acquisition of new knowledge & innovative approaches to enhance the scope & efficiency of plant production and protection. Having the right plants for the job is a major component of our ability to meet national agricultural goals, such as economic opportunities for farmers and ranchers, a secure food supply, a healthy population, responsibly-managed natural resources, & a protected environment. Plants serve purposes ranging from food to industrial feedstock. We need to increase food production for the growing world population utilizing new methods that minimize negative environmental impacts associated with some agricultural practices. There is increasing need for new crop plants with traits suitable for emerging applications such as biofuel production.	**Funding Sources:** - Federal - State - Commodity groups - Industry - Other sources **Human Capital**: - CSREES NPLs - Administrative support - Teachers - Researchers - Graduate students - Stake holders	- Develop tools and reagents useful to biologists & breeders - Utilize tools to understand genome wide function - Sequence agriculturally relevant plant genomes - Implement large-scale plant translational genomics Coordinated Agricultural Projects (CAPs) to bridge the gap between genome researchers & plant breeders enabling the U.S. to be at the forefront of applied plant genomics, genetics, & breeding research, education & extension	Research, education and extension outputs - vetted by scientists and educators -submitted to CSREES - Research findings disseminated - Publications - Citations - Disclosures - Patents - Best management practices - Curricula designed - Undergraduate and graduate students graduate - Training provided to producers	Increased level of knowledge & understanding about: - Gene structure and organization on both the genetic and physical map - How genes, gene networks or genetic mechanisms affect agricultural traits - Agricultural traits that are directly useful to breeders that lead to the development of useful cultivars - New or improved high-throughput genotype and phenotype technologies	- More plant genome sequence information available; more genes identified - More detailed info from diverse plant genomes including grain, fruit, vegetables and trees - More genes identified in hard-to-work with and understudied plants such as trees & horticultural crops - Translational Genomics used in integrated REE projects with plant breeding; new crosses & novel source populations developed using knowledge from genomics & genetic mechanisms research - Educated, skilled, & motivated students, the human resources of the future	- More plant genome sequences known; more genes identified; detailed genomic information from additional species - Advanced knowledge of a wide range of genetic mechanisms in plants - Advanced plant breeding populations & new varieties developed using knowledge & methods from genomics & genetic mechanisms research - Highly qualified human resources & continued strong research capabilities

Assumptions - KA 201 occupies a strategic place in the R&D chain. Along with KA 206 (Basic Plant Biology), work in KA 201 captures & focuses initial results of basic research, such as funded by NSF, for the study of agricultural plants & microbes. CSREES accomplishes work on genomics, genetics, & genetic mechanisms by collaborating with partner organizations & agencies. CSREES personnel establish networks to conduct this research & to integrate it with plant breeding & other applied research, & with education & extension, develop materials & technologies useful to farmers, ranchers, processors, & consumers.

External Factors - National /foreign policy changes; domestic & international economic trends; costs to implement advances; cooperation of other federal agencies & state partners with CSREES; level and flexibility of funding; interest and ability of private sector in partnering. Success of partners in managing pioneering genomics-based integrated REE projects (CAP projects).

Key KA 201 Outputs and Outcomes

Wheat Applied Genomics
NRI Competitive Grant CRIS accession no. 0205761
Mission Area: Research, Extension, Education

The applied wheat genomics project is a consortium that includes public breeders from 25 states and four USDA-ARS genotyping centers. It has strong collaborations with GrainGenes, a publicly accessible suite of web services and databases for the triticeae. Since public wheat varieties account for 78% of the wheat production in the United States, the incorporation of modern marker assisted selection (MAS) techniques in these programs has a significant economic impact. The competitiveness of U.S. public wheat breeding programs is being increased by the utilization of high-throughput marker technologies that facilitate the rapid selection for important agronomic traits. With input from regional stakeholders, each breeder determines the most important traits to select through MAS and uses 5,000-10,000 marker analyses per year to accelerate their deployment. The traits selected include disease and pest resistance genes, quality traits, tolerance to abiotic stresses, and agronomic traits. The project has empowered 20 U.S. public wheat breeders to incorporate modern marker assisted selection techniques into their programs. Incorporation of modern selection technologies is essential to maintain the international competitiveness of U.S. wheat.

Key Outputs

- Project participants have published 20 papers in peer-reviewed journals and submitted 5 additional papers.
- Lecture presentations on MAS and 6 educational field trips for students.
- MAS talks in more than 120 field days, more than 70 presentations to growers and industry, and 11 hands-on workshops.

Outcomes

- The release of 37 improved germplasm and varieties, including two resistant against the new virulent race of stem rust UG99.
- The project has trained a large number of students, including 16 high school students, 59 undergraduate students, and 50 graduate students in genetics, breeding and molecular markers.

Barley Coordinated Agricultural Project: Leveraging Genomics, Genetics, and Breeding for Gene Discovery and Barley Improvement
NRI Competitive Grant CRIS accession no. 0206216
Mission Area: Research, Extension, Education

The Barley Coordinated Agricultural Project is a community effort of 30 scientists from 19 institutions with expertise ranging from genetics/genomics, breeding, pathology, databases, computer science, food science, malt quality, and statistics. This project has developed “The Hordeum Toolbox" (THT) a web portal that contains SNP, pedigree, and phenotypic data of germplasm from U.S. barley breeding programs. As a community resource, THT is integrating rapidly expanding SNP data sets with traditional phenotypic data, structural genomics, and gene

expression profile data sets available from PLEXdb (Plant Expression Database). Having markers linked to particular traits like yield, nutrition, malting quality and disease resistance is making breeding more efficient and effective because large populations can be screened quickly, even when traits are not visible. THT is harnessing the power of ten U.S. barley breeding programs, database technologies and genomics to identify important genes for barley improvement.

Key Output
A workshop on association genetics and marker-assisted selection (MAS) was held at the University of Minnesota, St. Paul, MN that consisted of lectures discussing aspects important to association genetics intermingled with demonstrations of software. Presenters included faculty and federal scientists from the University of Minnesota. The workshop was attended by 60 professionals from across the country. Attendees included industry personnel, USDA-ARS scientists, and university faculty, post docs, graduate students, and technicians. Student stipends were provided to ten of the 29 graduate students in attendance.

Outcome
The workshop helped participants to gain an understanding of association genetics and empowered participants to utilize these tools for plant breeding.

Development and Use of Novel Tools for Functional Genomic Analysis of Seed Storage Metabolism in the Model Genome *Medicago truncatula*
NRI Competitive Grant CRIS accession no. 0207345
Mission Area: Research

Medicago truncatula, is a model or reference species for legume genetics, genomics, and breeding. Legumes are a key to sustainable agriculture and are also a rich source of food and feed for humans and animals, respectively. Genomics and functional genomics technologies offer new ways of breeding legumes to improve food and feed quality. Transcriptomics research using DNA microarrays is enabling researchers to measure gene expression throughout the plant on a genome-wide scale. Bioinformatic analysis of microarray data yields insight into the potential role of genes and gene products in plant growth, development, and response to the environment.

Key Output
Researchers now have developed a novel repository of such data for the legume family called the "The Medicago Gene Expression Atlas". Data were generated for three biological replicates of all the major organ systems of this model legume using the Affymetrix *Medicago* GeneChip, which contains over 50,000 probe-sets for *Medicago* genes. The database is the most comprehensive set of transcriptome data available for any legume at present, and the database is being updated regularly with complementary data as it becomes available.

Outcome
This project has converted information from the analog world of a living *Medicago* plant to the digital realm of DNA microarrays.

Conifer Translational Genomics Network (CTGN)
NRI Competitive Grant CRIS accession no. 0211940
Mission Area: Research, Extension, Education

The Conifer Translational Genomics Network Coordinated Agricultural Project (CTGN-CAP) is an integrated research, education and extension project aimed at maintaining and enhancing healthy forests and ecosystems by bringing genomics-assisted breeding to application in the United States. CTGN-CAP is a collaborative effort of 20 scientists, tree breeders, post-doctoral fellows and graduate students representing eight university and government institutions. Participants include the Directors of the four largest cooperative tree improvement programs in the United States. Collectively, these cooperatives annually provide 1.3 billion improved seedlings for reforestation (~80% of commercial U.S. tree planting needs). Together with cooperative members and stakeholders, Directors have selected economic and adaptive traits for improvement, including growth, disease and insect resistance, and wood quality, and have identified 10,000 trees that will be genotyped for > 20,000 SNP polymorphisms representing over 6,000 genes. This effort should lead to verification of associations between genotypes and phenotypes in the elite breeding populations of loblolly and slash pines and Douglas-fir.

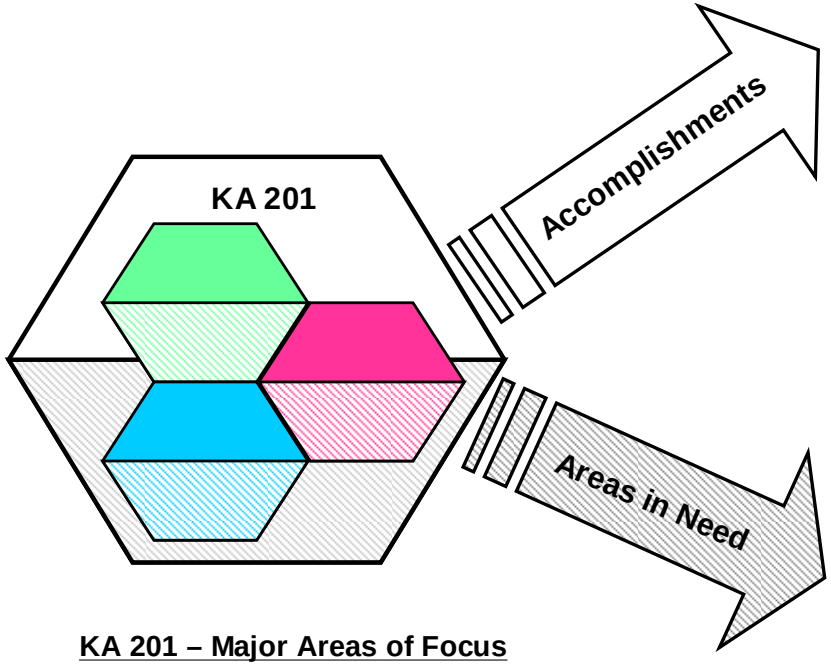
CTGN plans include hosting a week-long workshop on genomics-assisted breeding in forestry for graduate and post-graduate audiences. Presented in 10 separate modules, the workshop will provide both lecture and computer-lab experience on topics ranging from population and quantitative genetics to association mapping and marker assisted selection. Refined teaching materials will be made available to universities for classroom instruction.

Key Output
As part of their extension program, CTGN members in the first 9 months have given more than 25 presentations to nearly 1000 people representing forest plantation growers and owners, tree breeders, animal and crop breeders, cooperative members, international conference attendees and the lay public.

Outcome
Though still early in the project, high-throughput bioinformatics tools for resequencing analysis and SNP calling and SNP diversity and divergence measures are in use. A high-throughput, low cost DNA extraction facility is now available to handle current and future needs of the forestry research community.

KA 201 Honeycomb:

Knowledge Areas 201: Plant Genome, Genetics and Genetic Mechanisms



KA 201 – Major Areas of Focus

- Development of fundamental information in plant genetics and genomics and plant breeding technologies
- Development of plant genome databases and bioinformatics
- Development of knowledge of plant genetic mechanisms

- Report of the first sequence data for small RNAs in a crop plant rice, published in the journal *Nature Biotechnology*.
- A gene from wild wheat identified that increases the protein, zinc and iron content, published in the journal *Science*.
- Increased understanding of the mechanism of self pollination in tomato, published in the journal *Science*.
- Physical maps of the common bean (*Phaseolus vulgaris*) genome, published in the journal *Tropical Plant Biology*; and the apple genome, published in the journal *Genomics*.
- New knowledge of the effect of gene mutation and genome ploidy and its impact on the domestication of modern wheat varieties, published in the journal *Science*.
- Gene transformation method developed for the specialty crop chokecherry (*Prunus virginiana L.*), published in the journal of *HortScience*.

- Additional tools or methods for enhancing integration of basic research, applied research, education, and extension, including translational genomics
- Transfer knowledge gained from model systems (e.g. Arabidopsis) to agricultural species to develop genomic tools and resources for crop species
- Genome sequence for additional US crop groups e.g. wheat, barley, peach, apple, strawberry and common bean.
- Data handling and analysis capabilities (bioinformatics) for all crops
- Genomic tools repository (including plant genetic stocks) with curation and distribution
- Biology and genomics of crops for energy and industrial feedstocks

Knowledge Area 202: Plant Genetic Resources

KA 202 Introduction

This area focuses on discovery, acquisition, preservation, characterization, and development of plant genetic resources for plant production or protection. Both in-situ and ex-situ preservation methods are included, as well as preservation of species and within-species variation. Areas of work include but are not limited to: acquisition and preservation of genetic resources; germplasm characterization and evaluation, including screening for diversity or specific traits for production or protection; biosystematics/taxonomy; population genetics associated with germplasm preservation; gene pool enrichment and pre-breeding activities such as interspecific crosses, introgression of traits into breeding lines, increasing frequencies of desirable genes within crop gene pools, and adaptation of material to day length or other cultural requirements; long-term storage of genetic materials, including seeds and vegetative propagated materials.

The value of plant genetic resources is increasing because:

- Research in KAs 201, 206, and others provides new knowledge and tools to study and use diverse plant materials for genetic elements that enhance plant performance and quality
- The international political climate has made it increasingly difficult to acquire new plant genetic resources
- Climate change and national security concerns increase uncertainties facing agriculture and, consequently, the importance of diverse materials for adapting agriculture to unforeseeable changes
- Consumer interest in diversity, and advances in human nutrition research, are creating demand to diversify our foods

Note: Because access, characterization, and development of genetic resources are a part of all plant breeding, plant breeding projects have been asked to include KA 202 in their coding. As this coding practice becomes more widely observed, it will resolve previous difficulties in locating information about plant breeding projects.

KA 202 Logic Model

KA 202: Plant Genetic Resources

Situation	Inputs	Activities	Outputs	Outcomes		
				Knowledge	Actions	Conditions
Plant genetic resources are basic to meeting national goals for agriculture. Access to diverse plant genetic resources supports global trade, rural economic opportunities, a secure supply of agricultural products, a healthy population, responsible management of natural resources, and other goals. To contribute to these goals, plant genetic resources must be • Obtained by collection or exchange; • preserved and increased; and • characterized and developed for use "as is" or, most frequently, in breeding programs.	**Funding Sources:** - Federal - State - Commodity groups - Industry - Other sources **Human Capital**: - Researchers - Teachers - Graduate students -Farmers & Gardeners - CSREES NPLs - Administrative support	- Plant breeding with hulless barley genetic resources. State/federal research collaboration to quantify energy gains. Two-way communication between farmers and breeders through Extension. - Molecular studies to characterize diversity of wild vs. cultivated soybeans. - Tropical genetic resources used to enhance Northern Corn Belt genetic diversity. Graduate education. Outreach to Tribal Groups for genetic resources preservation. - Characterization and use of wheat genetic resources in breeding. - Evaluation of heirloom vegetables for ethnic and other markets.	- New barley varieties combining high yield and high energy content. New feed and bio-fuel crop for SE region. New rotation crop for SE soybean growers. - Refereed research publication, molecular data. Professional society award, "Best published results, 2007." - Private companies request materials to produce hybrids for Northern Corn Belt. SARE grant (university and United Tribes Council) to preserve corn genetic resources. Industry-supported fellowships. - Yield increase of 1/2 bushel/ acre/per year over the past decade. - Vegetable varieties identified having good yield, taste, and appearance.	- Breeders aware of farmer needs. Farmers aware of new local feed source for SE swine, poultry. Private investors aware of new regional high-energy feedstock for biofuel. - Molecular data to help breeders identify genetic resources to increase narrow genetic base of U.S. soybeans. - Graduate students trained in plant breeding, from lab to field. Corn breeding training modules for Native American tribal groups. - New breeding strategies; new information about which genetic resources to use. - Students trained in field plot work and analysis of plants for nutritional compounds.	- SE swine, poultry producers replace Midwestern corn with local high-energy barley. SE farmers plant more barley. Private investment in local ethanol/ protein feed plants using barley. - (***Anticipated:*** *Breeders use characterized genetic resources; increased genetic diversity in U.S. soybeans)* - More farmers planting corn (increased acres) in Northern Corn Belt. Enhanced university/tribal council interaction. - Greater efficiency and genetic progress for yield and quality, winter hardiness, insect resistance - (***Anticipated:*** *Varieties with income potential for farmers on small acreages.)*	- Lower production costs for SE livestock and consumers. Soil cover reduces erosion on barley acres. Increased soybean yields after barley. (***Anticipated****: lower costs for SE biofuel users.*) - (***Anticipated:*** *Enhanced food security; greater genetic progress in soybean breeding)* - Economic opportunity for Northern Corn Belt areas not served by private sector research; ethanol production plants in those areas. Future workforce for plant breeding. Corn diversity preserved. - Enhanced security of world food supply and U.S. grain exports; income for regional farmers - (***Anticipated:*** *New economic opportunity for farmers on small acreages.*

Assumptions - CSREES accomplishes work on plant genetic resources by collaborating with partner organizations & agencies. CSREES personnel establish networks to conduct this research & to integrate it with plant biology & genomics, plant breeding & other applied research, & with education & extension, to develop materials & technologies useful to farmers, ranchers, processors, & consumers.

External Factors - Increasing value of plant genetic resources due to national & foreign policies; domestic & international economic & market trends; consumer trends; trends in pathogen dispersal & co-evolution; long-term climate trends; scientific advances in KAs 201, 206, & others; cooperation of other federal agencies & state partners with CSREES; level & flexibility of funding; interest & ability of private sector in partnering.

Key KA 202 Outputs and Outcomes

Genetics and Breeding of Traditional and Specialty Barley and Wheat Cultivars for Increased Productivity, Value, and Durability/Modern barleys for the Southeast: Biofuels, Beverages, and Exports

Hatch funds, Smith-Lever funds, Commodity check-off funds CRIS accession nos. 0191103
Mission area: Research and 0212716

Plant breeding research and extension at Virginia Polytechnic Institute and State University (VPI) have developed modern barley germplasm that is transforming the economic position of barley in the Southeastern USA. Barley is well-adapted to the region. As a winter crop, it reduces soil erosion and holds soil nutrients, helping to keep streams and rivers clean. It is harvested earlier than wheat, allowing earlier spring soybean planting, which translates to up to five bushels higher soybean yields. In spite of these advantages, barley has been grown on limited acres because of the lack of a high-value market. New varieties of Southeast barley have been developed for biofuels, beverage, and export purposes. By using regionally-grown barley, new fuel-and-feed facilities are expected to have a cost advantage in the Southeast over Mid-Western, corn-based ethanol. This is an example of Hatch-funded long-term variety development research, effective extension outreach, and state-federal collaboration that together have created an opportunity for local value-added production and for private investment. *Without the long-term Hatch investment in applied research, the varieties on which all these benefits depend could not have been developed.*

Key Outputs

- Research at ARS/USDA developed the initial know-how and ethanol conversion/processing statistics for new varieties of barley.
- Six states are evaluating new high-energy 'hulless'-type barley varieties from this research for use in feed and ethanol markets.

Outcomes

- Private investment has recently been announced in four new ethanol and protein-feed production facilities in the Southeast that will be based on these new barleys as feedstocks.
- VPI's new high-quality, regionally-grown barley varieties are being used by local swine and poultry producers in place of more expensive corn that must be imported from other regions.
- The Southeast is exporting barley for the first time in many years.
- The new barleys are also being used as the base commodity in a new market to produce malt-derived beverages. The new markets allow regional farmers to grow more barley, earn more, and reduce their environmental footprint.

Soybean Breeding and Genetics/Genetic Diversity from Chinese Wild and Cultivated Soybeans, for Greater Advances in U.S. Soybean Breeding
Illinois Soybean Association and Hatch funds CRIS accession no. 0182063
Mission area: Research

Soybean cultivars in North America have a narrow genetic base. Over 85% of the genes present in North American soybean cultivars can be traced to only 18 original ancestors. Since genetic variability is necessary for genetic progress, this limited genetic base impedes further advances in soybean breeding. Potential sources of genetic variability for North American soybean breeding include Japan, Korea, and China. Germplasm collections of wild soybean, *Glycine soja*, are also a potential source of genetic variability for soybean breeding programs.

This research used genetic markers to characterize diversity among 60 wild soybeans (*G. soja)* collected in China, and to compare their diversity with 18 U.S. ancestral soybean genotypes, 12 Chinese soybean plant introductions (PIs), and 47 elite soybean lines from the northern USA. These accessions were genotyped with a set of 72 simple sequence repeat markers. The wild *G. soja* accessions contained more diversity than the U.S. ancestral genotypes, the Chinese PIs, or the elite U.S. lines. Multivariate analyses were able to separate the cultivated soybeans lines from the accessions of their wild relatives and identify the most diverse subset of wild accessions. These data will be used by breeders selecting parents for breeding for greater diversity and more robust genetic progress in soybeans; and for establishing a core collection of *G. soja* to make future research with wild soybean relatives faster and more efficient.

Outcome

- This work was voted one of the top three outstanding published results of 2007 by the members of the Genetic Resources Division of the Crop Science Society of America.

Corn for the North: **NDSU Breeding Adds Value to Corn, Wheat, Beans, and Soybeans**

Hatch Funds For Corn; North Dakota Corn Utilization Council; North Dakota Corn Growers Association; North Dakota Board of Agricultural Research; North Dakota Agricultural Products Utilization; USDA, ARS - GEM Project Corn breeding Industry (general on site, fellowships, winter nursery, grain quality screening, etc; plenty of cooperation); SARE grant; CSREES NRI-funded Wheat Genomics Coordinated Agricultural Project (CAP) and the CSREES NRI Barley Genomics Coordinated Agricultural Project.

Source of Example: North Dakota State University Annual Report; CRIS accession no. 0215146, Applied corn breeding for early maturity; 0187182, 0210257, Exotic germplasm conversion & breeding in common bean; 0202827, Breeding and genetics of spring barley; 0196586, Soybean breeding and production (all the above are Hatch projects); Wheat genomics CAP: CRIS accession # 0205761; Barley genomics CAP: CRIS accession # 0206216
Mission area: Research

North Dakota crop agriculture generates over four billion in cash receipts annually. Constant improvement of genetic resources for North Dakota agriculture is the basis for this economic value. Unlike wheat, beans, and soybeans, corn lines, developed by NDSU, reach farmers

through private companies who use the lines to develop hybrids. NDSU corn inbred lines have been requested by 11 companies and are believed to be part of the basis of an over 400% increase in corn acreage in ND in the past decade, and the existence of corn ethanol plants in areas where only NDSU research locations are present. NDSU is working with a Native American Tribal Council to preserve traditional northern corn plant genetic resources and to provide training in methods for tribal breeders to enhance this material for present-day needs.

Key Outputs

- University releases of grain crop varieties include Faller Wheat (estimated value $250,000,000), Lariat and Stampede pinto beans ($17,600,000), conventional soybean Sheyenne ($4,500,000), transgenic soybean RG700RR ($1,000,000) and Pinacle barley ($17,500,000).

Outcome

- Although the private sector does not reveal what inbreds it ultimately uses, corn is becoming a more valuable crop in areas where no private-sector inbred line development is taking place. NDSU inbreds are the most likely basis for this impact.

Keep it Coming: Wheat from the Northern Plains for World Food Supplies

Hatch Funds; CSREES-managed Special Grant "Barley for Rural Development"
Montana State University is a participant in the CSREES NRI-funded Wheat Genomics Coordinated Agricultural Project (CAP); Commodity group funding.

Montana State University Annual Report; See also CRIS accession no. 0080117; Plant germplasm resources conservation and utilization 0178497; Small grains quality and molecular biology 0161313; Winter wheat breeding and genetics 0138331; Spring wheat breeding and genetics 0080898; Quantitative genetics and cultivar development 0093505; Barley breeding and genetics 0207071; Barley for Rural Development (all the above are Hatch projects); and Wheat Genomics CAP: CRIS accession no. 0205761.

Mission Area: Research

Reliable yield of high quality grain is essential for long-term marketing. Toward this objective, a major effort is underway in this Northern Plains state to characterize wheat and barley germplasm and increase the utilization of world germplasm collections. Researchers are developing more efficient screening, selection and breeding strategies to maximize efficiency and genetic progress, in order to meet increasing world demands for quality, while maintaining yields for producers. Breeding objectives include increasing yield potential, winter hardiness, wheat stem sawfly resistance, imidazolinone herbicide tolerance, and dual-purpose end-use quality.

For a decade, successful research at Montana State University has consistently maintained a positive yield increase of 0.5 bushels per acre for spring and winter wheat. To put this in perspective: based on average planted acres and prices, an improved winter wheat cultivar

producing an additional one bushel per acre potentially impacts the state economy by $5–$6 million annually.

New varieties from Montana and other states are grown by Extension in dual-purpose variety trials. The trials allow farmers to observe the newest varieties before deciding which to grow, and their feedback informs breeders on farmer needs and preferences. Future productivity of the breeding program will be addressed by research to improve understanding of the genetics of key traits and develop new selection tools.

Key Outputs

- Research results are distributed to farmers, colleagues, and stakeholders through technical and non-technical publications and through the release of germplasm and new genomics tools and techniques.
- A new solid stem winter wheat cultivar, Genou, with improved yield especially in wheat stem sawfly-infested areas of Montana was the top winter wheat variety planted in Montana in 2007.
- MSU also recently released four new feed, forage, and malt barley varieties that will provide added-value to growers throughout the Northern Plains.

Outcomes

- Increased contribution to world food supply.
- Improved ability of farmers in Montana and other Northern Plains states to compete in a global marketplace.
- Strengthening of export markets for U.S. wheat.

Evaluation and Characterization of Heirloom Varieties of Tomato, Pepper, and Eggplant/ Finding Profitable Combinations for Small-Scale Farmers: Varieties and Cultural Practices

Evans-Allen project, Tennessee State University Annual Report CRIS accession no. 0211029
Mission area: Research, Education

As the population of international residents of the United States increases, (Hispanic, Kurdish, and others) the demand for increased variety and quantities of ethnic foods of different types also increases. Limited-resource stakeholders will benefit from these new markets if they have information about crops for relatively small acreages that have commercial income potential. The crops examined here have potential in the specialty, restaurant, gourmet, and health-food trade. They could become an income source for small, limited-resource producers. Twenty heirloom varieties of peppers and 26 heirloom tomato cultivars were planted in the field and evaluated for production and fruit quality during the 2007 growing season on Tennessee State University's main campus farm. Twelve pepper and 14 tomato varieties were selected, based on fruit size and taste, to be evaluated based on response to different cultural practices.

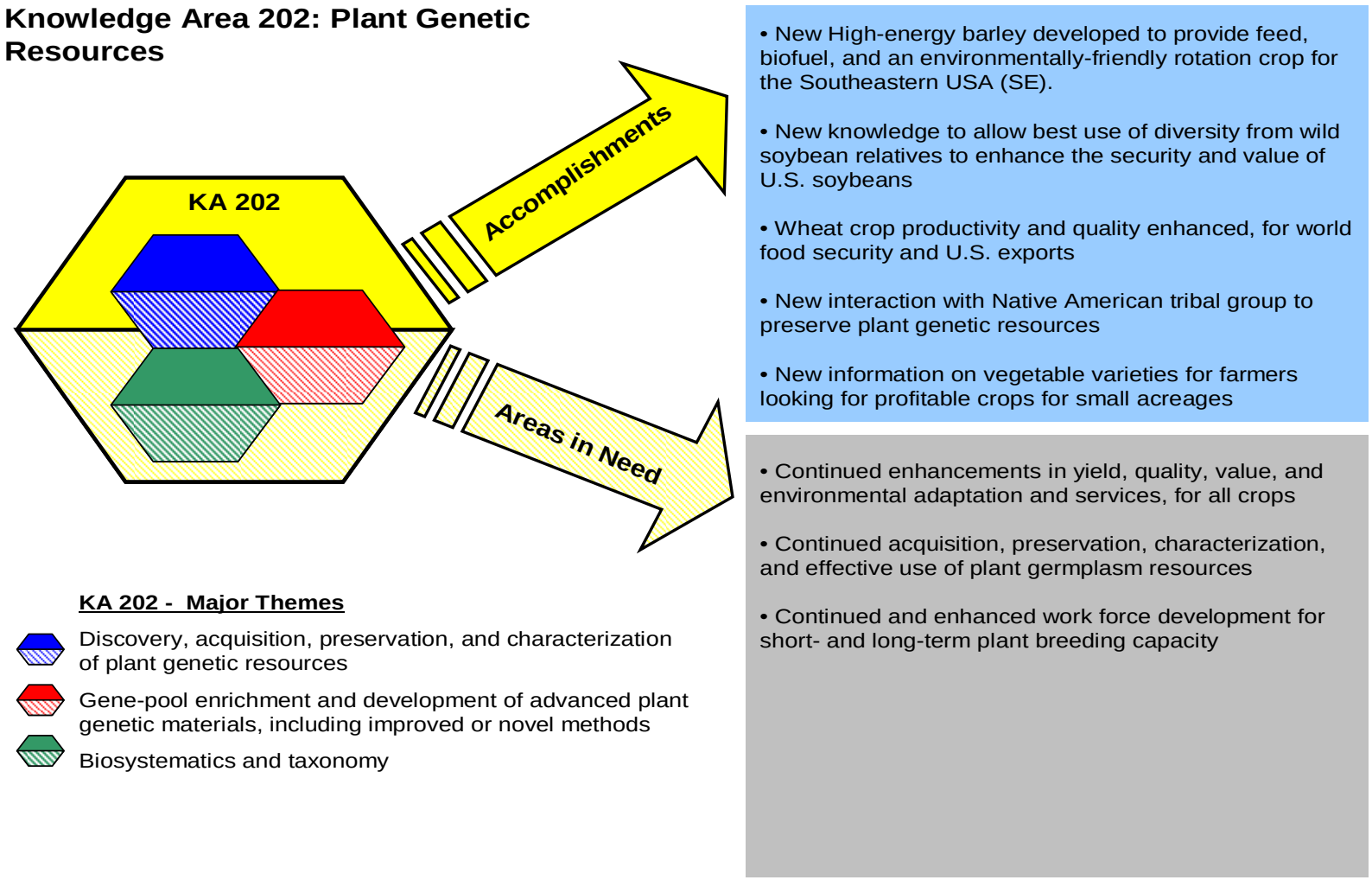
Key Outputs

- The project has trained three TSU students in sampling leaf tissue from field plots, sample preparation for cryogenic storage, and the use of laboratory equipment and materials (the DNeasy Plant Mini Kit [Qiagen, Santa Clara, CA], Bio Fast Prep System

[Q. Biogene, Irvine, CA], agarose gel analyses and Eppendorf spectrophotometer [Hamburg, Germany]).

- A capacity-building proposal led by Delaware State University has included the protocol developed in this project in a proposal to measure pepper, tomato and other species for their functional compounds.

KA 202 Honeycomb:



Knowledge Area 203: Plant Biological Efficiency

KA 203 Introduction:
Knowledge Area (KA) 203 addresses basic and applied research on plant biological efficiency and abiotic stresses affecting plant productivity and growth. The goal of research in this area is a better understanding (targeted towards improvement) of plant productivity, quality, and response to reduced inputs, such as water or fertilizer, or to abiotic stresses such as drought, temperature extremes, and nutrient availability. The findings and outcomes of CSREES-supported research can lead to crops with improved drought, salinity, and flooding tolerance, with increased productivity in nutrient-poor soils, and with improved yield under broader temperature ranges or under temperature stress.

Drought and salinity stress are increasing agronomical problems in the arid midwest and western growing areas. Although irrigated land tends to be significantly more productive than rain-fed land, long-term irrigation inevitably increases salinity. Plants with increased salinity tolerance will maintain productivity on irrigated land while plants with increased drought tolerance can reduce the need for irrigation.

Plants with increased biological efficiency will minimize fertilizer input and allow sufficient quantities of food, feed, and fiber to be grown on less land. Thus, land is available for other purposes, and forests and wilderness are not converted to cropland. The quality of the environment and natural resources is also protected through reduced use of fertilizer and irrigation.

The increased understanding of plant response and tolerance of environmental stress is vital in face of global climate change, increasing population size, and loss of agricultural lands, either due to urban/suburban growth or to harmful chemicals in the environments. CSREES-supported research is also leading to improved propagation and cultivation techniques for applied projects and serving as the basis for small businesses. These outcomes will encourage agricultural sustainability and environmental protection not only for the U.S. but also for the world.

KA 203 Logic Model

KA 203: Plant Biological Efficiency

Situation	Inputs	Activities	Outputs	Outcomes		
				Knowledge	Actions	Conditions
The study of plant biological efficiency characterizes effects of factors such as light, water, temperature, nutrient supply, & soil conditions on plant production. This knowledge permits the development and/or improvement of plant varieties & production management systems to ensure the stability of the nation's food supply & the value of U.S. agricultural products under varied & changing environmental conditions.	**Funding Sources:** - Federal - State - Commodity groups - Industry - Other sources **Human Capital**: - Researchers - Teachers - Graduate students -Farmers - Ranchers - Greenhouse operators - Green industry - CSREES NPLs - Administrative support	- Identification of plant genes, proteins, and physiological and biochemical mechanisms and pathways associated with superior performance under abiotic stress - Characterization and understanding of the mechanism(s) used by plant species to adapt to or tolerate specific environmental condition(s) - Analysis of the effect of abiotic stress on plant growth and yield - Study of ecosystem recovery and dynamics from environmental stress - Commercial development of products for restoration/reclamation for agricultural and nursery plant industries	Research, education and extension outputs - vetted by scientists and educators - submitted to CSREES - Research findings disseminated - Publications - Citations - Disclosures - Patents - Best management practices - Curricula designed - Undergraduate and graduate students trained and graduated - Training provided to producers	- Increased level of knowledge and understanding of plant response to environmental stresses, including identification of genes and biological processes involved in detection, adaptation, or tolerance of abiotic stresses. - Increased level of knowledge regarding the effects and mitigation of effects of abiotic stress on plant production and yield. - New methods and biological tools to develop plant varieties tolerant of abiotic stress and/or with enhanced yield in specific environments.	- Crop models (e.g., tomato, rice, alfalfa, wheat) being developed for studying plant tolerance of or adaptation to stress conditions. - Developed new models to predict the effect of ozone on soybean yield - Development of submergence tolerant rice varieties - Generated plants with modified gene expression to study temperature, nutrient, water and salt stress tolerance - Use of novel growth media for mycorrhiza to enhance plant growth on poor soils	- New approaches to stress tolerance in crop plants using classical and molecular breeding techniques - More efficient and effective use and management of water and plant nutrients - Sustainable production of crops and other economically important plants - Productive and economically- and environmentally-sustainable agriculture under environmental stress conditions - Reduced losses in plant production due to drought, flooding, nutrient, or temperature stress, resulting in increased profits for producers

Assumptions - This KA integrates work in KAs 201, 202, 206, & 102 in support of work in KAs 204 & 205. CSREES accomplishes work on plant biological efficiency by collaborating with partner organizations & agencies. CSREES personnel establish networks to conduct research & integrate it with applied research to develop materials & technologies useful to agricultural producers--the immediate beneficiaries of this research--& ultimately to processors & consumers.

External Factors - National /foreign policy changes; domestic & international economic trends; costs to implement advances; cooperation of other federal agencies & state partners with CSREES; level & flexibility of funding; interest & ability of private sector in partnering. Success of partners' management of research, education, & extension programs. Trends in the abiotic environment (e.g., changes in climate; or, in air, water, or soil quality).

Key KA 203 Outputs and Outcomes

Drought Responsive Genes and Physiological Traits as Enriched Sources of Candidate Markers to Improve Alfalfa Drought Tolerance

NRI Competitive Grant CRIS accession no. 0204583
Mission Area: Research, Education

Drought significantly reduces plant production and yield, resulting in billion dollar losses annually to U.S. agriculture and related industries. Drought and diminishing underground water resources for irrigation regularly plague large portions of the Great Plains and the southwestern U.S. Thus, more efficient screening methods and selection criteria for crop drought tolerance are needed to enable and improve development of new drought-tolerant crop varieties. This project focuses on identification of genes and physiological traits involved in plant response to drought with the goal being to use this knowledge to improve drought tolerance in alfalfa. Alfalfa, a perennial legume, is one of the most important cultivated forage in the United States, as illustrated by the 2002 estimated direct sales value for alfalfa hay of $7.2 billion. Alfalfa also provides the primary forage base for the multi-billion dollar dairy livestock industry and is a critical legume rotation component in sustainable agricultural systems.

This project has identified markers in alfalfa that can be used in breeding to select against alleles that reduce forage and root biomass yield under drought stress and to select for alleles that increase biomass production. The research identified individual marker alleles accounting for up to 15% of yield variance in a given harvest under drought conditions. The results suggest that selection for specific marker combinations can potentially improve yield performance by 3 to 14% under drought stress. Additional analyses are uncovering other physiological and genetic mechanisms influencing drought tolerance in alfalfa. This knowledge will enable development of cultivars that can remain productive in environments with widely varying soil moisture availability and during episodes of drought, potentially improving water use efficiency and reducing the need for irrigation. Use of such crop varieties will also conserve water resources, permitting expansion of agricultural related industries or transfer of conserved water to urban communities.

Key Outputs

- 6 publications and/or published abstracts.
- 5 presentations.
- 1 technology/technique development or improvement.
- Training for 2 undergraduate students, 2 graduate students, and 1 postdoctoral researcher.
- Industry interest in hiring students trained during this project and in applying marker development protocols and markers per se, to screen/evaluate germplasm breeding programs and to identify QTL for salt tolerance in alfalfa.

Outcomes

- Increased knowledge of genes and physiological traits associated with drought tolerance.
- Use of this knowledge to develop cultivars that are drought tolerant and/or use less water, sustaining or potentially enhancing plant yield with less water.

- Long term outcomes include decreased need for irrigation and improved conservation of water, minimized impact of drought on U.S. agriculture production and profits.
- Workforce trained in use of markers for breeding water stress-tolerance crop plants

Identification of Heat Response Mechanisms and Genes in Plants with Different Levels of Tolerance to High Temperature

Special Grant CRIS accession no. 0200860
Mission Area: Research, Education

High temperatures during the growing season can cause significant yield losses and crop failures in the U.S. and also limit where crops can be grown worldwide. Some plant species have developed heat resistance or tolerance mechanisms which allow them to survive high temperatures. An increased understanding of these mechanisms will aid development of new strategies to enhance heat stress tolerance in crop plants.

This research project focuses on discovering mechanisms for heat tolerance in specific heat tolerant plants. The research has identified genes involved in heat stress response and tolerance and has begun characterization of gene function. Through the funding, an 1890 land grant university has also been able to purchase equipment that allows them to conduct experiments that previously were difficult or potentially impossible to complete. Using biotechnology approaches, the genes and proteins identified in this project from the heat tolerant species may be incorporated into heat sensitive agricultural crops to improve tolerance to temperature stress, thus minimizing impacts of heat stress on plant yield and enhancing economic stability of plant production. The results may also be used to potentially extend growing range of plants and increasing productivity.

Key Outputs

- 8 publications or abstracts.
- Training of 2 Ph. D. candidates, 5 M.S. graduate students, and 3 undergraduate students.
- Identification of genes expressed in response to heat stress and/or associated with heat tolerance.

Outcomes

- Increased knowledge of genes associated with plant response to high temperatures and/or with heat tolerance.
- Use of this knowledge to develop cultivars that are heat tolerant, sustaining or potentially enhancing plant yield under high temperatures.
- Long term outcomes include minimizing impact of heat stress and global climate change U.S. agriculture production and profits.
- Workforce trained in use of techniques used for agricultural biotechnology.

Nutrient Efficiency in Plants
Hatch Project CRIS accession no. 0202517
Mission Area: Research, Education

Soil fertility significantly affects plant production and lack of proper nutrients in the soil can severely limit plant yield. Low soil fertility along with drought are primary limitations to agricultural production in developing nations. This project has identified physiological, anatomical, and genetic traits important for nutrient, specifically phosphorus, acquisition and utilization in soybean, common bean, corn, and the reference plant Arabidopsis. The research showed that specific root architectural traits are important for phosphorus acquisition and these novel architectural traits have been useful in crop breeding to develop plants with enhanced ability to take up phosphorus. Nutrient stresses persist from year-to-year over large areas, and are worsening in many regions due to soil erosion and degradation. It was hypothesized that crop genotypes with superior root architecture could conserve soil fertility by reducing nutrient loss through erosion, but this study found that for annual dicotyledonous crops such as bean and soybean with relatively low root length densities, root traits had little direct effect on soil erosion.

The knowledge and tools from this project are being used in breeding and selection of crop genotypes with greater productivity in low fertility soils, such as those that predominate throughout the tropics and the developing nations of the world. As a result of this study, common bean genotypes with enhanced root traits and enhanced phosphorus efficiency are being used and developed in breeding programs in Africa and Latin America. Collaboration with colleagues in China has resulted in the development and release of new soybean cultivars with enhanced phosphorus efficiency. The novel root traits are now of interest for maize breeding in the U.S. The development of plants with enhanced nutrient uptake and utilization can reduce fertilizer use and costs and protect water resources from fertilizer effluents.

Key Outputs
- 25 publications.
- Research training for 5 Ph.D. graduate students, 2 M.S. graduate students, 2 undergraduate students.
- Identification of physiological, anatomical and genetic traits involved in phosphorus acquisition and utilization by plants.
- Identification of anatomical/architectural traits for breeding plants with enhanced phosphorus or general nutrient acquisition.

Outcomes
- Increased knowledge of nutrient uptake and utilization in plants.
- Use of this knowledge to develop cultivars with enhanced nutrient (phosphorus) acquisition.
- Long term outcomes include decreased fertilizer use, reducing production costs and minimizing harmful effects (chemical inputs) on water resources.
- Workforce trained in plant physiology, an area of need for plant biology.

Mechanism for Aluminum Inhibition of Plant K^+ Channels; Signaling Pathways for Stress Responses in Higher Plants

NRI competitive grant and Hatch funds — CRIS accession nos. 0189227
Mission Area: Research, Education — and 0187246

Soil quality particularly in terms of acidity and salinity can significantly limit plant productivity and yield. These complementary NRI and Hatch projects are examining the mechanisms used by plants to sense and tolerate nutrient and salt levels in soil that affect plant survival, growth, and yield. Nutrient sensing is critical for plant adaptation to the environment. Mineral nutrients such as potassium are essential for plant growth but may be depleted in soils through extensive farming or erosion and thus become a limiting factor for plant growth. The research identified a calcium signaling pathway which regulates a potassium channel to enhance potassium uptake through the plant's roots. This research provides important new information on potassium channel function and regulation and may lead to new approaches for improving plant nutrition to increase productivity and quality. In the complementary project studying another aspect of calcium signaling, research identified a calcium sensor protein that functions as a critical regulator of salt tolerance in plants. This protein appears to moderate a novel calcium-signaling pathway involved in sequestration or compartmentalization of sodium ions in the plant. This study is revealing molecular components important for plant salt tolerance and may lead to new strategies to develop plants that remain healthy and productive in saline soils.

Key Outputs

- 15 publications.
- Training for 3 graduate students, and 3 postdoctoral researcher(s).
- Identification of molecular components of calcium signaling pathways.

Outcomes

- Increased knowledge of genes and proteins involved in sensing and responding to nutrient and salt stress.
- Use of this knowledge to develop cultivars that can tolerant potentially deleterious levels of salt or minerals in the soil and/or are capable of more efficient uptake of mineral nutrients.
- Long term outcomes include decreased impact of poor soil quality (for example saline soils due to irrigation) on plant production and improved production and yield on nutrient-poor soils.

An Integrated Approach to Identify and Deploy Novel Genetic Determinants from Resurrection Plants for Improved Dehydration Tolerance of Crop Plants

NRI competitive grant — CRIS accession no. 0210787
Mission Area: Research, Education, Extension

This integrated project addresses two important needs for agriculture: developing genetic resources to improve drought tolerance in plants and training scientists in plant breeding. Drought is a leading cause of agricultural productivity losses and can reduce average yield by more than 50%. This project incorporates breeding/genetics, genomics and physiology research on resurrection plants with education and outreach in plant breeding. The tissues of resurrection

plant species can recover from being nearly air dry. As there are no desiccation tolerant crops, this project will identify genetic determinants of desiccation tolerance using resurrection plants as a model and link gene discovery with functional analysis, potentially leading to new strategies to develop crops with enhanced water use efficiency and tolerance to drought and water stress. The challenge of breeding plants with enhanced abiotic stress tolerance such as increased drought tolerance requires scientists trained in breeding techniques and capable of using the increasing wealth of genomic tools and resources. However, the number of active scientists with expertise in plant breeding is declining. To meet future U.S. agricultural needs, then, educational efforts are required to attract and train young scientists in the discipline and methodology of plant breeding. The education component of the project includes development of plant breeding and related courses at the University of Nevada-Reno and University of Missouri. Education and outreach are coupled to research through a program focused on hands-on breeding and teaching modules for *Sporobolus,* a type of resurrection plant.

This project will provide vital new training opportunities in plant breeding to help agriculture face future needs for plant breeders. It will also provide increased knowledge of how plant cells tolerate water loss. This knowledge can be used for developing new breeding strategies to improve drought tolerance and maintain biomass and seed production in agricultural crop plants. The increasing wealth of plant genomics data and resources is providing innovative tools to develop new plant varieties, and scientists, as well as agriculture, will benefit from the knowledge and the genomics tools developed through this study for breeding programs. The project may also lead to use of *Sporobolus* as a new forage grass for dry-land agriculture. The ability to maintain U.S. expertise in plant breeding and to utilize a combined breeding and genomics approach for developing drought tolerant agricultural plants will provide agricultural producers with the plant varieties needed to maintain and increase plant production and quality. (The project just started in 2007, so it doesn't have significant outputs and outcomes so far).

Outputs

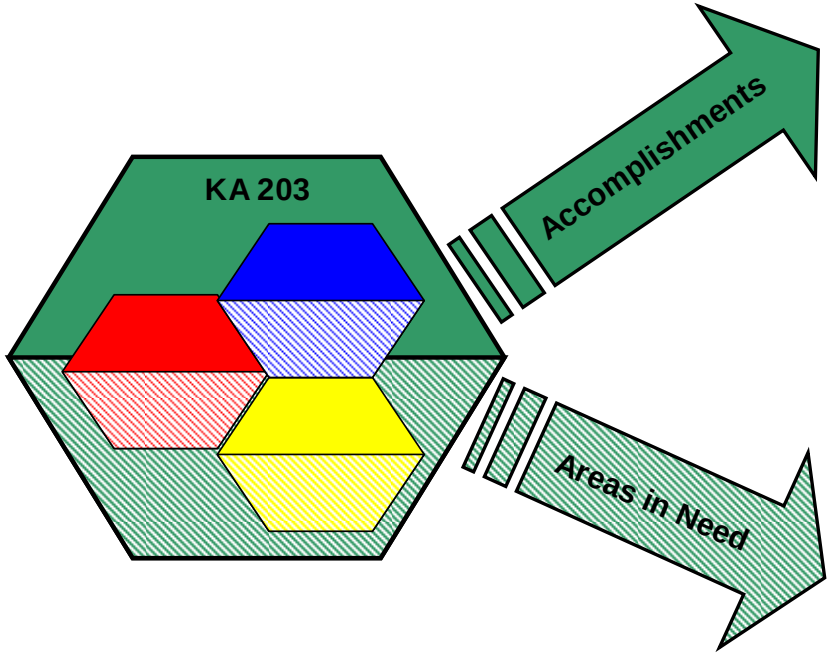
- This project will provide vital new training opportunities in plant breeding to help agriculture face future needs for plant breeders.
- This project will provide increased knowledge of how plant cells tolerate water loss.

Outcome

- Knowledge gained from this project can be used for developing new breeding strategies to improve drought tolerance and maintain biomass and seed production in agricultural crop plants.
- The increasing wealth of plant genomics data and resources is providing innovative tools to develop new plant varieties, and scientists, as well as agriculture, will benefit from the knowledge and the genomics tools developed through this study for breeding programs.

KA 203 Honeycomb:

Knowledge Area 203: Biological Efficiency and Abiotic Stress



KA 203 - Major Themes

- Improving plant performance affected by reduced inputs or abiotic stresses
- Understanding and enhancing biological mechanisms related to plant biological efficiency and stress tolerance
- Cultural practices to improve plant biological efficiency or stress tolerance

- Genes and physiological mechanisms identified in several agricultural plants, such as rice, alfalfa, wheat, soybean, sorghum, grape, tomato, azalea, involved in water stress (drought, flooding) tolerance
- New varieties of rice developed with improved flooding tolerance and in use in developing countries
- Mechanisms and genetic factors identified in reference species Arabidopsis and in agricultural plants for heat tolerance, and salt tolerance
- Genes and physiological mechanisms identified for improved nutrient uptake in Arabidopsis and tomato
- Curriculum development and students trained through NRI and SERD programs to move genomics knowledge to future generations of plant breeders

- More complete knowledge of plant mechanisms (molecular, genetic, genomic, physiological, biochemical) for tolerance of abiotic stresses including drought, flooding, salinity, cold, heat, nutrient, and global climate change
- More complete knowledge of plant-soil-water relationships including nutrient uptake and water use efficiency
- Drought and salt-tolerant agricultural plants and varieties for food, feed, fiber, and biofuel production and greenscapes
- Additional tools or methods for enhancing integration of basic research, applied research, education, and extension

Knowledge Area 204: Plant Production Quality (Pre-harvest)

KA 204 Introduction:
Knowledge Area (KA) 204 relates to research and extension focused on maintaining and improving specific quality or utility parameters within crop plants prior to harvest. This may refer to biological processes that affect crop quality or utility, breeding or genetic engineering to increase crop quality or utility, cultural practices that affect crop quality or utility, and the maintenance of seed crop quality through the adoption of field practices. It does not refer to basic plant biology, post-harvest quality or utility, integration of research results into production management systems, evaluation of germplasm for variation in specific quality or utility parameters, seed processing technology, or forest or range plants. CSREES-sponsored programs in this KA provide science-based information, knowledge and learning to help expand markets and reduce trade barriers, support international economic development, and promote efficiency of agricultural production systems.

KA 204 Logic Model

KA 204: Plant Product Quality and Utility (Pre-harvest)

Situation	Inputs	Activities	Outputs	Outcomes		
				Knowledge	Actions	Conditions
Quality in plant products is essential in today's competitive agricultural marketplaces. Pre-harvest quality attributes add value for farmers, for the processing industry, the green industry, & consumers. Continual attention is needed to provide a quality advantage for U.S. farmers & to meet the demands of consumers increasingly aware of quality in foods, fibers, & green environment plants	**Funding Sources:** - Federal - State - Commodity groups - Industry - Other sources **Human Capital**: - Researchers - Teachers - Graduate students - Farmers - Ranchers - Greenhouse operators - Green industry - CSREES NPLs - Administrative support	- Knowledge of the genetics of pre-harvest quality - Knowledge of production & harvesting practices enhancing pre-harvest quality - Distance curriculum for seed quality - Experiential learning for production of organic & local/fresh vegetables & herbs - Home gardener outreach on pre-harvest practices for food safety - Extension workshops on seed quality for seed producers & inspectors - Producer field days on value-added crops for enhancing economic activity on remote tribal lands	Research, education and extension outputs - vetted by scientists and educators - submitted to CSREES - Research findings disseminated - Publications - Citations - Disclosures - Patents - Best management practices - Curricula designed - Undergraduate and graduate students graduate - Training provided to producers	Increased level of knowledge and understanding about: -genetic quality trait identification, selection and modification - value-added crop traits - production management to ensure quality trait expression and enhancement - education and outreach	- phenotypic evaluation, genomics, plant breeding, molecular biology - research on identifying and controlling qualitative traits in crops - research on production management influencing quality trait expression in crops - curricula to support the development of researchers and extension specialists to develop and transfer technology leading to improved preharvest crop quality	- new crop genotypes with enhanced pre-harvest quality traits - new value-added crop traits are identified - management practices for preserving or enhancing pre-harvest quality traits in crops are developed - researchers and technology transfer specialists are trained

Assumptions - KA 204 integrates work from KAs 201, 202, 203, 205, 206, & 102 to identify genetics, conditions & systems for improved seed & crop quality. CSREES accomplishes work on plant biological efficiency by collaborating with partner organizations & agencies. CSREES personnel establish networks to conduct research & integrate it with applied research to develop materials & technologies useful to farmers, processors, & consumers.

External Factors - National /foreign policy changes; domestic & international economic trends; consumer trends; costs to implement advances; cooperation of other federal agencies & state partners with CSREES; level & flexibility of funding; interest & ability of private sector in partnering. Success of partners' management of research, education, & extension programs.

Key KA 204 Outputs and Outcomes

Goldenseal, Germplasm Improvement through Micropropagation

SBIR grant CRIS accession no. 0206433

Mission Area: Research

Goldenseal is a native medicinal plant that grows in the southeast. It is quite popular due to purported health benefits and as a result wild populations have declined due to overharvesting. To address this problem Sleepy Hollow Farm has received grant support from the SBIR program to develop procedures for successful cultivation of this plant.

The primary active ingredients in goldenseal are the alkaloids berberine and hydrastine. The content of these alkaloids in the rhizomes can vary significantly from one plant to the next and the researchers are working to select cultivars with enhanced levels of these two alkaloids. From one pound of rhizome they can produce approximately 400 oz of an extract that contains 2.5 mg/ml of berberine and hydrastine. They sell the extract for $5/oz so one pound of rhizomes will yield about $2,000 for the farmer. This year a number of farmers will begin to harvest goldenseal and they hope to harvest over 600 pounds of rhizomes from all the farms combined.

Goldenseal exhibits good biological activity for use in oral care, cholesterol reduction and improvement in digestive functioning. Sleepy Hollow Farm has received grant support from NIH to standardize the biological activity of their extracts. Thus, this work will lead to the availability of new medicinal plant extracts that can have beneficial health effects. The project is also benefitting the small farmers who have started to grow goldenseal. If they produce 10 pounds of goldenseal rhizome each year they will receive nearly $20,000 in income and this will help to make their small farms more profitable and sustainable.

Key Outputs

- Micropropagation procedures designed to produce more plant material that farmers can use to establish new plantings.
- Procedures to extract goldenseal rhizomes with 60% alcohol to obtain extracts of the alkaloids.
- Last year Sleepy Hollow Farm produced 80 pounds of rhizomes valued at $160,000.

Outcome

- Over 20 other small farmers in the southeast are growing goldenseal (11 are currently qualified as organic and the rest should achieve this status in the next few years).

Environmental and Genetic Determinants of Seed Quality and Performance

Hatch Multi-State Project (W1168, W2168)

Mission area: Research

Insuring that seeds are of high quality is of critical importance to successful crop production. A variety of both biological and environmental factors can influence the quality of seeds and how well they will germinate and the vigor of the plant seedlings that are produced. The objectives of the study are to 1) determine the influence of pre-harvest stress on seed quality, 2) identify the

biophysical, biochemical and genetic factors governing seed desiccation tolerance and longevity, 3) identify genes associated with seed development, germination, vigor and dormancy, and 4) develop technologies to assess seed quality, improve seed performance and enhance seed utilization. The expected outcomes from this project include 1) obtain a better understanding of the influence of environmental stress on seed quality, 2) develop improved methods for seed storage that will result in improved long term seed viability, 3) identification and characterization of genes that determine seed quality and performance, and 4) development of technologies that can be used to enhance seed quality and result in improved seedling establishment and crop performance.

Key Output

- Several publications dealing with the influence of early season frost on seed development and ultimate seed quality in maize and on drought tolerance in wheat have been produced.

Characterizing the Effect of Plant Genotype and Processing Techniques on Carotenoid Stability in Tomato Products by Direct Infrared Spectroscopy

NRI Grant CRIS accession no. 0208143
Mission Area: Research

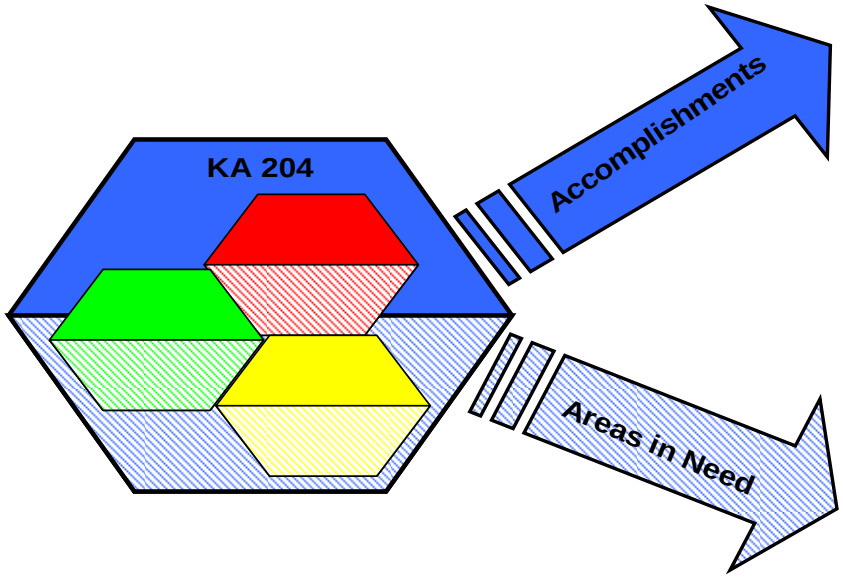
Tomatoes are the second most produced and consumed vegetable in the U.S., and provide a rich source of dietary carotenoids. Plant breeders want to maximize carotenoid content in their breeding lines and industry desires to minimize loss during processing and distribution. Attenuated total reflection infrared (ATR-IR) spectroscopy shows promise for the rapid (5 min), accurate, and reliable quantification of lycopene and beta-carotene in tomato samples with minimal sample preparation. The development of varieties with increased phytochemicals is possible through direct selection in structured populations and through molecular assisted strategies, but efficient selection requires the ability to measure these compounds in thousands of samples. Current assay methods are time consuming, expensive, and use hazardous organic solvents. The ATR-IR technique will contribute to the development of simple and rapid protocols that will lead to improved processes for products with enhanced bioactivity as functional foods that would meet industry and consumer demands and safety regulations of government. Furthermore, the ATR-IR information will be used to further the understanding of the factors affecting release of phytochemicals from the food matrix and degradation processes during processing and storage.

Key Output

- Researchers developed a simple ATR-infrared spectroscopy method to determine dietary carotenoids in tomato juice and extracts.

KA 204 Honeycomb:

Knowledge Area 204: Plant Product Quality



KA 204 - Major Themes

- Understanding pre-harvest biological processes that affect plant product quality and usefulness
- Understanding the genetics of plant product quality
- Developing cultural practices that preserve or improve plant product quality and usefulness

- New knowledge developed regarding the genetics of crop quality, e.g. anti-oxidants in sweet corn; processing quality in wheat
- New methods developed for measuring crop quality
- Education and extension of production methods to enhance specific desired crop qualities, including local food systems and organic production systems

- Enhanced understanding of the genetics of crop quality
- Continued development of crops and varieties with enhanced qualities for food, fiber, ornamentals, and export
- Continued and enhanced development of new methods for measuring crop quality, such as sensor technology to determine optimum harvest time, especially for fruit crops
- Improved understanding of quality attributes preferred by consumers in general, and by Native American and minority populations

Knowledge Area 205: Plant Production Management Systems

KA 205 Introduction:
Knowledge Area 205 relates to research and Extension that is focused on integration of production practices into systems for managing annual and perennial plant population densities, fertility, irrigation and other cultural practices. This may also include application of remote sensing and other automated sampling methodologies in managing crops, modeling and decision support systems for use in managing crops and evaluation of integrated production management systems. It does not include development of integrated pest management systems, application of remote sensing or other automated sampling methodologies for pest management, modeling and decision support for pest management, basic studies related to improving, maintaining or restoring the inherent production capacity of soils or forest or range plants. CSREES-sponsored programs in this Knowledge Area provide science-based information, knowledge and learning to help expand markets and reduce trade barriers, promote international economic development, and promote efficiency of agricultural production systems.

KA 205 Logic Model

KA 205: Plant Management Systems

Situation	Inputs	Activities	Outputs	Outcomes		
				Knowledge	Actions	Conditions
Agricultural production that is sustainable & competitive requires cost-effective & environmentally-friendly practices for managing fertility, water, & other production factors. Constant improvements in production management are critically needed due to increases in competition from countries with lower labor costs & attention to environmental quality.	**Funding Sources:** - Federal - State - Commodity groups - Industry - Other sources **Human Capital**: - Researchers - Teachers - Graduate students -Farmers - Ranchers - Green industry - CSREES NPLs - Administrative support	- Management practices tested - Monitoring systems developed - Curricula on best management practices developed for a range of crops & situations - Conducted on-site education for specialized local needs & opportunities; Wide-area distance education in greenhouse production principles - Conducted specialized seminars for minority scholars on opportunities in agriculture - Developed grower outreach re new & improved production systems - Conducted a community-based evaluation of new production methods & results - Established nation-wide collaborative programs to link horticultural & turf plant production management research, education, & extension	Research, education and extension outputs - vetted by scientists and educators - submitted to CSREES - Research findings disseminated - Publications - Citations - Disclosures - Patents - Best management practices - Curricula designed - Undergraduate and graduate students graduate - Training provided to producers	- Increased knowledge about reseeding cotton fields can save growers $70/ha - Increased knowledge about using legume cover crops for pumpkins to reduce N applications by 50% - Increased knowledge about integrated fruit production practices can be used by apple growers and marketers to help satisfy foreign buyers' demands for sustainably produced apples	- Based on an eight-month training course, ag professionals reported new collaborations and new educational and research programming in organic agriculture - Many Miss. Delta small farmers have adopted vegetable crop diversification and conservation practices, and formed a marketing cooperative - Salt-tolerant halophytes have been adopted for phytoremediation by the US DOE, Twentynine Palms CA, and the State of Arizona	- Twenty-five potato growers adopted new conservation-based production practices, positively impacting one-quarter of Idaho's potato production acreage - R&D on the use of cotton gin waste has led to a new cotton-straw hydro mulch that is commercially produced in a new Alabama plant, reusing part of the 3 million tons of cotton waste generated annually - Two new eastern potato varieties were released with improved quality and pest resistance - Using perimeter trap cropping, New England vegetable growers reduced insecticide use by 96% and increased earnings by $11,000 on average

Assumptions - This KA integrates knowledge from KAs 203, 204, & 206; 101-104 (Soil); 111-112 (Water); & the 400 series (Engineering & Support Systems). CSREES accomplishes work on plant biological efficiency by collaborating with partner organizations & agencies. CSREES personnel establish networks to conduct research & integrate it with applied research to develop materials & technologies useful to agricultural producers--the immediate beneficiaries of this research--& ultimately to processors & consumers.

External Factors - National /foreign policy changes; domestic & international economic trends; costs to implement advances; cooperation of other federal agencies & state partners with CSREES; level & flexibility of funding; interest & ability of private sector in partnering. Success of partners' management of research, education, & extension programs.

Key KA 205 Outputs and Outcomes

Improving Yield and Quality of Selected Cucurbit and Solanaceaous Crops in Alabama
Hatch project CRIS accession no. 0184233
Mission Area: Research

There is a need to develop more sustainable vegetable production systems. Using cover crops & strip-tillage for pumpkin production would conserve soil moisture, protect the soil from erosion, provide a suitable crop for rotation, & supply the pumpkins with a source of nitrogen.

Key Outputs

- The use of legume cover crops enhanced the growth and development of pumpkins, while yield, average fruit weight and average fruit number per acre all increased as compared to the conventional bare ground production.
- Cover crops reduced weed pressure and helped to mediate soil moisture levels between the rows providing a reservoir of moisture for the pumpkins.

Outcome

- In Alabama, growers can safely reduce by one-half the application rate of nitrogen (45 lb/acre instead of 90 lb/acre) on pumpkins without a detrimental effect to yield or quality whether they are using a cover crop or producing on bare ground.

Halophytes for Revegetation, Phytoremediation and Forage Production on Saline Soils
Hatch project CRIS accession no. 0175212
Mission Area: Research

The food supply for future generations is uncertain. This project has developed native halophytes as phytoremediation plants for abandoned mine sites, farmland, and as landscape plants to recycle industrial brines in urban areas. A primary use will be for animal feed, especially for ruminants. The project has received approximately 3 million dollars in outside funding from a variety of sources, including the U.S. Department of Energy, Arizona Public Services Co., the Monsanto Company, the U.S. Fish & Wildlife Service, and the Seawater Foundation.

Key Outputs

- The project developed remote sensing methods to estimate water use by salt-tolerant invasive plants compared to native species in riparian ecosystems.

Outcomes

- The U.S. Department of Energy has adopted phytoremediation as the preferred alternative for nitrate clean-up at its Monument Valley UMTRA site as a result of these studies.
- The city of Twentynine Palms, CA, used halophytes as the method of brine disposal in a water treatment plant.
- Arizona Public Services has planted halophytes on abandoned farmland near Avalon, AZ.

Potato Growers Emulate Best Management Practices for Higher Profits

SARE grant CRIS accession no. 0192002
Mission Area: Research, Extension

University of Idaho potato cropping specialists went straight to the source when they wanted to learn why more potato farmers weren't using the best management practices recommended by researchers. After convening an informal farmer focus group, they learned that growers wanted to see a respected neighbor apply a new practice before they made major changes. With a SARE grant, the Idaho group found and publicized 14 "model" potato growers who use a range of growing practices that enable them to reduce their pesticide and fertilizer use while maximizing returns.

Key Outputs

- The list of best management practices for potatoes, with a dozen potato scientists from three Northwest States contributing, spans more than 40 pages. They include recommendations about incorporating crop residue into soil for fertility, scouting fields to check on crop health, and incorporating green manure to reduce populations of nematodes and pathogens.
- At field days, demonstrations, and workshops, organizers showed results from on-farm trials comparing the best management grower practices alongside plots receiving higher rates of chemical fertilizers and pesticides. Growers were wowed by the results: The model plots netted 3 percent more profit per acre than the plots with higher inputs. Similar yields and reduced costs for buying agrichemicals shifted the management-heavy plots into the profit column.

Outcome

- By showcasing successful potato growers, the Idaho team prompted some 25 farmers to try new conservation measures. Twenty-five potato farmers have changed their practices, impacting some 110,000 acres—or one-quarter of Idaho's potato production.

Advanced Training of Ag Professionals in Organic Agriculture

SARE Project ENE04-086, part of CSREES Award #2004-47001-01829 (no CRIS accession number. 2004 Extension (Smith-Lever 3(d)) projects aren't in CRIS. The full project report can be found at: www.sare.org)
Mission Area: Education

A Northeast SARE Professional Development Program (PDP) grant led by University of Vermont and Cornell provided an in-depth training experience to Northeast agricultural professionals (e.g., extension, consultants, NRCS) to strengthen the human and technical capacity to better serve organic farmers. The target audience was experienced agriculture service professionals.

Key Output

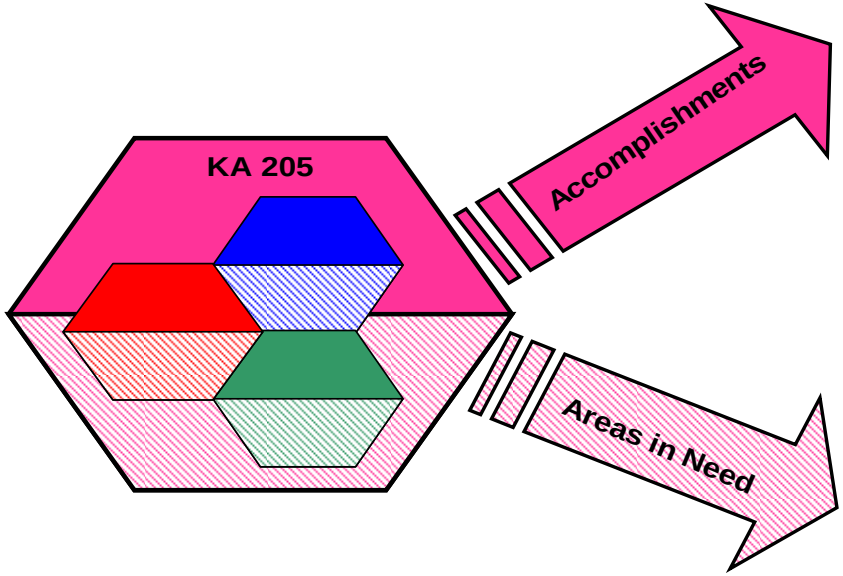
- The format was an 8-month intensive training in Organic Agriculture, with four face-to-face meetings (14 days) that combined lectures with on-farm studies, and continuous inquiry and networking via electronic discussion. All participants were required to attend all sessions in order to facilitate peer teaching, enhance camaraderie, and help expand the Northeast Organic Network of service providers.
- Twenty-two agricultural professionals completed the course. The key measure of success was that participants become active trainers and advisors on organic systems, creating an expanded cadre of organic service providers throughout institutions in the Northeast.
- Participants reported that as a result of the training, they had shared information on organics with at least 50 other agricultural educators, 356 farmers, 13 non-agriculture office colleagues, and more than 163 other people (which includes the general public, students, aspiring farmers, and media).

Outcomes

- Participants reported that 17 months after the beginning of this training, they had developed seven new organic teaching resources, 8 new research projects, 10 grant proposals, 9 educational courses, and 19 other types of projects. They regularly work with 155 others and two-thirds of the respondents had formed new collaborations-- with colleagues from this training or from their home state—to carry out programming in organic agriculture.

KA 205 Honeycomb:

Knowledge Area 205: Plant Management Systems



KA 205 - Major Themes

- Development of efficient and sustainable production systems for specialty crops
- Development of efficient and sustainable production systems for green industry crops and home gardening
- Development of efficient and sustainable production systems for agronomic crops

- New methods for conserving inputs in greenscapes and high-value crops
- Development of new rotations that buffer against weather and price fluctuations
- Increase of 150% in state ag experiment station area certified for organic research and extension work
- Started an extension grant to extend large amounts of existing data relevant to reduced reliance on methyl bromide for high value crops in green industry, fruits, and vegetables
- Two agency funding programs for organic agriculture combined; saves funds from program costs to be used for research.
- New production systems developed for new crops

- Sensor technology and robotics for globally-competitive cultivation of specialty crops
- Biological approaches for reducing inputs and improving commercial crop production including floriculture, nursery production, and other crops
- Development of sustainable crop systems responsive to changes in federal farm policy (e.g. removal of support payments, removal of acreage restrictions, or other changes)
- Information transfer from research to farmers and growers (extension)
- Expanded Master Gardener's program to achieve long-term new behavior to enhance human nutrition and exercise and reduce obesity in adults and children

Knowledge Area 206: Basic Plant Biology

KA 206 Introduction:
This area focuses on inquiry into fundamental processes and mechanisms in agricultural plants basic to the life of the plant. This knowledge area supports projects that will provide fundamental knowledge for improvement and sustainability of agricultural plant and forestry production. Knowledge of plant biology from the molecular to the systems level provides the foundation for development of plants with increased productivity, fitness, and use. Such fundamental understanding of plant biology will allow scientists to make use of the increasing wealth of genomics data and tools and to develop new varieties of agricultural plants through biotechnology and plant breeding approaches.

The science-based knowledge contributed by this knowledge area can lead to increased economic opportunities for producers and consumers by reducing production costs, improving quality, and increasing value of agricultural plant products, thus providing greater profit for the farmers in the ever more competitive global market.

Areas of work supported through this knowledge area include but are not limited to: functional analysis of agriculturally important genes; regulatory mechanism of gene expression; developmental processes; hormonal regulation of growth and development; signal transduction mechanisms; cellular structures and processes; primary and secondary metabolic pathways, cell wall structure and function; photosynthesis and respiration; and nitrogen fixation.

KA 206 Logic Model

KA 206: Basic Plant Biology

Situation	Inputs	Activities	Outputs	Outcomes		
				Knowledge	Actions	Conditions
Future advances in agriculture will require advanced understanding of the processes & mechanisms underlying plant growth, adaptation, & quality. Basic biology research is essential for understanding of newly-discovered plant genomic data and its effective use in plant breeding and other applied research.	**Funding Sources:** - Federal - State - Commodity groups - Industry - Other sources **Human Capital**: - CSREES NPLs - Administrative support - Researchers - Graduate students - Stake holders	- Elucidation of plant genetic, developmental and biochemical pathways - Analysis of plant growth regulation - Study of the regulation of plant gene expression - Improved understanding of metabolism, cell wall structure, photosynthesis and nitrogen fixation - Innovative methods for identifying function of agriculturally important genes and gene products	Research, education and extension outputs - vetted by scientists and educators - submitted to CSREES - Research findings disseminated - Publications - Citations - Disclosures - Patents - Best management practices - Curricula designed - Undergraduate and graduate students graduate - Training provided to producers	- Mechanism of integration of Agrobacterium DNA into the host plant genome - Genes and biochemical pathways conferring resistance to plant diseases and pests - Modes of action of plant hormones (e.g. cytokinin, brassinosteroids, auxin) - Role of programmed cell death in disease resistance and plant development - Proteins and genetic pathways important for nitrogen fixation, chlorophyll biosynthesis and seed oil composition - Source-sink regulation of carbon allocation	- Crop models (e.g. tomato, rice, alfalfa) being developed for the study of basic plant biology including developmental and biochemical studies, and transfer of knowledge gained from model organisms to agricultural species - Signal transduction pathways and cross-talk between hormones or between hormone and light being elucidated. - Developed commercial methods for production, shipping and marketing of flowering orchid plants - Developed tomato plants expressing new genes to improve pest resistance	- Detailed understanding of the physiology, biochemistry, gene function, and regulation of gene expression in crop plants to better use agriculturally important genes for improved crop production, quality and sustainability - Detailed understanding of developmental pathways and signal transduction mechanisms in agricultural plants to improve their performance - Detailed understanding of plant metabolic pathways and their interactions to improve quality and add value

Assumptions - Knowledge, methods & materials from KA 206 are used in KA 201, in a synergistic cycle also including KA 202. CSREES accomplishes work on plant biological efficiency by collaborating with partner organizations & agencies. CSREES personnel establish networks for research, education, and extension.

External Factors - Funding will determine the availability of capable scientists & graduate students; Flexibility of funding sources, & the vision of participants & administrators will determine if work in this KA is integrated from basic through applied research & education, to extension & practice.

Key KA 206 Outputs and Outcomes

Gene Silencing Mechanisms in Plants
NRI competitive grant CRIS accession no. 0208072
Mission Area: Research

Plants contain a remarkable set of genetic control mechanisms that involve "gene silencing," in which tiny RNA molecules associated with proteins called ARGONAUTE shut down the function of certain genes. Genetic and genomic analyses have revealed many distinct silencing pathways that function to regulate specific sets of "target" genes. Silencing mechanisms are used by plants to regulate genes involved in the development of organs, respond to environmental extremes, and defend against pathogens like viruses. Understanding how gene silencing works will illuminate important mechanisms that govern plant form, function, and productivity.

Outputs

- Researchers deciphered the basis whereby several ARGONAUTE proteins interact with specific subsets of small RNAs.
- Chemical differences at the ends of small RNAs were shown to be key "codes" that direct different small RNAs to different ARGONAUTE proteins, thus conferring molecular specificity. Results were published in the journal *Cell*, April, 2008.

Gene Imprinting in Plants
NRI competitive grant CRIS accession no. 0204589
Mission Area: Research

Gene imprinting is the phenomenon whereby the maternal or paternal copy of a gene (but not both) is expressed in the offspring. Imprinting regulates a number of genes essential for normal development in plants and mammals. A research group at the University of California-Berkeley has been studying a plant gene whose maternal copy, but not the paternal copy, is expressed in the seed. This basic work will enhance our understanding of plant seed development and therefore impact agriculture, because the seed is the edible part of many crop species. This work also has implications beyond agriculture, as gene imprinting is important for normal human development as well.

Outputs

- The researchers discovered that imprinting of this gene is regulated by another gene in a novel way.
- This novel mechanism of gene imprinting, as well as other plant processes involving similar mechanisms, is summarized in the review article published in the journal *Cell* in 2008.

Early Ripening of Tomato Fruit
NRI competitive grant CRIS accession no. 0204250
Mission Area: Research

The plant hormone ethylene is essential for the ripening of many fruits, including tomato. The perception of the ethylene signal by the cell is mediated by an ethylene receptor at the cell surface. In tomato, this receptor is known as *LeETR4*. A research group at the University of Florida discovered that suppression of the *LeETR4* receptor causes early ripening, whereas fruit size, yield and flavor-related chemical composition are largely unchanged. Early fruit ripening is a highly desirable and valuable trait in tomato, because it allows the plant to be grown outdoors in high altitude locations where the growing season is shorter.

Tomato is the most economically important vegetable crop grown in the USA, and is a significant dietary source of important phytochemicals, such as carotenoids and flavonoids. Knowledge gained from this research will provide useful tools for the generation of tomato cultivars with this desirable trait.

Output

- Results were published in the *Plant Biotechnology Journal* in 2008.

Outcome

- Knowledge gained from this research will provide useful tools for the generation of tomato cultivars with this desirable trait.

Increased Phosphorus Uptake by Plants
NRI competitive grant CRIS accession no. 0207807
Mission Area: Research

Plants challenged by low phosphorus levels in the soil undergo dramatic morphological and architectural changes in their root systems in order to increase their absorptive surface area. Researchers at the University of Connecticut and Purdue University found that these changes were mediated by increased expression of an enzyme called AVP1. These changes are accompanied by increased soil acidity which results in increased displacement of phosphorus from insoluble soil complexes, making the phosphorus more available to the plant. Molecular manipulation of AVP1 expression in crop plants such as tomato and rice results in plants that outperform controls when challenged with limited phosphorus.

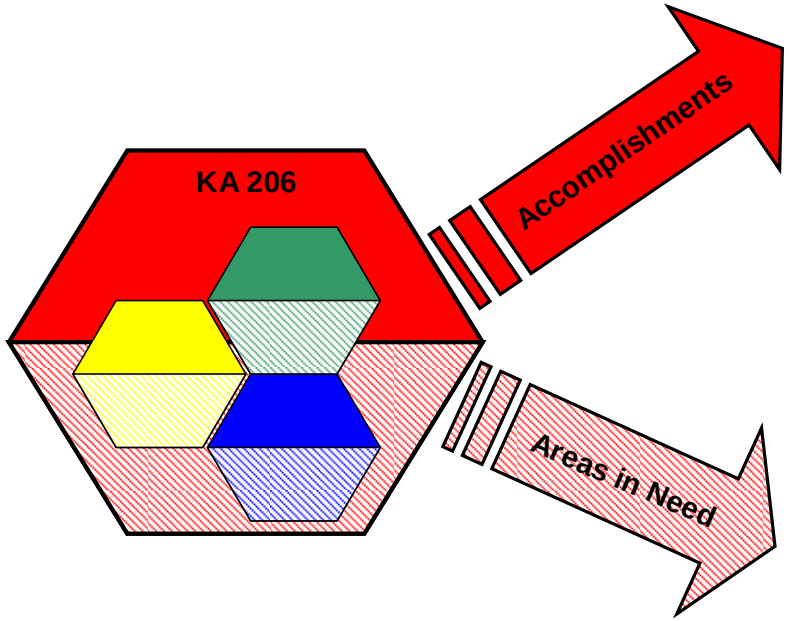
Thus, over-expression of AVP1 helps alleviate agricultural losses in low-phosphorus soils which are prevalent in the tropical and subtropical areas of the world. Consequently, it helps reduce phosphorus runoff pollution because the reliance on phosphorus-containing fertilizers is reduced. Crops over-expressing AVP1 also exhibit enhanced resistance to water deficits and are likely to require minimal irrigation.

Output

- Results were published in the *Plant Biotechnology Journal* in 2007.

KA 206 Honeycomb:

Knowledge Area 206: Basic Plant Biology



- •New knowledge developed for the mechanism of integration of Agrobacterium DNA to the host genome
- •New knowledge developed of genes and biochemical pathways conferring resistance to plant diseases and pests
- •New knowledge developed of signal transduction pathways and cross-talk between hormones or between hormone and light signals
- •New knowledge developed of identified receptors for major plant hormones (ethylene and brassinosteroids)

KA 206 - Major Themes

- Determination of the functions of agriculturally important genes and gene regulation mechanisms
- Development of fundamental information on plant biosynthetic and metabolic systems and cellular structures and processes
- Development of fundamental information on developmental and hormonal biology

- •Understanding of plant pathways and their interaction, to drive understanding of plant systems
- •New knowledge of development and physiology of crop plants, for improving essential and valuable characteristics
- •Crop models for the study of basic plant biology, and transfer of knowledge gained from model systems (e.g. Arabidopsis) to agricultural species
- •.Detailed understanding of the regulation of gene expression in crop plants to better use agriculturally important genes for improved crop production and quality
- •Detailed understanding of signal transduction mechanisms in agricultural plants to improve their performance.

Knowledge Area 211: Insects, Mites, and Other Arthropods Affecting Plants

KA 211 Introduction:
This Knowledge Area (KA) 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 KA 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 (KA 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 Knowledge Area KA 404. Biosecurity measures to limit invasive insects, mites, and other arthropods in plant management systems are included here.

KA 211 Logic Model

KA 211: Plant Insects, Mites, and Other Arthropods Affecting Plants

Situation	Inputs	Activities	Outputs	Outcomes		
				Knowledge	Actions	Conditions
This knowledge area focuses on plant yield and quality as affected by indigenous and exotic insects, mites, & other arthropods. Research, education and extension topics supported within KA 211 include 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 widely diverse audience	**Funding Sources:** - 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	- Investigate and understand the advantages of polyandry in honey bee populations - Investigate and understand the history, biology and behavior of fire ants - Develop and provide tools to minimize/eliminate the negative environmental effects of fire ants - Research conducted to investigate effective methods for minimizing/eliminating the negative effects of the leaf-feeding beetle - Investigate methods for increasing blueberry yield by controlling flower thrips	- Expanded knowledgebase about plant protection methods and products - Trained workforce - Shared knowledge - Exchanged experiences among producers - Research, education and extension findings vetted by scientists - Research, education and extension findings submitted to CSREES - Research findings disseminated - Publications - Citations - Patents - Best management practices - Curricula - Undergraduate and graduate education - Training provided to producers	- Radio frequency (RF) treatments as a pest control method can effectively control insect pests at life stages present without negatively affecting commodity quality or storability and may serve as a non-chemical alternative to chemical fumigants for post-harvest pest control in commodities such as almonds, pecans, pistachios, lentils, peas. - Because growers lost crops due to misidentifying species and applying the wrong insecticide, entomologists created a pocket-sized, colorful insect guide that would follow farmers into the field. The education and exposure that this tool provided should increase farmer adoption of IPM practices in the coastal plains region of Virginia. - The *Nature's Partners* curriculum increases the public's awareness and sense of responsibility that are essential to a successful conservation program for pollinators.	- Growers are now able to use a non-insecticidal control that is friendly to biological controls, and fits well into the integrated pest management strategy. - Growers are now able to correctly identify pest species and adopt IPM strategies for their control. - The introductory pollinator curriculum focuses on two of the many pollinators as a means for teaching basic concepts about the process and importance of pollination for school aged children.	- Increased control efficiency for U.S. agriculture - Increased plant pest identification - Improved commodity quality - Reduced use of pesticides - Increased public awareness of the importance of pollinators.

Assumptions - CSREES has the funds, personnel and facilities to accomplish this objective. There is a need to collaborate with lateral partner organizations and agencies.

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.

Key KA 211 Outputs and Outcomes

Advantages of Genetic Diversity in Mating Bees
NRI Competitive Grant CRIS accession no. 019623
Mission Area: Research

Bees, unlike many insects, practice polyandry, when the queen mates with multiple, different males. This process promotes genetic diversity within the colony by decreasing intracolony relatedness. Understanding the advantages of polyandry in honey bee populations may lead to improved management of colonies and higher pollination efficiency for U.S. agriculture. Researchers at Cornell University in Ithaca, NY, conducted a study of honeybee swarms to determine if genetic diversity proved to be an advantage or disadvantage to a colony in establishing a new nest.

Their work revealed that the productivity of the genetically diverse colonies far exceeded that of the uniform colonies in all categories evaluated. The higher production rates of the genetically diverse colonies early in the study enhanced the growth rates of the swarms later in the study. Advantages of the genetically diverse population allowed colonies to more effectively survive the winter and produce swarms the following season. The founding of a successful colony depends on efficient foragers that can quickly supply the colony with food reserves. The results from this study suggest the evolutionary practice of polyandry in honeybees is intimately linked to colony fitness.

Key Output

- Publication in the journal Science.

Outcome

- The results from this study suggest the evolutionary practice of polyandry in honeybees is intimately linked to colony fitness.

Using Demographic Models to Assess Biocontrol of an Invasive Plant
NRI Competitive Grant CRIS accession no. 0201842
Mission Area: Research

Garlic mustard, *Alliaria petiolata* (M. Bieb.) Cavara and Grande, is a major invasive plant in North America. A biological control program is under development, and currently five agents are in host-specificity testing in anticipation of possible North American release. The overall goal of the proposed research is to predict the most effective natural enemy(s) of garlic mustard in North America as a guide to importation decisions. For garlic mustard, the computer identified a tiny weevil, *Ceutorhynchus scrobicollis.* This insect, which is no larger than an "o" in 12-point type, is a native pest to the plant in Europe; it feeds on the plant at several stages of its life cycle. Scientists perform a stringent battery of tests in a quarantined environment before they release the control agent. In the case of garlic mustard, the weevil was exposed to no-choice feeding tests on 76 different species. Forty-five of these species were in the cabbage family, of which garlic mustard belongs. Test plants within the cabbage family included horticultural varieties. If the weevil liked, and could complete its life cycle on, cabbage, it could prove a threat to an

important agricultural crop. This particular weevil passed that test and proved it was an acceptable biological control agent.

The weevil is scheduled for release into an infested forest once it receives approval from the regulatory arm of the USDA, the Animal and Plant Health Inspection Service-Plant Protection & Quarantine. Davis believes the simulation models provide the guidance to effectively and safely select biological control organisms to reduce the threat of invasive plants.

Key Output

- Host-specificity testing completed for the weevil, *Ceutorhynchus scrobicollis* for the biological control of garlic mustard.

Outcome

- Simulation models can provide the guidance to effectively and safely select biological control organisms to reduce the threat of invasive plants.

Radio Waves May Offer a New, Environmentally Safe Pest Control Method

Methyl Bromide Transition Grant CRIS accession no. 0201015
NRI Competitive Grant CRIS accession no. 0203893
Mission Area: Research

In today's global marketplace, agricultural exports carry the risk of introducing exotic insect pests into new environments, causing major economic losses. Effective pest control methods, such as methyl bromide, unfortunately come with toxic gases and chemicals. New research using radio frequency (RF) treatments as an environmentally-friendly pest control method may provide a new alternative.

RF treatments effectively control insect pests at life stages present in in-shell walnuts without negatively affecting walnut quality or storability. This process is technically feasible for large-scale commercial applications. RF treatments may serve as a non-chemical alternative to chemical fumigants for post-harvest pest control in similar commodities (such as almonds, pecans, pistachios, lentils, peas, and soybeans), reducing the long-term impact on the environment, human health and competitiveness of agricultural industries.

Key Outputs

- Two papers published in *Postharvest Biology and Technology*
- Book chapter published in *Heat Treatments for Postharvest Pest Control: Theory and Practice*.

Outcome

- Radio frequency treatments may serve as a non-chemical alternative to chemical fumigants for post-harvest pest control in similar commodities (such as almonds, pecans, pistachios, lentils, peas, and soybeans), reducing the long-term impact on the environment, human health and competitiveness of agricultural industries.

Photo Guide of Pests and Beneficial Insects of Corn, Soybean and Wheat in the Mid-Atlantic Region
2004 IPM Enhancement Grant: Special Projects
Mission Area: Extension

Discovering that many mid-Atlantic growers lost crops due to misidentifying species and applying the wrong insecticide, entomologists Ames Herbert and Sean Malone with Virginia Tech decided to create a resource that would help growers identify what pests were devouring their crops. Contacting extension specialists and researchers at the University of Delaware and the University of Maryland, the Virginia Tech group began brainstorming the specifications for a pocket-sized, colorful insect guide that would follow farmers into the field. Gathering ideas from growers, commodity boards, pest control industries and other stakeholders and collecting lists of insect pests from Delaware and Maryland specialists to complement Virginia's list, Herbert and Malone developed a template for a new, regional mid-Atlantic guide to pests and beneficial insects. They have also received positive comments from the evaluation cards that they included in each copy of the printed guide. Returned survey cards indicate that on a scale of 1=not useful to 5=very useful, the insect identification guide was useful (4.7, n=178), improved the user's ability to identify an insect (4.6, n=177), and helped the user in making a better pest management decision (4.4, n=170). Herbert and Malone said that the education and exposure that these IPM projects provided should increase farmer adoption of IPM practices in the coastal plains region of Virginia. In response to the helpfulness of the guide, one farmer wrote, "I quickly identified a true armyworm and took action with the help of my extension agent."

Key Outputs

- Photo guide of Pests and Beneficial Insects of Corn, Soybean and Wheat in the Mid-Atlantic Region produced.

Outcome

- Results from a card survey indicated that the photo guide was useful, improved the user's ability to identify an insect, and helped the user in making a better pest management decision.

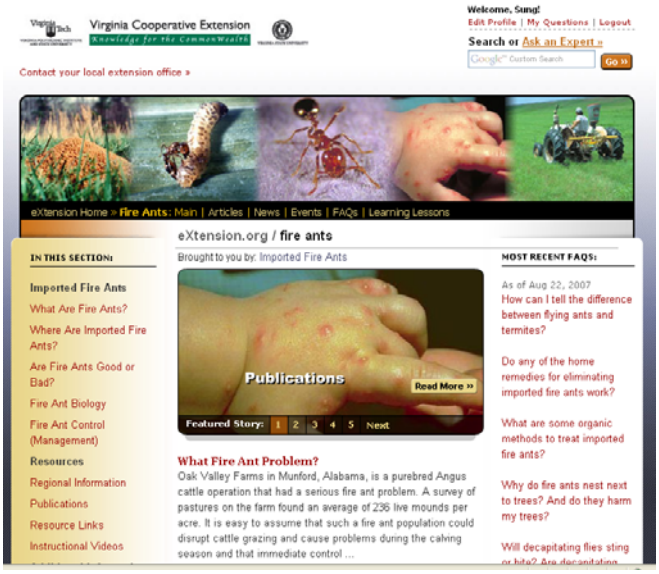
eXtension Fire Ants Community of Practice
CSREES eXtension Initiative
Mission Area: Extension

The eXtension Fire Ants Community of Practice, a virtual community led by four Extension professionals from across the country, includes nearly 100 members from land-grant universities and other agencies, including USDA-APHIS. The public web site is located at: http://www.extension.org/fire+ants

The goal of the Imported Fire Ants Community of Practice is to promote better understanding of the history, biology and behavior of fire ants, and to provide tools to help manage fire ant

problems in an environmentally and economically sound way. The Fire Ant team's ongoing collaborative work will provide consumers a source of reliable, up-to-date information from a vast knowledge base of science-based, peer reviewed materials.

This site provides online learning lessons, videos, publications, frequently asked questions, and interactive Decision Modules to help users customize the resources according to their situation. For users that register, the view is modified so the information is customized for their locality (State and County).



Key Outputs

- An eXtension Fire Ants Community of Practice and associated website was established.

Outcomes

- The eXtension Fire Ants Community of Practice will provide consumers with a source of reliable, up-to-date information from a vast knowledge base of science-based, peer reviewed materials.
- This will promote a better understanding of the history, biology and behavior of fire ants, and provide tools to help manage fire ant problems in an environmentally and economically sound way.

The Fire Ant community of practice has been developed through funding provided to the e-eXtension initiative by CSREES.

The Nature's Partners: Pollinators, Plants, and You

2002 Award no. 2002-38831-01524, Richard Ponzio, UC Davis
2007 Proposal no. 2007-04955 (new project), Coevolution InstituteCRIS accession no. 0212060
Mission Area: Education

The *Nature's Partners* curriculum is a step toward increasing the public's awareness and sense of responsibility that are essential to a successful conservation program for pollinators. This curriculum focuses on pollinators and the important role they play in providing many of the foods we eat and the plant fiber used in our clothing and household goods, and presents ways young students can help pollinators survive and flourish by protecting and creating pollinator-friendly habitat.

This introductory curriculum focuses on just two of the many pollinators as a means for teaching basic concepts about the process and importance of pollination. Bees were chosen due to their primary importance among pollinators and butterflies were chosen because of the interesting and distinctive stages of their life cycle and their intrinsic appeal.

- The Nature's Partners Curriculum is an inquiry learning-based curriculum for young people in the 4th through the 6th grade.

The activities are appropriate for the formal classroom or for a non-formal education setting and can easily be adapted to fit the needs of the students and the teaching situation.

Service Learning

The context of community is an important aspect of this program. The program will be most effective when the young people are involved in contributing to the community through a service learning project.

Key Outputs

- The *Nature's Partners* curriculum was developed. It focuses on pollinators and the important role they play in providing many of the foods we eat and the plant fiber used in our clothing and household goods, and presents ways young students can help pollinators survive and flourish by protecting and creating pollinator-friendly habitat.

Outcome

- The *Nature's Partners* curriculum will help increase the public's awareness and sense of responsibility that are essential to a successful conservation program for pollinators.

Reading, Writing, and IPM
Northeast Regional IPM Grant
Mission Area: Education

Today, IPM outreach is extending beyond the agricultural community to all citizens. Teaching IPM concepts to school children has emerged as a strategy that prepares all citizens to make decisions that safeguard the environment and human health. With IPM fundamentals under their belts, children will understand how growers help to protect the environment, and they will be more likely to apply IPM principles in their own homes and daily lives.

In 2006, Connecticut Extension Educator Donna Ellis received Northeast IPM funding to expand an IPM Environmental Education Curriculum that engages students and their families in learning about insects, invasive plants, and other pests that occur in and around homes, buildings, farmland, and natural areas. The University of Connecticut curriculum teaches students what pests are (insects, weeds, pathogens), how to control them (mechanical, biological, chemical, cultural controls), and how to protect the environment by keeping our food and water safe and preserving biological diversity. The curriculum is especially relevant to science programs but also links to social studies, language arts, math, and art.

The IPM curriculum is developed as modules, presented to educators through workshops and training sessions. “Our trainees have been very enthusiastic,” Ellis reports, “because the modules promote critical thinking and scientific inquiry.”

Key Outputs

- An IPM Environmental Education Curriculum was expanded to engage students and their families in learning about insects, invasive plants, and other pests that occur in and around homes, buildings, farmland, and natural areas.

Outcome

- With IPM fundamentals under their belts, children will understand how growers help to protect the environment, and they will be more likely to apply IPM principles in their own homes and daily lives.

Teaching Kids about IPM: A Curriculum for K-5 Education in Urban and Landscape IPM
Southern Regional IPM Grant
Mission Area: Education

In several South Carolina schools, children prowl the halls in a unique scavenger hunt. The treasures? Bugs. Using a new elementary school curriculum developed by Clemson University IPM staff, teachers hope to teach kids about integrated pest management, helping them change their habits not only to reduce pests on school grounds - and in turn reduce the use of pesticides - but to tell their parents how they can reduce pesticide use at home. A fully furnished miniature house includes several situations that attract pests, including a leaky outside faucet, food left on the kitchen counter, bushes located too close to the house, and even a puppy who is not

housebroken. The house comes with its own activity guide that includes a game that challenges children to label pest hazards with a red sticker. Geoff Zehnder and his colleagues at Clemson hope that what the children are learning will filter up to their parents. According to a pesticide fact sheet from the California Environmental Services Department, homeowners may use up to 10 times more pesticides per acre than farmers use. They are hoping that the Discovering IPM curricula will help lower that average in the state.

Key Outputs

- A new elementary school curriculum was developed by Clemson University IPM staff.

Outcome

- Teachers hope to teach kids about integrated pest management, helping them change their habits not only to reduce pests on school grounds—and in turn reduce the use of pesticides— but to tell their parents how they can reduce pesticide use at home.

IR-4 2007 Accomplishments
USDA Special Grant
Mission Area: Research

US EPA established 203 permanent tolerances and five exemptions based on IR-4 submissions. These decisions support 628 new specialty crop use registrations for conventional and reduced risk pest control products and 19 for biopesticides for a total of 647. New use registrations were spread over 33 pest control products.

Key Outputs

- EPA published the Final Rule for two expanded crop groups and one new group. Final Rules included an expanded Bulb vegetable group 3, and expanded Berry and small fruit group 13, and the establishment of a new Edible fungi group 21. The decision for these crop groups will significantly increase the number of additional registrations for crops in these groups.

- IR-4 conducted 644 field trials associated with 95 high priority studies on food crops to support eventual registration of conventional/reduced risk pest control products to answer specialty crop grower pest management needs.

- 2007 was the first year the Canadian Minor Use Program served as sponsor and study director in joint residue studies.

- The Biopesticide Grant Program funded five Early Stage, 19 Advanced Stage, and 13 Demonstration Stage projects. These were conducted at 21 universities and USDA research centers. The research involved 30 scientists and nearly 100 product-crop combinations. EPA co-funded and co-reviewed the demonstration stage grants. EPA

also provided additional resources to support three Technology Transfer Projects associated with the demonstration projects to further develop the extension phase of those projects.

- Working with funding provided through a US EPA Region 2 grant, IR-4 created and posted on its website, a Biopesticide and Organic Label Database for Integrated Pest Management (IPM) practitioners.

- IR-4 submitted eight Ornamental Horticulture data packages to registrants: two summaries on efficacy and six on crop safety. These comprehensive data packages contained results from 1658 field trials managed by IR-4.

- The IR-4 Ornamental Horticulture program conducted nearly 1246 trials with greenhouse and field ornamental crops. These will support recommendations in 2008/2009.

- The Center for Economic Analysis at Michigan State University published an economic analysis of IR-4 Project activities and concluded that IR-4 contributes $7.7 billion to the annual gross domestic product.

- IR-4, working alongside the USDA-Foreign Agricultural Service, US EPA and the Food and Agricultural Organization of the United Nations, brought together nearly 250 people from 56 countries to participate in the first Global Minor Use Summit. The Summit initiated a dialogue among countries toward the concept of working together to solve the minor use problem on a global basis.

- IR-4 had to navigate through one of the most challenging financial situations in the Project's 44-year history. This challenge resulted from Congressional mandates which changed how USDA funds are administered. These changes could have resulted in a 25% reduction of IR-4 funding, as well as created delays in the distribution of IR-4 allocated funds.

- IR-4 along with industry continues to work to implement the provisions of the Pesticide Registration Improvement Act of 2007 (PRIA II). The new provisions are more complicated and cumbersome. However, IR-4 packages are reviewed by EPA within an extremely rapid time frame, where most decisions are made in less than one year.

Outcome

- The Center for Economic Analysis at Michigan State University published an economic analysis of IR-4 Project activities and concluded that IR-4 contributes $7.7 billion to the annual gross domestic product.

Western IPM Center: IPM Implementation in the Nation's Schools
USDA Special Grant
Mission Areas: Research, Extension, Education

Regional Integrated Pest Management (IPM) Centers encourage the development and adoption of IPM drawing expertise from many disciplines to support effective, economical pest management practices that reduce risks to the environment and human health. Established in 2000 by the CSREES, the Regional IPM Centers play a key role in implementing the National Road Map for IPM, which identifies strategic directions for IPM research, implementation, and measurement for all pests, in all settings, throughout the nation.

Pest management practices in our nation's schools often lead to unmanaged pest infestations, unsafe and illegal use of pesticides, and unnecessary pesticide exposure. In response to these risks and the need to protect schoolchildren from pesticide exposure, the Western IPM Center led a large collaborative effort involving the Regional IPM Centers, U.S. EPA, the IPM Institute, land-grant universities, school district personnel, and private companies.

Outcome

- Collaborative effort between Regional IPM Centers, U.S. EPA, the IPM Institute, land-grant universities, school district personnel, and private companies has produced the first national Pest Management Strategic Plan (PMSP) for IPM in Schools.

Southern IPM Center: Protecting Crops and Lowering Costs
USDA Special Grant
Mission Area: Research, Extension, Education

Regional Integrated Pest Management (IPM) Centers encourage the development and adoption of IPM drawing expertise from many disciplines to support effective, economical pest management practices that reduce risks to the environment and human health. Established in 2000 by the CSREES, the Regional IPM Centers play a key role in implementing the National Road Map for IPM, which identifies strategic directions for IPM research, implementation, and measurement for all pests, in all settings, throughout the nation.

According to the USDA's Economic Research Service, savings attributable to the use of Integrated Pest Management Pest Information Platform for Extension and Education (ipmPIPE) during the 2005 season alone were as high as $299 million. A competition in 2008 added two new components:

Outputs

- Two new ipmPIPE platforms were developed in 2008. These included forecasting powdery mildew in cucurbits and predicting pecan nut casebearer activity.

Outcome

- According to the USDA's Economic Research Service, savings attributable to the use of Integrated Pest Management Pest Information Platform for Extension and Education (ipmPIPE) during the 2005 season alone were as high as $299 million.

Integrating Conventional and Biological Control of European Corn Borer in Sweet Corn: Efficacy and Economics

Pest Management Alternatives Program Special Research Grant
Mission Area: Research, Extension

Sweet corn, a valuable crop in the U.S., is plagued by European corn borer. Despite multiple insecticide applications, it still causes economic losses. Field-scale use of *Trichogramma* for biological control has lagged in the U.S. because of inadequate research investment, widespread use of insecticides, and lack of supporting economic analyses. Our goal is to encourage integration of biological control with current production practices to improve management of European corn borer in sweet corn, and to reduce the number of insecticide sprays. We conducted research to quantify effects of *T. ostriniae* alone and integrated with insecticide sprays to control European corn borer in sweet corn and analyze the economics of *T. ostriniae*. With this approach, we present stakeholders with not only biological efficacy, but also a dollars-and-cents evaluation of *T. ostriniae* to improve IPM of European corn borer. We can potentially offer an economical tactic that is environmentally friendly and that can be easily integrated with current production practices, especially in the Northeast and North Central states. In 2006, trials were conducted on sweet corn plots measuring 80 x 100 ft. There were four treatments 1) untreated controls, 2) *T. ostriniae,* 3) insecticide treated, and 4) insecticide plus *T. ostriniae*. *T. ostriniae* was released at approx 82,000/ acre after detection of European corn borer oviposition. That rate was used rather than our standard of 30,000/acre to adjust for emigration from the plots and to ensure establishment after a single release. Plots were sampled semi-weekly to locate egg masses for European corn borer life table analyses and to determine the need for insecticidal sprays. All egg masses that were found were digitally photographed at 3-4 day intervals until the fate of the egg mass had been determined. Archived digital pictures were used to accurately count the number of eggs per egg mass and to determine if individual eggs had been parasitized, predated, died for unknown causes, or whether European corn borer larvae had emerged. At harvest, plant damage was recorded for each treatment. Results indicate that *T. ostriniae* plus insecticide was most effective in reducing ear damage (7.5 percent damage). *T. ostriniae* alone (10.7 percent damage) was equivalent to a methomyl spray (10.1 percent damage). Controls had significantly more damage (15.4 percent) than *T. ostriniae* plus insecticide, but were not significantly different than *T. ostriniae* or insecticide alone. Preliminary analyses indicate that *T. ostriniae* alone or integrated with insecticide is economically justifiable. The analysis was conservative, based on an assumption of 23 dollars/acre for *Trichogramma*. In actuality, the shipping cost goes down considerably if more than one acre is treated per shipment of wasps. Cost/acre would drop to approximately $16.60 if five acres were treated per shipment. Additionally, the effect of treatments on arthropod community structure was assessed to

determine non-target effects of each treatment. Analyses are pending, but a distinct reduction in all arthropod counts was noticed after treatments with insecticide.

Outputs

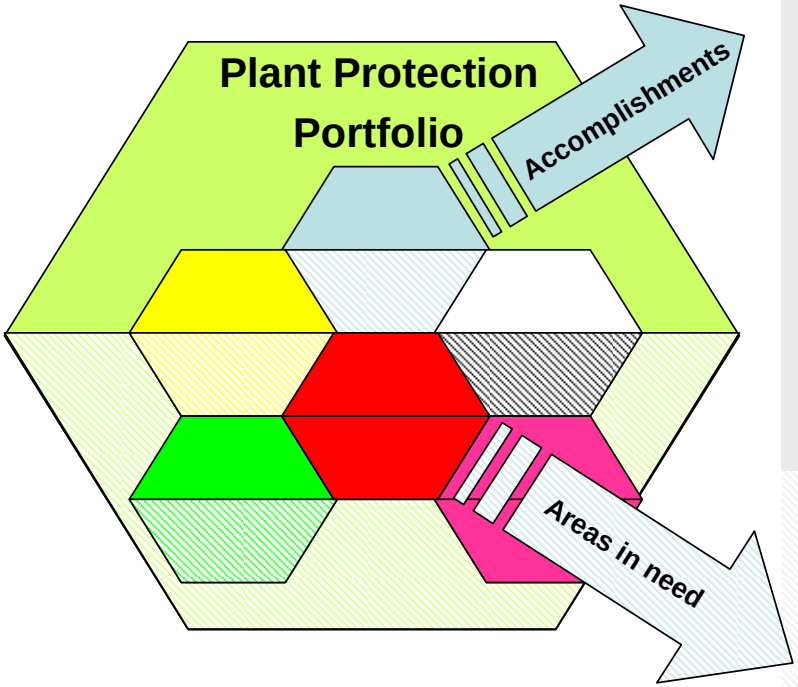
- Integrated Pest Management strategies were developed for corn earworm emphasizing biological and chemical control.

Outcome

- The use of IPM tactics significantly reduced corn earworm damage compared to control plots.

KA 211 Honeycomb:

Knowledge Area 211: Insects, Mites and Other Arthropods Affecting Plants



KA 211 – Major Themes

- **Prevention**
- **Biology and Ecology**
- **Epidemiology**
- **Detection and Diagnosis**
- **Management**
- **Economics and Safety**

- 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
- Global warming – documentation of range shifts of species
- Proactive biological control of weed 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
- West Nile transmission cycle
- Role of soybean aphid in virus transmission
- National Plant Diagnostic Labs
- Detection and distribution of invasive species , e.g., soybean aphid, pink hibiscus mealybug, Haanchen mealybug
- 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
- BT corn and monarchs
- Web-based pesticide safety education sites
- Economic thresholds established for key species
- Safer, less risky pesticides developed
- FQPA issues addressed

- Urban pest management
- Human-insect interactions
- Promote characterization of ecological factors limiting spread of introduced, invasive species
- 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
- Role of insects in transmission of food-borne pathogens
- Role of insects in the ecology of antibiotic resistance in microbes
- Detection of invasive species at low populations
- More rapid and inexpensive detection tools
- More efficient use of remote sensing technology
- Insects as biosensors
- Management strategies for honey bee CCD and 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
- Greater emphasis on ecological assessment of transgenic crops
- Promote research on preservation/management of native and managed pollinators

Knowledge Area 212: Pathogens and Nematodes Affecting Plants

KA 212 Introduction

KA 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. KA 212 comprises approximately 1/3 of the Plant Protection Portfolio budget. The scope of this knowledge area covers research, education, and extension concerning the health of crop, range and forest lands of the United States (approximately 1 billion acres), the nursery and horticultural industries, 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 projects in 2007, about 82% of the KA 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.

KA 212 Logic Model

KA 212: Pathogens and Nematodes Affecting Plants

Situation	Inputs	Activities	Outputs	Outcomes		
				Knowledge	Actions	Conditions
This knowledge area 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 of the country. In general, the discipline focus covers prevention, biology and ecology of pathogens, detection and diagnosis technology, epidemiology, management, and economic sustainability and safety.	**Funding Sources:** - Federal - State or local Some provide funding that contributes to research **Human Capital**: - NPLs - Extension personnel - Teachers - Researchers - Para-professionals - Stake holders - (Industry, farmers, etc.) - Volunteers	- Investigate plant-fungal pathogen interactions - Research methods that will reduce/eliminate the detrimental effects of Fusarium head blight (FHB) on wheat - Develop programs to educate growers about effective practices for reducing/eliminating the effects of pests	- Expanded knowledgebase about plant protection methods and products - Trained Workforce - Shared knowledge - Exchanged experiences among producers - Research, education and extension findings vetted by scientists - Research, education and extension findings submitted to CSREES - Research findings disseminated - Publications - Citations - Patents - Best management practices - Curricula - Undergraduate and graduate education - Training provided to producers	- Increased understanding of genetic control of pathogenicity and morphogenesis in fungi, and characterizing fungal interactions with host plants in molecular detail. - Reductions in deoxynivalenol (DON) mycotoxin levels resulted in higher quality grain - Growers who attended rice IPM monitoring programs indicated that their awareness and knowledge of controlling plant diseases without pesticides increased - Increased grower's awareness of late blight disease, proper identification of the disease, and practices for controlling late blight disease	- Arrays have been designed and are being optimized. Double mutants have been developed and through an improved method using dwarf maize will enhance the efficiency of the process. - Field monitoring for late blight disease increased - Use of the number of preventive spray applications were reduced because of early disease detection practices used	- Decrease spread of disease - Gain control of plant disease epidemics - Increase health of crop - Improved economic performance of producers - Plant protection related problems solved

Assumptions - CSREES has the funds, personnel and facilities to accomplish this objective. There is a need to collaborate with lateral partner organizations and agencies.

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.

Key KA 212 Outputs and Outcomes

Fire-Blight of Apples and Pears
Special Research Grant; New York State Ag & Markets Apple Research and Development Program; Michigan Apple Research Committee
Mission Area: Research, Extension

Fire blight, caused by the phytobacterium *Erwinia amylovora*, is a devastating disease of apple in Michigan and New York states, as well as other apple growing regions across the United States. In Michigan alone, apple acreage has declined about 20% in the last 5 years due to antibiotic-resistant *E. amylovora*. Fire-blight is not only destructive to the current year's crop, but reduces subsequent production by killing fruit spurs, branches, and whole trees. Until 2003, the industry standard for control of fire-blight was Streptomycin sprays; however the disease is not controlled completely by any single management procedure. With the advent of the Streptomycin resistant strain in Michigan, the race is on to find other solutions for integrated management of the pathogen. Infection of apple rootstocks with fire blight causes a particularly harmful and costly phase of the disease, since it almost always results in death of the tree. This is a multiple loss to the farmer, since several years of production are lost, and replacement trees must be bought and established. There are no chemical or cultural solutions for rootstock blight; the only answer is fire-blight resistant rootstocks.

The partnership between Drs. Herb Aldwinckle (Cornell University) and George Sundin (Michigan State University) on fire-blight is funded by a Special Research Grant. Dr. Aldwinckle has additional funds through the NYS Ag & Markets Apple Research and Development Program, and Dr. Sundin has additional support from the Michigan Apple Research Committee. Cornell University dedicates a research and an extension associate to the program. Dr. Sundin employs 2 full time post-doctoral fellows for this program. Both groups investigate solutions to immediate problems and longer-term basic initiatives aimed at managing fire blight disease through host resistance. A focus in Michigan has been on the Streptomycin resistance (Sm^R) problem, which has impacted the best material for fire blight management, and on finding alternative solutions for controlling Sm^R strains. Researchers have tracked the emergence and spread of Sm^R strains of the fire blight pathogen *E. amylovora* throughout Michigan in surveys from 2003-2008, and used genetic testing to determine that resistance is caused by two distinct strains whose populations have increased and spread due to Streptomycin selection pressure. When Sm^R was detected in New York, Dr. Aldwinckle was able to use genetic tools from the Sundin lab to identify the Sm^R strains, which were subsequently eradicated. Researchers at Michigan State have investigated the efficacy of using growth regulators, new antibiotics and biological control for integrated management of the disease. Research has evaluated the best of the Geneva rootstocks, and rootstocks from breeding programs in other countries for resistance to fire-blight in an orchard situation.

Outputs

- Several Geneva rootstocks (including G.41, G.16 and G.30) and the rootstock B.9 were confirmed as being highly resistant to infection during artificial epidemics in the field.

- Two alternative antibiotics, Agry-Gent and Kasumin, control Sm^R *E. amylovora* have been proven efficacious and are registered for use.

Outcomes

- New fire-blight resistant rootstocks are now entering the nursery trade providing apple growers with an excellent method to avoid rootstock blight. Nationwide the eventual benefit of the resistant rootstocks will be in the range of $10-20 million annually.
- While the new resistant rootstocks are being deployed, new fire-blight management options have been brought into operation to replace sprays with Streptomycin and to manage the disease during spring shoot growth.
- The intense pressure to urbanize apple production lands will not result in the permanent loss of acreage as growers have to replace rootstock.
- The new antibiotics that replace Streptomycin will remain effective.
- Many of the new resistant rootstocks are developed using molecular genetic manipulation through resistance gene amplification.
- Although the genetic enhancements are derived directly from apple, there may be reluctance to convert due to anti-GM bias.

Genome Sequence of Soybean Pathogen Provides Important New Insights into How It Causes Disease

NRI Competitive Grants — CRIS accession nos. 0193889
Mission Area: Research — and 0202578

The oomycete plant pathogen, *Phytophthora sojae,* causes $200 to $300 million in annual losses to the U.S. soybean crop. Worldwide annual losses are as high as $1 billion to $2 billion. Development of effective and environmentally sustainable methods of controlling these pathogens will be enabled by increased understanding of how *P. sojae* causes disease. Research was conducted by Virginia Polytechnic Institute and State University with funding from the National Research Initiative – Microbial Biology and Microbial Genomics Programs.

Using the *P. sojae* genome sequence, Daolong Dou, Brett Tyler and colleagues at Virginia Tech have found a pair of sequence motifs which are necessary and sufficient to deliver pathogen proteins into plant cells, even in the absence of the pathogen itself. They have also identified more than 370 *P. sojae* proteins containing the sequence motif, all of which are candidate effector proteins. Effector proteins can either elicit a defense response from the plant or they can interact with plant genes to cause disease. The researchers also showed that the *P. sojae* sequence motifs can be replaced by the erythrocyte targeting signals found in the plasmodium parasite which causes malaria in humans. Thus, the host (soybean and human) machinery targeted by the effectors must be very ancient. Now that these candidate effector proteins have been identified, researchers can focus on understanding how they work together to cause disease or to elicit a plant defense reaction.

Outputs

- Researchers have identified more than 370 *P. sojae* proteins containing the sequence motif, all of which are candidate effector proteins.
- This research has led to publications describing how *Phytophthora* genome sequences uncover evolutionary origins and mechanisms of pathogenesis.

Outcome

- The development of effective and environmentally sustainable methods of controlling these pathogens will be enabled by increased understanding of how *P. sojae* causes disease.

Preparing for Wheat Stem Rust Races: Enhancing the Surveillance Network and Developing Management Recommendations
Hatch, Critical Issues Competitive Program, NRI Plant Biosecurity Program
Mission Area: Extension

Stem rust has historically been one of the most destructive diseases of wheat grown in the Great Plains and Mid-Western U.S. The use of host resistance in combination with eradication of the alternate host, common barberry, has decreased the frequency of epidemics of stem rust. The recent emergence of pathogen races with virulence on two widely used resistance genes presents a new threat to wheat production in the U.S. The USDA-ARS Cereal Disease Lab (CDL) currently coordinates a surveillance network for cereal rusts involving members of the multi-state research committees, NCERA-184 and WERA-097. However, the sampling provided by this network may miss some epidemiologically important areas and may be too infrequent in other areas to find new races of stem rust before they become widespread. Furthermore, most cereal pathologists in the U.S. have little experience managing stem rust, because regional epidemics have been rare during recent decades.

Given the threat posed by the new races of the fungus, NCERA-184 and WERA-097 propose a cooperative project that will enhance the existing surveillance for stem rust in the U.S. and provide disease management recommendations for producers. Specific activities of this project include workshops that bring disease specialists from the USDA and land grant universities together with key stakeholders to develop enhanced surveillance protocols and best management practices, and pilot program that will evaluate the effectiveness of the enhanced surveillance using stripe rust and leaf rust as model systems.

Outputs

- While the project was in its earliest stages, a synergy has developed among Land Grant Universities, USDA-ARS scientists, and industry stakeholders to address the wheat stem rust threat and be prepared for its introduction.
- A workshop has been held to plan an enhanced surveillance network and develop management recommendations for stem rust. Participants of the workshop will included

wheat pathologists from across the U.S. that actively participate in the NCERA-184 and WERA-097 multi-state research committees, researchers at the USDA-ARS Cereal Disease Laboratory, representatives of USDA-CSREES, and wheat and barley stakeholders.

- Results of the workshop include:
    - A protocol to improve field surveillance was developed and is in review;
    - A design for improved sentinel surveillance was introduced and defined;
    - Priorities were set for sampling to increase the likelihood of detecting novel races of stem rust and other cereal rusts;
    - A plan to reassess the information technology platform was discussed with the plan to use the Cereal Disease Laboratory as the gateway to information;
    - Plans for developing training materials were defined and assigned;
    - Plans were established to enhance communications among wheat workers and improve the chain of communications if a positive test is realized;
    - Plans to assess fungicides for grower use recommendations were established.

Outcomes

- Using lessons learned from managing the arrival of Asian soybean rust, the human resource infrastructure and technical expertise are in place to track movement, predict arrival, monitor and manage this new strain of a highly destructive pathogen that threatens an estimated 600,000 acres of U.S. wheat.

Ralstonia solanacearum Race 3 biovar 2: Detection, exclusion, and analysis of a select agent pathogen

NRI Competitive Grant CRIS accession no. 0209013
Mission Area: Research, Education, Extension

The purpose of this project is to protect U.S. potato growers and ornamental producers and offshore ornamental producers from losses caused by the plant pathogenic bacterium *Ralstonia solanacearum* Race 3 biovar 2 (R3bv2). Many *R. solanacearum* biovars, including those already present in the United States, are primarily found in Solanaceous plants in semi-tropical to tropical environments. There is abundant epidemiological evidence that R3bv2 is very destructive in cooler areas like the tropical highlands of South America, Africa, and Asia. The chance that a biovar of *R. solanacearum* could establish in colder temperate zones makes it a significant risk to potato production and lands R3bv2 on the Select Agent list. However, the biological basis of this key epidemiological trait is not understood. Alternate hosts for R3bv2 are common in the ornamental industry. Two incursions of R3bv2 have occurred on geraniums and have caused significant economic loss to the offshore ornamental producers and the U.S. distributors.

Rapid and reliable diagnostic tools to detect this pathogen are being developed. Results from research studies are increasing our understanding of how the pathogen survives and spreads.

Education and outreach efforts are focusing on building a package of training modules that will help growers, regulators, and educators detect, exclude, and control this pathogen. The research component of this project has two thrusts. Groups at University of Hawaii, University of Georgia, and University of Florida are working to develop diagnostic methods that will quickly and reliably detect the presence of R3bv2 in infected plant tissue. Ongoing experiments at Hawaii are screening for R3bv2-specific monoclonal antibodies. The second research thrust focuses on the mechanism of cold tolerance in R3bv2. R3bv2 is a U.S. Select Agent pathogen because this strain can cause brown rot of potato in cooler zones than the tropical strains of *R. solanacearum*. Researchers are initiating a global analysis of pathogen gene expression during infection of plants at cool and warm temperatures, using microarrays.

Outputs

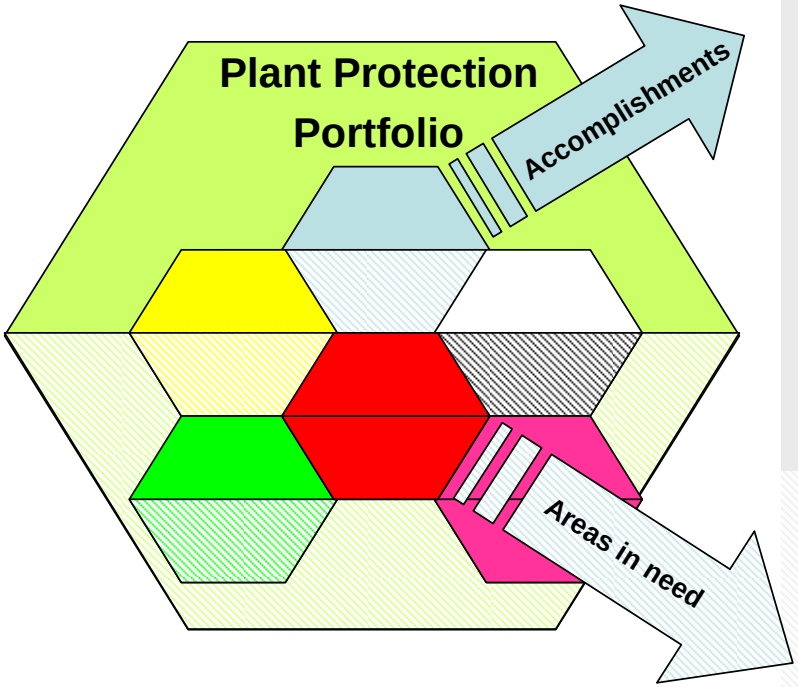
- A set of PCR primers have been identified that are collectively completely specific to R3bv2; these could be used either to expand existing PCR-based diagnostic methods or to generate oligonucleotides that could be used for nucleotide hybridization-based detection methods.
- Two detection technologies have been developed and in proof-of concept will link specific detection events to a readable signal. One involves linking R3bv2-specific antibodies or oligonucleotides to magnetic beads and ultimately using magnetic capture hybridization or secondary antibody reaction to detect a positive result. The second approach links R3bv2-specific antibodies or oligonucleotides to fluorescent nanodots which can then be detected using a portable sensitive fluorescence detector.
- It has been determined that the special ability of R3bv2 to cause disease at cooler temperatures is not due to a differential ability to survive in water at 4 degrees C or to grow in culture at 20 degrees C; both tropical and R3bv2 strains do this equally well. However, R3bv2 strains do survive much better than tropical strains in potato tubers at 4C, and they cause disease on tomato plants at 20C much better than a tropical strain. Thus, R3bv2's unique ecological capacity to threaten crops in cold climates is expressed only in interaction with host plants.

Outcomes

- Rapid and reliable diagnostic tools to detect this pathogen are being developed.
- The extension and education components of the project ensure that growers, diagnosticians, and inspectors are familiar with the symptoms and risks of plants infected with R3bv2, as well as the best methods to detect and identify this pathogen.
- A combination of effective sampling and monitoring of off-shore ornamentals destined for the U.S., trained first detectors, and highly sensitive detection technologies will assure that infected plant material does not threaten U.S. potato production.
- Understanding the basic biology of cold tolerance in R3bv2 strains has informed regulatory understanding about the level of threat to temperate crop production.

KA 212 Honeycomb:

Knowledge Area 212: Pathogens and Nematodes Affecting Plants



KA 212 – Major Themes

- **Biology and Ecology**
- **Epidemiology**
- **Detection and Diagnosis**
- **Prevention**
- **Management**
- **Economics and Safety**

- 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
- Understanding dynamics of spread
- Understanding mechanisms of spread
- Forecasting of disease based on knowledge of environmental parameters
- Pathogen's genetic fingerprint used for rapid diagnosis
- Pathogenicity sequences identified
- Digital diagnosis / NPDN
- Seed propagation certification programs
- Quarantine programs
- Traditional detection methods
- Disease free seed and stock for some diseases
- Breeding resistant plants
- Novel types of resistance genes
- Marker assisted selection
- Biological control –e.g., *Agrobacterium radiobacter*, *Trichoderma* ssp., nematodes
- Chemical control (pathogen and / or vector)
- Cultural practices, IPM
- Disease loss estimates
- Trade embargoes – international and interstate
- Safer pesticides, reduced use through IPM

- Functional genomics, proteomics, bioinformatics
- Non-host resistance
- Publicly accessible databases for genome-enabled biology
- Influence of global change on pathogen spread and disease establishment
- Accurate determination of disease origin
- 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
- Isolate resistance genes, create resistance genes
- Interfere with mechanisms of signaling, pathogen's virulence systems
- Durable resistance (understanding)
- BC agents – establishment, mechanisms, compatibility
- Alternatives to methyl bromide
- Post-harvest disease
- Chemical induction of resistance
- Chemical resistance management
- Better understanding of impacts of diseases
- Development of sustainable production practices
- Development of trace-back

Knowledge Area 213: Weeds Affecting Plants

KA 213 Introduction:
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).

KA 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 KA 213. Biosecurity and invasive weeds in management systems are a part of the portfolio.

This KA does not focus on single component issues but supports integrated efforts with other KAs. Work is excluded in KA 213 on single weed species management tactics, and biological control (see KA 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 KAs. This area focuses on yield and quality affected by competition from indigenous and exotic weeds, including aquatic weeds and parasitic plants.

KA 213 Logic Model

KA 213: Weeds Affecting Plants

Situation	Inputs	Activities	Outputs	Outcomes		
				Knowledge	Actions	Conditions
This knowledge area is focused on plant yield and quality as affected by competition from indigenous and exotic weeds, including aquatic weeds and parasitic plants. This work includes both fundamental and applied work. Areas of work include the basics of taxonomy and biosystematics to population dynamics and ecology. Breeding, genetic engineering and cultural practices are areas of study. Pest resistance, remote sensing and predictive modeling are also covered as well as biosecurity and invasive weeds.	**Funding Sources:** - Federal - State or local Some provide funding that contributes to research **Human Capital**: - NPLs - Extension personnel - Teachers - Researchers - Para-professionals - Stake holders - (Industry, farmers, etc.) - Volunteers	- Investigate management methods for reducing the harmful effects of invasive plant species -Development of integrated weed management strategies for jointed goatgrass -Develop reduced risk nightshade management systems for tomato - Develop decision support tools to implement integrated weed management on a regional scale	Expanded knowledgebase about plant protection methods and products - Trained workforce - Shared knowledge - Exchanged experiences among producers - Research, education and extension findings vetted by scientists - Research, education and extension findings submitted to CSREES - Research findings disseminated - Publications - Citations - Patents - Best management practices - Curricula - Undergraduate and graduate education - Training provided to producers	- Increased knowledge of invasive weed species and their impacts on agriculture and natural resources - Increased knowledge of integrated weed management strategies for jointed goatgrass. - Increased grower knowledge about reduced risk nightshade management systems for tomato - Increase farmer knowledge about decision support tools that can help in the implementation of integrated weed management on a regional scale	- Jointed goatgrass populations suppressed using integrated management systems utilizing herbicide-resistant wheat and multiple cultural management tactics - Better nightshade management systems will save farmers inputs (hand-weeding, tillage, and high-use rate herbicides), reduce soil erosion, and lessen soil and ground water pollution. - Improved nightshade management in tomato will allow farmers to provide a quality and economical tomato crop to meet consumer demand for locally-grown produce. - Adoption of IWM on a regional scale	- Improved weed control options - Increased plant yield - Decreased economic loss by competition from indigenous and exotic weeds - Increased yield and quality in crop production and natural areas - Improved economic performance of producers - Reduced farmer inputs (hand-weeding, tillage, and high-use rate herbicides), soil erosion, and soil/ground water pollution.

Assumptions - CSREES has the funds, personnel and facilities to accomplish this objective. There is a need to collaborate with lateral partner organizations and agencies.

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.

Key KA 213 Outputs and Outcomes

***Aegilops cylindrica* (Jointed Goatgrass)**
Special Grant CRIS accession no. 0208014
Mission Area: Research, Extension

Jointed goatgrass infests nearly five million acres of winter wheat lands in the west and Midwest and costs wheat producers in the United States an estimated $145 million annually in lost yield, reduced quality, production of less profitable crops, increased management costs, and reduced land values. Jointed goatgrass has increased rapidly in the past 25 years in part because of widespread adoption of conservation tillage systems. A Special Grant, supported research efforts by about 30 scientists in 10 western and Midwestern states on systems for suppression of jointed goatgrass in winter wheat production systems. Currently, there are six long-term Best Management Practices studies being conducted across the western United States to determine how to best integrate a herbicide-resistant wheat, developed by traditional breeding, into jointed goatgrass management systems. The studies show that under normal rainfall conditions, integrated management systems utilizing herbicide-resistant wheat and multiple cultural management tactics will aid greatly in suppressing jointed goatgrass in winter wheat and improve the yield and quality of winter wheat.

All funded projects contain a technology transfer component. Extension bulletins have been completed and published; these provide a lasting and readily-accessible record of the accomplishments of this program; and they provide wheat producers with new information to help them manage jointed goatgrass. A World Wide Web site located at www.jointedgoatgrass.org, has been established and updated annually to further enhance information transfer. Summaries of annual progress reports are also posted on the web site. Also, a videotape, a poster, and a slide set have been produced to assist extension personnel in transferring to producers information on jointed goatgrass biology and management.

Key Outputs

- Website, videotape, poster, and slide set produced to transfer research technology to producers as well as the following publications:

  EB1931 - Introduction to Jointed Goatgrass EB1932 - Ecology of Jointed Goatgrass
  EB1935 - Jointed Goatgrass Control Tactics
  EB1934 - Jointed Goatgrass Genetics
  Jointed Goatgrass Herbicide Resistance (*Scheduled 2008*)
  EB2003 - Jointed Goatgrass, Best Management Practices, Intermountain Region
  Jointed Goatgrass, Best Management Practices, Southern Great Plains (*Scheduled 2008*)
  Jointed Goatgrass, Best Management Practices, Central Great Plains (*Scheduled 2008*)
  Jointed Goatgrass, Best Management Practices, Pacific Northwest (*Scheduled 2008*)

Outcome

- Under normal rainfall conditions, integrated management systems utilizing herbicide-resistant wheat and multiple cultural management tactics will aid greatly in suppressing jointed goatgrass in winter wheat and improve the yield and quality of winter wheat.

Reduced Risk Nightshade Management Systems for Tomatoes
Risk Avoidance and Mitigation Program (RAMP) funds CRIS accession no. 0190077
Mission Area: Research, Extension

Eastern black nightshade is a solanaceous weed that occurs throughout the eastern U.S. It is the key weed which can not be controlled in tomatoes. The research objectives of this project were to understand the interrelationships between nightshades and to develop strategies for managing these weeds. Most eastern black nightshade plants are genetically similar but still differ in susceptibility to herbicides. Nightshade competitiveness with tomato is similar throughout the eastern U.S. Improved eastern black nightshade management will depend on understanding susceptibility of accessions to new environmentally-friendly herbicides and overcoming the limitations of alternative systems. Better nightshade management systems will save farmers inputs (hand-weeding, tillage, and high-use rate herbicides), reduce soil erosion, and lessen soil and ground water pollution. Improved nightshade management in tomato will allow farmers to provide a quality and economical tomato crop to meet consumer demand for locally-grown produce.

Key Outputs

- Biology, ecology, and taxonomy of nightshades and their relationship to other solanaceous plants determined.
- Determining susceptibility of nightshades to environmentally-friendly herbicides.
- Eleven publications produced.
- Development of control methods for nightshade in tomatoes.

Outcomes

- Better nightshade management systems will save farmers inputs (hand-weeding, tillage, and high-use rate herbicides), reduce soil erosion, and lessen soil and ground water pollution.
- Improved nightshade management in tomato will allow farmers to provide a quality and economical tomato crop to meet consumer demand for locally-grown produce.

IWM (Integrated Weed Management) Implementation: A Regional Approach
Risk Avoidance and Mitigation Program funds CRIS accession no. 0193144
Mission Area: Research, Education, Extension

Weed management decision making is a complex problem requiring integration of weed biology, environmental risk, crop yield potential, efficacy of control measures, and economics. A decision support system is helping users manage these complex factors. One of the expected impacts of this project is to provide the user with options for cost effective weed management scenarios that can reduce total herbicide use while improving weed control. The impact of WeedSOFT has not been limited to farmers and consultants. It has been used in many classrooms at the university, post-secondary technical school and high school level to teach proper weed management practices and demonstrate the economic benefits. Educational modules developed by their participants also provided additional learning opportunities to the user. One of their goals was to enable WeedSOFT to be used in a more site-specific capacity. WeedSOFT supplied tools to allow the user to maintain records about weed problem areas and herbicide application in those areas. WeedMapper and Pocket WeedMapper enabled the applicator to target problem areas and reduce herbicide use. In 2005, over 580 copies of WeedSOFT were in the hands of users in 21 states extending its reach outside the original participating states. They estimate that this widespread distribution of WeedSOFT has had an impact on over 2.1 million acres in these states. This estimation of impact is based on the number of copies of WeedSOFT in use and preliminary user survey results.

Key Outputs

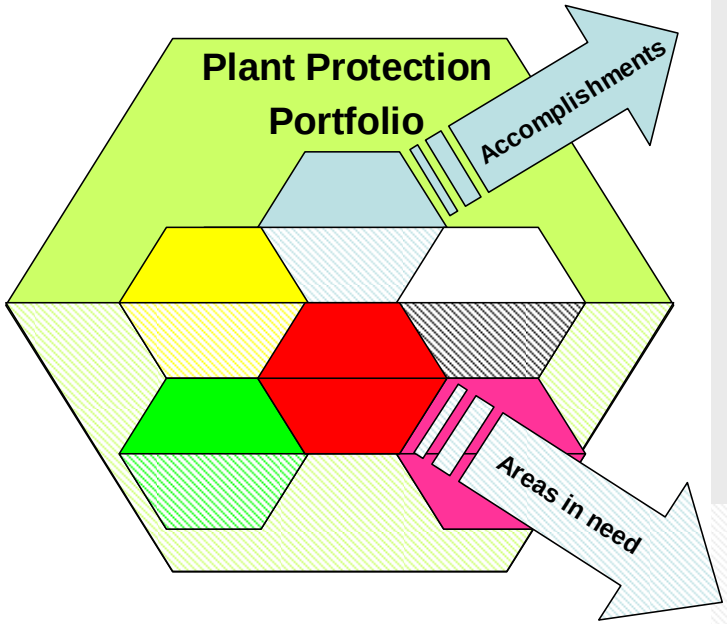
- Decision support tools (WeedSOFT, WeedMapper, and Pocket WeedMapper) developed for weed management.
- In 2005, over 580 copies of WeedSOFT were in the hands of users in 21 states extending its reach outside the original participating states.
- Five publications produced.

Outcomes

- WeedMapper and Pocket WeedMapper enabled the applicator to target problem areas and reduce herbicide use.
- It is estimated that this widespread distribution of WeedSOFT has had an impact on over 2.1 million acres in these states.

KA 213 Honeycombs:

Knowledge Area 213: Weeds Affecting Plants



KA 213 – Major Themes

- **Prevention**
- **Biology and Ecology**
- **Epidemiology**
- **Detection and Diagnosis**
- **Management**
- **Economics and Safety**

- Major development of weed management systems including herbicides to prevent crop losses due to weed competition; 58% of pesticide dollars spent on herbicides
- Development and adaption of resistant crop varieties
- 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)
- Photosynthsis pathway discovery and eluciation using triazine resistant weeds
- 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
- Contributions made to the FICMNEW Early Detection and Rapid Response strategy
- National Plant Diagnostic Labs
- Extension programs that use research information such as the Fire Model for Invasive weeds in Utah and the Invasive Plant Atlas of New England (NRI funded)
- Development of multistate weed management programs using herbicides in integrated weed management systems (e.g., leafy spurge and jointed goatgrass)
- Development of allelopathic cover crops for weed control
- Invasive weed management in crop and non-crop land
- Input into IR-4 program to register weed 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
- Introduction of reduced risk herbicides and using IPM resulting in greater environmental safety
- Environmental impacts reduced and crop production costs are lower due to herbicide use in no-till / conservation tillage (herbicide resistant crops [glyphosate])

- Funding for the FICMNEW Early Detection and Rapid Response strategy for Extension and Research
- Research on weed seed bank and weed seed dormancy
- 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
- Continue research on resistant weed biology
- Continued multistate research and extension on specific troublesome weeds
- Support for herbarium and plant systematics to be used for weed identification and for higher education
- 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
- 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
- NASS data on pesticide use in major crops

Knowledge Area 214: Vertebrates, Mollusks, and Other Pests

KA 214 Introduction:
This Knowledge area (KA) 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 KA 214. Projects under this KA 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 KA 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, 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 Knowledge 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 KA 214; however, the actual projects in KA 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.

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

KA 214 Logic Model

KA 214: Vertebrates, Mollusks, and Other Pests Affecting Plants

Situation	Inputs	Activities	Outputs	Outcomes		
				Knowledge	Actions	Conditions
This knowledge area focuses on plant yield and quality affected by indigenous and exotic vertebrate pests, mollusks, and other plant pests. This KA does not include indigenous and exotic insects, mites, and other arthropods covered under KA 211.	**Funding Sources:** - Federal - State or local - Some provide funding that contributes to research **Human Capital**: - NPLs - Extension personnel - Teachers - Researchers - Para-professionals - Stake holders - (Industry, farmers, etc.)- Volunteers	- Develop a medium for educating the public about wildlife damage management - Develop human methods for minimizing/eliminating the negative effects of vertebrate pests, mollusks, and other plant pests on crops - Improve human-wildlife relationships through teaching, research, and extension	- Expanded knowledge base about plant protection methods and products - Trained workforce - Shared knowledge - Exchanged experiences among producers - Research, education and extension findings vetted by scientists - Research, education and extension findings submitted to CSREES - Research findings disseminated - Publications - Citations - Patents - Best management practices - Curricula - Undergraduate and graduate education - Training provided to producers	- eXtension portal provides the public with information regarding a wide variety of species through news stories, frequently asked questions and access to Wildlife Damage Management Community of Practice members - Farmers and ranchers knowledge increased on how to manage vertebrate pests, mollusks, and other plant pests - Increased knowledge of vertebrate pests such as beaver control, impacts of feral hogs, deer-vehicle collisions, black bears, urban deer, effective communication skills, coyote control , and raccoon impacts, and effective communication on these issues	- Farmers and ranchers use best management practices for the control of vertebrate pests, mollusks, and other plant pests.	- Improved management practices - Increased yield - Improved economic performance of producers - Improved human-wildlife relationships

Assumptions - CSREES has the funds, personnel and facilities to accomplish this objective. There is a need to collaborate with lateral partner organizations and agencies.

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.

Key KA 214 Outputs and Outcomes

eXtension Wildlife Damage Management Community of Practice

Smith-Lever 3(d) CRIS accession no. 0207967

Mission Area: Extension, Education Web site www.eXtension.org

eXtension is an educational partnership of more than 70 universities, found in every state and territory throughout the United States, that provides 24/7/365 access to dynamic and evolving objective, research-based information and educational opportunities. eXtension is new and unique. For the American public: the "best of the best" peer-reviewed information on myriad topics; research-based, objective, information delivered any time, any place, on any Internet-ready device. The eXtension portal (www.extension.org) provides public access to several published Communities of Practice content and programs. From August 2007 to August 2008, the eXtension Communities of Practice was visited 600,000 times by the public. Wildlife Damage Management resources are available at: http://www.extension.org/wildlife+damage+management. The site provides extensive resources for the management of rodents, carnivores, other mammals, birds, and reptiles.

The Wildlife Damage Management Community of Practice mission is to assist individuals with the complex decision process involving balancing human and wildlife concerns. Its members include nationally recognized wildlife biologists, nuisance wildlife control operators, educators and people interested in the field of human-wildlife relations. Their goal is to help people live in harmony with wildlife and minimize the conflicts that occur in human-wildlife relations. The eXtension Wildlife Damage Management website provides detailed resources on a wide variety of wildlife species, news stories, frequently asked questions, and event calendar, and access to the Wildlife Damage Management Community of Practice members.

Wildlife damage management requires the ability to identify the damage, select appropriate mitigation techniques, and suggest ways to prevent future damage. Additionally, the wildlife damage controller must also consider human needs and concerns in addition to issues related to animal welfare and the environment. The Wildlife Damage Management website also includes a training/education resource. The Nuisance Control Training Manual provides a training manual for “best management practices” for nuisance wildlife control.

Key Outputs

- eXtension Wildlife Damage Management Community of Practice and website developed.
- The eXtension Wildlife Damage Management website provides detailed resources on a wide variety of wildlife species, news stories, frequently asked questions, an event calendar, and access to the Wildlife Damage Management Community of Practice members.
- Nuisance Control Training Manual developed for nuisance wildlife control.

Outcomes

- Information provided by the eXtension Wildlife Damage Management Community of Practice, the Wildlife Damage Management website, and the Nuisance Control Training Manual will aid wildlife managers in identification of wildlife damage, selection of appropriate mitigation techniques, and identification future damage prevention strategies.
- Such information will help assist wildlife managers with the complex decision process of balancing human and wildlife concerns, which will help people live in better harmony with wildlife and minimize the conflicts that occur in human-wildlife relations.

Berryman Institute

Competitive grants, Hatch Funds, Smith-Lever, and others CRIS accession No. 0198860
Mission Area: Education, Research Website: http://www.berrymaninstitute.org

The Berryman Institute is a national organization based in the Department of Wildland Resources at Utah State University and the Department of Wildlife & Fisheries at Mississippi State University. The Berryman Institute is dedicated to improving human-wildlife relationships and resolving human-wildlife conflicts through teaching, research, and extension. The Berryman Institute's mission is to support and conduct effective, science-based research and outreach programs aimed at addressing issues pertaining to wildlife damage management and human-wildlife conflicts. To achieve this goal, the Berryman Institute has developed a program to financially support research and education programs conducted by institutions in the United States that address these issues. Funding opportunities are available each year in all regions of the country.

The Berryman Institute continues to provide research funding, technical assistance, and outreach education through its funding of multiple projects throughout the United States that address the critical issue of human-wildlife conflicts. The Institute is supporting or has supported 20 doctoral students, 42 M.S. students, and through internships with prospective federal and state employers, supported 69 undergraduate students. Their research program is national, with 26 states now receiving funding (via an intensive review process) to address state-specific wildlife-human conflict issues. These projects address such relevant issues as beaver control, impacts of feral hogs, deer-vehicle collisions, reforestation, depredation at aquaculture facilities, endangered species, black bear, urban deer, effective communication skills, coyote control, and raccoon impacts. Additionally, the institute continues to train undergraduate and graduate students in the field of human-wildlife conflicts. It also conducted national workshops that positively impacted over 200 professionals.

Through a National Outreach Coordinator, the Institute has hosted workshops on conflict resolution, animal capture and handling, safe firearm usage, and geo-spatial applications that have received very high evaluations. Berryman also is hosting these workshops for other state and federal employees.

Key Outputs

- The Berryman Institute continues to provide research funding, technical assistance, and outreach education through its funding of multiple projects throughout the United States that address the critical issue of human-wildlife conflicts.
- The Institute is supporting or has supported 20 doctoral students, 42 M.S. students, and through internships with prospective federal and state employers, supported 69 undergraduate students.
- The Institute's research program is national, with 26 states now receiving funding (via an intensive review process) to address state-specific wildlife-human conflict issues.
- Workshops have been held on conflict resolution, animal capture and handling, safe firearm usage, and geo-spatial applications that have positively impacted 200 professionals.

Outcome

- Research, teaching, and extension programs supported by the Berryman Institute will help improve human-wildlife relationships and resolve human-wildlife conflicts.

Identity and Origins of Apple Snail Pests
State funds CRIS accessions no. 0202035
Mission Area: Research

Alien apple snails (*Pomacea canaliculata* group) are major wetland crop pests in Asia and Hawaii. Recent introductions to the U.S. mainland threaten rice crops notably in Texas and California. The identity and precise geographic origins of the pest species are not understood. The project is distinguishing the major taxa in the group that includes the pest species, resolving the identity and geographic origins of the pest species, and developing diagnostic tools to distinguish pest and non-pest species.

This research has resulted in changes in knowledge including the distribution and origin of species and haplotypes found in Hawaii, California, Arizona, Texas, Florida, and Georgia. In addition to identifying the alien species, fundamental knowledge of the diversity and distribution of apple snail species in their native ranges in South and Central America has been gained. Changes in actions have also occurred. With the wide dissemination of the BMC Evolutionary Biology paper, the correct names of the apple snail species in the continental U.S. are increasingly being acknowledged. The use of the term "channeled applesnail" is being questioned. Similarly, the correct identities of the species in SE Asia will become more widely understood with the publication of the 2006 book chapter and the future publication of the paper submitted to Diversity and Distributions. Changes in conditions also have occurred. The project has developed basic use of molecular phylogenetic techniques for identification of otherwise difficult to identify pest species. Knowledge of the correct identities of species introduced into the U.S. has permitted estimation of their potential range within the U.S., including the possibility of their establishment in rice-growing areas. A graduate student and an undergraduate have been trained.

Key Outputs

- The distribution and origin of species and haplotypes of apple snails have been determined for those found in Hawaii, California, Arizona, Texas, Florida, and Georgia.
- Diagnostic tools are being developed to distinguish pest and non-pest apple snail species.
- Fundamental knowledge of the diversity and distribution of apple snail species in their native ranges in South and Central America has been gained.
- A graduate student and an undergraduate have been trained.

Outcome

- Knowledge of the correct identities of species introduced into the U.S. has permitted estimation of their potential range within the U.S., including the possibility of their establishment in rice-growing areas.

Experiential Learning in Agriculture and Wildlife as an Aid to Recruitment
Science and Education Resources Development Grant CRIS accession no. 0197953
Mission Area: Education

Lincoln University, Department of Agriculture and Natural Sciences increased recruiting efforts by developing a course using decision cases and field techniques to resolve various wildlife/agriculture problems and, thus, expand field opportunities for students. The program objectives were to improve success in recruiting under represented minorities, expand field training opportunities and increased use of decision cases in the curriculum. Measurable impacts are increased enrollment, a new recruiting brochure, a new web page and increased skills of students using typical wildlife equipment.

The activities supported by this project impacted students in all of the courses that we offer in the wildlife area including the new courses that were developed within the framework of this project. The field and experiential-based Wildlife Techniques Course provided a unique opportunity to introduce students to field-based wildlife techniques and wildlife management topics. These students learned a variety of skills such as bird identification skills, native vegetation identification skills, global positioning system skills, use of optical equipment and numerous wildlife management techniques. A second course that has had direct impact was the course in Communication and Education for Wildlife Management. The students in this course developed and presented wildlife materials to local public elementary school classes and published a children's magazine. Some of the other courses that have had an impact include Urban Wildlife, Natural Management Resource Conflict Resolution, Wildlife Management, Wildlife Damage Management and Ecology. Almost all of these courses have incorporated the use of case-based student learning to some extent. The three courses that were specifically developed with this grant (Wildlife Techniques, Natural Management Resource Conflict Resolution and Communication and Education for Wildlife Management) have been well enrolled and successful in our academic program.

Key Outputs

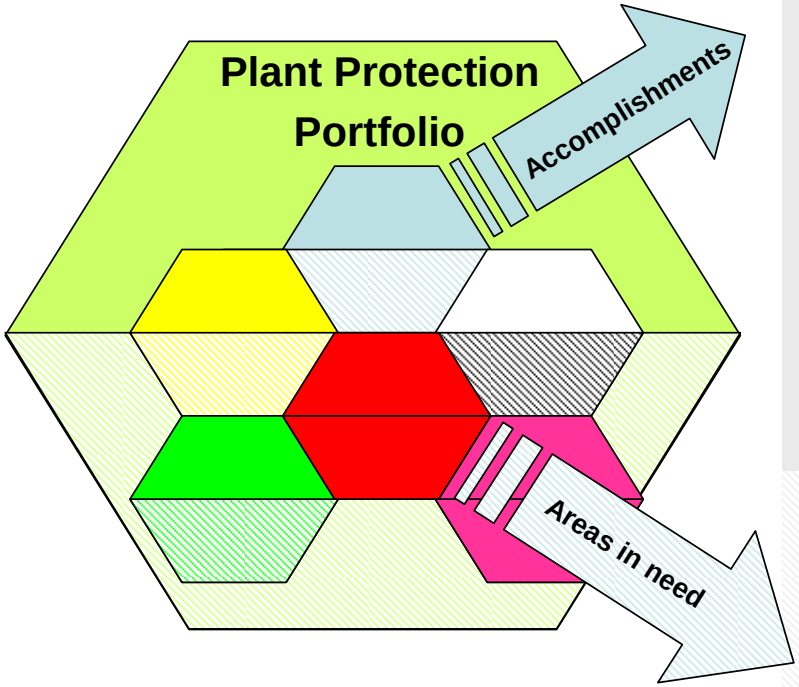
- Lincoln University, Department of Agriculture and Natural Sciences developed a course (called Field and Experiential-based Wildlife Techniques) using decision cases and field techniques to resolve various wildlife/agriculture problems and, thus, expand field opportunities for students.
- A second course that has had direct impact was the course in Communication and Education for Wildlife Management.
- Students in this course developed and presented wildlife materials to local public elementary school classes and published a children's magazine.
- A recruiting brochure and new web page were produced to help attract students to the wildlife area.

Outcomes

- The field and experiential based Wildlife Techniques Course provided a unique opportunity to introduce students to field based wildlife techniques and wildlife management topics.
- These students learned a variety of skills such as bird identification skills, native vegetation identification skills, global positioning system skills, use of optical equipment and numerous wildlife management techniques.
- The three courses that were specifically developed with this grant (Wildlife Techniques, Natural Management Resource Conflict Resolution and Communication and Education for Wildlife Management) have had strong enrollment and have been successful additions to their academic program.
- Measurable impacts are increased enrollment and increased skills of students using typical wildlife equipment.

KA 214 Honeycomb:

Knowledge Area 214: Vertebrates, Mollusks, and Other Pests Affecting Plants



KA 214 – Major Themes

- **Prevention**
- **Biology and Ecology**
- **Epidemiology**
- **Detection and Diagnosis**
- **Management**
- **Economics and Safety**

- Novel barriers for birds and insects (patent)
- Novel barriers for deer
- Evaluation of deer repellents
- Evaluation of slug pesticides
- Groundcovers for vole control
- Mating disruption in voles
- Deer fertility control
- Apple snail taxonomy / origin
- Tick-borne disease risk from deer population
- Evaluation of methods for deer population estimates
- Deer management strategies
- Wildlife management strategies (ground squirrels, raccoons, etc.)
- Evaluation / development of non-lethal methods
- IPM slug control
- Depredation estimates

- Improved prevention methods
- Ecological impacts of management practices
- Ecological impacts of conservation practices
- Factors influencing pest population changes
- Efficient use of remote sensing
- Real time detection tools
- Improved non-lethal control (i.e. sterility)
- Improved damage estimates and thresholds for food / crop safety
- Cost-effective wildlife control

Knowledge Area 215: Biological Control of Pests Affecting Plants

KA 215 Introduction:
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.).

KA 215 Logic Model

KA 215: Biological Control of Pests Affecting Plants

Situation	Inputs	Activities	Outputs	Outcomes		
				Knowledge	Actions	Conditions
This knowledge area focuses on the biological control of plant pests (arthropods, weeds, and plant pathogens) affecting plant production and quality using beneficial organisms (predators, parasitoids, pathogens, and other organisms). The Food Quality and Protection Act of 1996 and resultant elimination or restrictions in the use of most broad-spectrum pesticides, combined with concerns over the impacts of pesticides on the environment and human health have encouraged the development of more sustainable bio-based pest management strategies such as biological control	**Funding Sources:** - Federal - State or local Some provide funding that contributes to research **Human Capital**: - NPLs - Extension personnel - Teachers - Researchers - Para-professionals - Stake holders - (Industry, farmers, etc.) - Volunteers	- Import and establish effective natural enemies (classical biological control) - Conserve natural enemies to increase biological control of target pests - Augment natural enemies to increase biological control efficacy - Evaluate environmental and economic impacts and raise public awareness of biological control	Expanded knowledgebase about plant protection methods and products - Trained Workforce - Shared knowledge - Exchanged experiences among producers - Research, education and extension findings vetted by scientists - Research, education and extension findings submitted to CSREES - Research findings disseminated - Publications - Citations - Patents - Best management practices - Curricula - Undergraduate and graduate education - Training provided to producers	- Increased farmer knowledge about the use of biocontrol agents to control mole crickets and corn earworm - Increased grower knowledge about the use of bio-based methods for controlling codling moth and oriental fruit moth - Increased swine producer knowledge of bio-based strategies to control cockroaches - Increased research knowledge of genes involved in host specif. of fungal pathogens of insects - Increased farmer knowledge about lygus management thresholds and impacts from B.C. and ranch design - Increased grower knowledge of enhanced B.C. by providing plant refugia	- Growers able to rely on B.C agents to reduce mole cricket densities - Growers are achieving successful control of codling moth and oriental fruit moth using bio-based PM strategies - Swine producers reduced pesticide inputs by emphasizing bio-based strategies for cockroach control - Knowledge of links between genetics and host specificity will allow “designer” pathogens to be produced - Use of bio-based PM and ranch design against lygus bug will reduce pesticide loads in cotton - The addition of perennial hedgerows to provide refugia for natural enemies will enhance biocontrol of pests in annual cropping systems	- B.C. agents reduced mole cricket densities to 5% of levels found in 1980’s - Use of B.C. agents reduced pesticide applications against corn earworm by 90% - Use of mating disruption has reduced fruit injury by codling moth and oriental fruit moth and lowered the use of broad-spectrum pesticides. - Bio-based PM strategies used in cockroach PM have reduced insecticide use to <10% of previous practices - Promoters will allow *M. anisopliae* to express a specific enzyme or toxin - Bio-based PM and ranch design will reduce pesticide use in cotton - Use of plant refugia is improving B.C. in annual crops

Assumptions - CSREES has the funds, personnel and facilities to accomplish this objective. There is a need to collaborate with lateral partner organizations and agencies.

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.

Key KA 215 Outputs and Outcomes

Soybean aphid in the North Central U.S.: Implementing IPM at the landscape scale
Risk Avoidance and Mitigation Program funds CRIS accession no. 0201072
Mission Area: Research, Extension

The soybean aphid is a major new invasive pest of soybean in North America. In 2003, over 42 million acres of soybean in the North Central U.S. were infested and over 7 million acres were treated with insecticides to control soybean aphid. Producers, industry and university research/Extension personnel have identified the soybean aphid as one of the greatest threats to the U.S. soybean industry. The overall goal of the proposed RAMP project is to help transition the North Central U.S. soybean industry to a sustainable and ecologically-based IPM system for soybean aphid that is compatible with the multi-pest and multi-crop ecosystems that occur in the region. Surveys of producers show widespread knowledge and use of IPM recommendations for SBA control, particularly adoption of the 250 aphid/plant threshold. The estimated aggregate economic impact of plausibly achieving 75% adoption of IPM recommendations in the North Central USA by the end of the 15-year period 2003-17 is a net gain of $1.1 billion over prophylactic SBA control (adjusted for inflation and a 5% return on assets). The gain comes chiefly from avoiding the cost of unnecessary insecticide treatments. Use of IPM practices for SBA control has also reduced insecticide use. The release of *Binodoxys* wasps in multiple states was the first classical biocontrol release against for SBA.

Key Outputs

- Ecologically-based IPM strategies developed for soybean aphid.
- The release of *Binodoxys* wasps in multiple states was the first example of classical biocontrol targeted for soybean aphid.

Outcomes

- Surveys of producers show widespread knowledge and use of IPM recommendations for SBA control, particularly adoption of the 250 aphid/plant threshold.
- The estimated aggregate economic impact of plausibly achieving 75% adoption of IPM recommendations in the North Central USA by the end of the 15-year period 2003-17 is a net gain of $1.1 billion over prophylactic SBA control (adjusted for inflation and a 5% return on assets).
- The gain comes chiefly from avoiding the cost of unnecessary insecticide treatments.
- Use of IPM practices for SBA control has also reduced insecticide use.

Reduced-Risk IPM strategies for sustainable livestock production.

Risk Avoidance and Mitigation Program funds CRIS accession no. 0205253
Mission Area: Research, Education, Extension,

Swine production has generated serious health and environmental concerns, which in turn require the attention of agricultural extension agents and research personnel. Cockroaches must be controlled because they represent considerable risks of transmission and maintenance of disease agents that affect the growth, development, and efficiency of feed conversion of the animals. Cockroach populations can expand to many thousands of individuals per barn and pose problems to both swine and workers. There is a need for the continued development of safe, effective, and environmentally compatible, integrated pest management-based insect management programs. This project addresses a new pest management program for confined animal production systems. The pest management program is based on reduced-risk strategies that include monitoring-based action thresholds, insect growth regulators, inorganic insecticides, pest-specific biological control agents. Our approaches will be coupled with the following goals, implemented in close collaboration with commercial growers: We will assess the environmental and occupational health risks associated with pest problems, develop, validate, and implement a pest monitoring strategy, develop and implement ecologically-based, IPM-information-intensive approaches to reduce pest infestations, develop innovative integrated Extension and Education module that can be delivered to growers by Extension personnel, and evaluate the adoption and impact of the new pest management program. Our recommendations to date have reduced insecticide use to <10% of previous practices and are largely based on an easy-to-use and realistic decision-making algorithm. Because the confined livestock industry is well integrated and becoming more standardized, the pest management program developed here will apply equally well to other regions of the U.S. Moreover, federal and local regulations have dictated the implementation of IPM programs in municipalities (offices, schools, recreation areas), and results obtained from implementation of this research in swine barns will be applicable to other structural environments. Lessons learned from this project will also guide pest management in sensitive environments such as schools, zoos, and hospitals.

Key Outputs

- The livestock pest management program is developing reduced-risk strategies that include monitoring-based action thresholds, insect growth regulators, inorganic insecticides, and pest-specific biological control agents.
- Project participants will assess the environmental and occupational health risks associated with pest problems, develop, validate, and implement a pest monitoring strategy, develop and implement ecologically-based, IPM-information-intensive approaches to reduce pest infestations, develop an innovative integrated Extension and Education module that can be delivered to growers by Extension personnel, and evaluate the adoption and impact of the new pest management program.

Outcome

- Recommendations to date have reduced insecticide use to <10% of previous practices and are largely based on an easy-to-use and realistic decision-making algorithm.
- Lessons learned from this project will also guide pest management in sensitive environments such as schools, zoos, and hospitals.

Understanding and managing arthropod pests and natural enemies through various approaches on deciduous tree fruits in Pennsylvania.

Hatch, Risk Avoidance and Mitigation Program funds CRIS accession no. 0202302
Mission Area: Research, Extension

Evaluation of both experimental and commercially registered insecticides and biological products on pest efficacy and natural enemy toxicity has enabled us to quickly identify effective replacement options for many products that are continually being lost due to the implementation of the Food Quality Protection Act and pest resistance. This information will enable Penn State extension personnel to confidently recommend control options that are highly effective against pests and at the same time mitigate their impacts on established biological control agents present in grower orchards. In addition, the work on organic pest control products has helped our expanding organic industry in Pennsylvania achieve better control of arthropod pests. Implementation and adoption of an area-wide pheromone mating disruption program as a major control tactic for pest management has substantially reduced the amount of injured fruit by the codling moth and oriental fruit moth complex across various tree fruit crops as well as increased the awareness of this technology. Based on estimates from growers and pheromone supply companies over 2,500 ha of tree fruits utilized mating disruption in 2007. In combination with other IPM tactics, mating disruption has reduced fruit injury and lowered the use of broad-spectrum pesticides. The work on '*T. pyri*' enabled the fruit industry to better understand and adopt another predator to provide biological control of spider mites and further reduce the industry's dependency on miticides. For the estimated 3,240 ha of orchards in Pennsylvania having '*T. pyri*' populations, the savings to growers is calculated to be 700,000 dollars per year via a one ton reduction of miticide active ingredient and 45,000 gallons of oil. In addition, growers can receive payment from NRCS conservation programs to establish and conserve `*T. pyri*.' This program has already paid 31,000 dollars to growers. Penn State researchers are a part of two major USDA Risk Assessment & Mitigation Program (RAMP) Grants (1.9 and 1.7 million dollars) awarded to six eastern U.S. universities to examine the feasibility and financial impact of pesticide regulations under the Food Quality Protection Act in tree fruit crops. The initial grant (2002-2006) mostly looked at the feasibility and economic risk of substituting only reduced risk insecticides/miticides. This second grant (2007-2009) is to more closely examine the environmental benefits of reduced risk IPM in apple and peach crops, enhance the use of biological control, and reduce the cost differential between reduced risk and conventional practices. Environmental impacts calculated from the records of 60 apple and 30 peach orchards using the Environmental Injury Quotient (EIQ) found 10-15 fold lower values for reduced risk IPM. The information has allowed growers and consultants to make immediate changes in their IPM programs in order to achieve the most effective and economical control of pests while preserving natural enemies and reducing impacts on the environment.

Key Outputs

- Ecologically-based IPM strategies were developed for arthropod pests of tree fruits in Pennsylvania.
- Mating disruption tactics were developed for codling moth and oriental fruit moth.

Outcomes

- Evaluation of both experimental and commercially registered insecticides and biological products on pest efficacy and natural enemy toxicity has enabled researchers involved in the project to quickly identify effective replacement options for many products that are continually being lost due to the implementation of the Food Quality Protection Act and pest resistance.
- This information will enable Penn State extension personnel to confidently recommend control options that are highly effective against pests and at the same time mitigate their impacts on established biological control agents present in grower orchards.
- Work on organic pest control products has helped the expanding organic industry in Pennsylvania achieve better control of arthropod pests.
- Implementation and adoption of an area-wide pheromone mating disruption program as a major control tactic for pest management has substantially reduced the amount of injured fruit by the codling moth and oriental fruit moth complex across various tree fruit crops as well as increased the awareness of this technology.
- Work on the predatory mite '*T. pyri*' enabled the fruit industry to better understand and adopt another predator to provide biological control of spider mites and further reduce the industry's dependency on miticides.
- For the estimated 3,240 ha of orchards in Pennsylvania having '*T. pyri*' populations, the savings to growers is calculated to be 700,000 dollars per year via a one ton reduction of miticide active ingredient and 45,000 gallons of oil.

Microarray Based Analysis of Infection Processes of *Metarhizium anisopliae*
NRI competitive grant CRIS accession no. 0196336
Mission Area: Research

Problems with chemical insecticides have stimulated efforts to employ biological control agents, including entomopathogenic fungi. Fungi are probably the most common pathogens of insects in nature. However, the slow speed of kill and inconsistent results of fungi compared with chemicals has deterred development. In fact, the employment of all biopesticides represents only about 1.5% of the total crop protection market. Fungal expert, Raymond St. Leger, of University of Maryland, is researching *Metarhizium anisopliae*. Its use abroad is increasing (this year in China Metarhizium will be applied to 200,000 ha for locust hopper control), it is registered for use in the USA and Europe and can suppress soil- inhabiting pests, beetles, grasshoppers and mites which have few other pathogens. Industrial production of M. anisopliae is now highly automated allowing *Metarhizium* products to be competitively priced compared with many established insecticides. However, even with improved production and formulations, efficacy issues remain an important obstacle to broad acceptance of biological control agents, and insect killing fungi are not yet widely implemented in the USA. With NRI support, Dr. St. Leger has developed the biochemical, molecular and genomic tools that have made *M. anisopliae* a very tractable model system for probing the intimate associations between fungi and their insect hosts. The ongoing determination of how genes function in an insect pathogen has yielded new discoveries not only for *M. anisopliae* but all fungal biology. He has investigated the tremendous amount of genetic variation, distinct disease phenotypes and host ranges of *Metarhizium* strains,

and identified the origins of intraspecific differences. He has identified genes involved in establishing host range that will eventually allow production of “designer” pathogens that very specifically target pest insects. He has also identified promoters that allow *M. anisopliae* to express a specific enzyme or toxin in a tissue-specific manner without compromising host-specificity or contaminating the environment by production during saprophytic growth. The remarkable extent to which virulence can be increased was shown by expressing an insect specific scorpion toxin (AaIT) in *M. anisopliae*. The modified fungus achieved the same mortality rates in tobacco hornworm (*Manduca sexta*) at 22-fold lower spore doses than the wild type, and survival times at some doses were reduced by 40%. Similar results were obtained with an herbivorous beetle (LC_{50} reduced 16-fold) with less than 5 spores being lethal. M. anisopliae is thus able to test multiple pest control strategies as well as providing a delivery system for the many toxins not considered practical insecticides because they cannot cross the insect gut or cuticle.

The result of increasing pathogenicity and virulence is to greatly improve cost effectiveness. More rapid killing of insects provides better control, and lowering the effective dose means that equivalent control is achievable using less product. The effective persistence of the biopesticide should also increase. This research has implications for controlling other pest species as well (parasitic mites of honey bees and termites) where effective persistence is particularly important.

Key Outputs

- Biochemical, molecular and genomic tools have been developed that have made *M. anisopliae* a very tractable model system for probing the intimate associations between fungi and their insect hosts.
- Researchers have investigated the tremendous amount of genetic variation, distinct disease phenotypes and host ranges of *Metarhizium* strains, and identified the origins of intraspecific differences.
- Dr. St. Leger has also identified promoters that allow *M. anisopliae* to express a specific enzyme or toxin in a tissue-specific manner without compromising host-specificity or contaminating the environment by production during saprophytic growth.

Outcome

- Genes have been identified that are involved in establishing host range that will eventually allow production of “designer” pathogens that very specifically target pest insects.
- The remarkable extent to which virulence can be increased was shown by expressing an insect specific scorpion toxin (AaIT) in *M. anisopliae*.
- The modified fungus achieved the same mortality rates in tobacco hornworm (*Manduca sexta*) at 22-fold lower spore doses than the wild type, and survival times at some doses were reduced by 40%.
- Similar results were obtained with an herbivorous beetle (LC_{50} reduced 16-fold) with less than 5 spores being lethal.

- *M. anisopliae* is thus able to test multiple pest control strategies as well as providing a delivery system for the many toxins not considered practical insecticides because they cannot cross the insect gut or cuticle.
- The result of increasing pathogenicity and virulence is to greatly improve cost effectiveness.
- More rapid killing of insects provides better control, and lowering the effective dose means that equivalent control is achievable using less product; the effective persistence of the biopesticide should also increase.
- This research has implications for controlling other pest species as well (parasitic mites of honey bees and termites) where effective persistence is particularly important.

Bioinformatics for IPM: using consultant-generated data to solve difficult problems in applied insect ecology

NRI competitive grant CRIS accession no. 0208045
Mission Area: Research, Extension, Education

Cotton is a key crop produced in the southern and western United States. Across its range, among the most important pests of cotton are insects in the genus *Lygus*. *Lygus* feed on developing flower buds, causing them to abscise from the plant, and potentially having devastating affects on yield. Insecticides applied to control *Lygus* frequently kill many key beneficial insects (predators and parasites), which can lead to outbreaks of other insects and mites, creating a "pesticide treadmill" that generates significant costs for farmers and negative impacts on the agricultural environment. Despite decades of research, there is still no consensus among researchers or farmers regarding how many *Lygus* commercial cotton fields can tolerate before yield starts to decline. This has been an area of longstanding controversy. As a new approach to addressing this problem, UC Davis entomologist Jay Rosenheim is using the extensive data generated by private pest management consultants, coupled with yield data from farmers and pesticide use data, to evaluate how cotton responds to *Lygus* damage. Rosenheim's results to date suggest that the project will overturn current management practices in two key areas. First, for upland cotton (*Gossypium hirsutum*), which is the dominant cotton species grown in the U.S., his results are showing that most farmers are managing *Lygus* much more aggressively than they need to. Upland cotton can tolerate very substantial densities of Lygus with no detectable yield reduction. This result should allow insecticide use to be decreased very substantially on cotton attacked by *Lygus hesperus*. Second, for Pima cotton (*Gossypium barbadense*), which is an increasingly important crop in California; a previously unrecognized sensitivity to *Lygus hesperus* was revealed. Thus, California growers have been sustaining major losses of yield to *Lygus* feeding without knowing it. Pima cotton growers will produce higher yields in the future by managing their fields to achieve lower *Lygus* densities. Rosenheim is now developing new management techniques, including biological control (by *Geocoris* spp. and *Zelus* sp. predators) and ranch design (arranging fields across the agricultural landscape to protect sensitive crops like cotton) that will allow growers to reduce *Lygus* densities with less use of insecticides.

Key Outputs

- Research results have shown that for upland cotton (*Gossypium hirsutum*), which is the dominant cotton species grown in the U.S., most farmers are managing *Lygus* much more aggressively than they need to (i.e., upland cotton can tolerate very substantial densities of Lygus with no detectable yield reduction).
- For Pima cotton (*Gossypium barbadense*), which is an increasingly important crop in California, a previously unrecognized sensitivity to *Lygus hesperus* was revealed.
- Thus, California growers have been sustaining major losses of yield to *Lygus* feeding without knowing it.

Outcome

- A greater tolerance of *Lygus* damage on upland cotton should allow insecticide use to be decreased very substantially on cotton attacked by *Lygus hesperus*.
- Pima cotton growers will produce higher yields in the future by managing their fields to achieve lower *Lygus* densities.
- Rosenheim is now developing new management techniques, including biological control (by *Geocoris* spp. and *Zelus* sp. predators) and ranch design (arranging fields across the agricultural landscape to protect sensitive crops like cotton) that will allow growers to reduce *Lygus* densities with less use of insecticides.

Perennial habitat for conservation biological control in annual cropping systems
NRI competitive grant CRIS accession no. 0204225
Mission Area: Research, Extension, Education

Biological control of agricultural pests, a powerful alternative to insecticides, is difficult to achieve in short-term crops such as vegetables because frequent tillage and harvest of crops disrupts the natural enemies of crop pests. Improved biological control of pests could reduce reliance on pesticides along with concomitant environmental and public health problems. Although innovative California growers have implemented the use of hedgerows and farmscaping tactics such as patches of perennial vegetation in lands surrounding vegetable crops to enhance and conserve natural enemies for biological control by providing stable resources and refuges, these practices have not been evaluated. University of California, Santa Cruz researcher, Deborah Letourneau found that perennial hedgerows hosted key natural enemies that move into adjacent crop fields and affect biological control. Ichneumonid parasitoids, an indicator taxon for the abundance and diversity of natural enemies visiting vegetable crop fields, were more diverse and abundant in the presence of diversified landscapes containing perennial vegetation than in landscapes dominated by annual crop lands. Dissemination of conceptual information on conservation biological control (CBC) and perennial plant resources (whole farm planning) for natural enemies and results throughout her 3-year study to over 30 cooperating growers and field managers and through outreach organizations (e.g., CAFF, ALBA, Wild Farm Alliance), resulted in wide-spread interest in funding and policy frameworks for farmland innovations. Results of these studies have also been presented to a researcher-grower multi-state network, the Western Region Functional Agricultural Biodiversity (FAB) working group, a consortium of over 30

researchers and practitioners working collectively to advance the knowledge and practice of habitat management for improved agroecological services in the Western region of the U.S. This group sponsors a listserv and annual meeting to share CBC research results and project experiences. Clearly the time is right for prescriptive alternatives and CBC options for improved pest control.

Key Outputs

- Researchers evaluated the use of hedgerows and farmscaping tactics such as patches of perennial vegetation in lands surrounding vegetable crops to enhance and conserve natural enemies for biological control by providing stable resources and refuges.
- Results of these studies have also been presented to a researcher-grower multi-state network, the Western Region Functional Agricultural Biodiversity (FAB) working group, a consortium of over 30 researchers and practitioners working collectively to advance the knowledge and practice of habitat management for improved agroecological services in the Western region of the U.S.
- This group sponsors a listserv and annual meeting to share CBC research results and project experiences.

Outcomes

- University of California, Santa Cruz researcher, Deborah Letourneau found that perennial hedgerows hosted key natural enemies that move into adjacent crop fields and affect biological control.
- Ichneumonid parasitoids, an indicator taxon for the abundance and diversity of natural enemies visiting vegetable crop fields, were more diverse and abundant in the presence of diversified landscapes containing perennial vegetation than in landscapes dominated by annual crop lands.
- Dissemination of conceptual information on conservation biological control (CBC) and perennial plant resources (whole farm planning) for natural enemies and results throughout her 3-year study to over 30 cooperating growers and field managers and through outreach organizations (e.g., CAFF, ALBA, Wild Farm Alliance), resulted in wide-spread interest in funding and policy frameworks for farmland innovations.

Herbivore Produced Elicitors of Plant Volatiles: Influence on Caterpillar Physiology
NRI competitive grant CRIS accession no. 0204742
Mission Area: Research

There is a need to increase the effectiveness of biological control of insect pests of agricultural crops. With research funding from the NRI, James Tumlinson of Penn State University has discovered that when caterpillars feed on plants the plants synthesize and release chemical signals that attract natural enemies of the caterpillars. The plant response is triggered by substances in the oral secretions of the caterpillars. The objectives of this proposal are to determine how the caterpillars synthesize the substances that trigger plants to turn on chemical defenses and the role of the inducing chemicals in caterpillar metabolism. This research is leading to a better understanding of the chemical and biochemical mechanisms, by which plants

defend against insect herbivore attack, and the counteractive measures employed by the herbivores, which will allow development of more sustainable, environmentally sound methods for crop protection. In 2008, Dr. Tumlinson was awarded the prestigious Wolf Prize for Agriculture for his research and scientific contributions in chemical ecology and plant-insect interactions. According to the Wolf Foundation, he has fostered the development of integrated pest management and significantly advanced agricultural sustainability."

Key Outputs

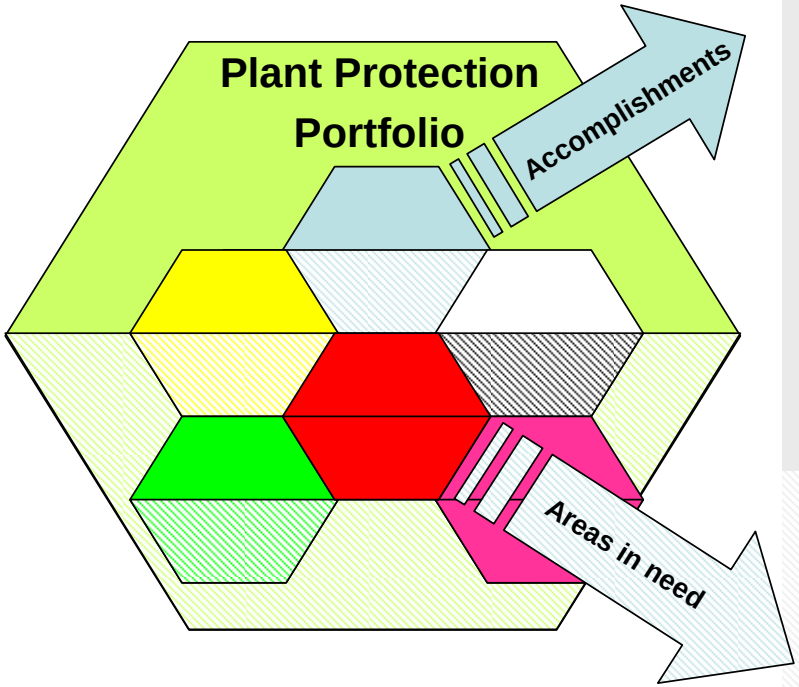
- James Tumlinson of Penn State University has discovered that when caterpillars feed on plants the plants synthesize and release chemical signals that attract natural enemies of the caterpillars.
- The plant response is triggered by substances in the oral secretions of the caterpillars.

Outcomes

- This research is leading to a better understanding of the chemical and biochemical mechanisms, by which plants defend against insect herbivore attack, and the counteractive measures employed by the herbivores, which will allow development of more sustainable, environmentally sound methods for crop protection.
- In 2008, Dr. Tumlinson was awarded the prestigious Wolf Prize for Agriculture for his research and scientific contributions in chemical ecology and plant-insect interactions.
- According to the Wolf Foundation, "he has fostered the development of integrated pest management and significantly advanced agricultural sustainability."

KA 215 Honeycomb:

Knowledge Area 215: Biological Control in Pest Management Systems of Plants



KA 215 – Major Themes

- **Biological Control**
- **Microbial Pesticides**
- **Behavior Modifying Chemicals**
- **Genetic Manipulation**
- **Transgenic Crops**
- **Plant Immunization**

- 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
- Novel formulations that enhance field stability and efficacy
- Non-target impact assessment
- Improved efficacy through use of recombinant pathogen strains
- Mating disruption
- Attract and kill strategies
- Improved pest and natural enemy monitoring and collection tools
- Sterile male technique
- Lethal genes (e.g., pink bollworm)
- Transgenesis/Paratransgenesis – gene insertions that prevent disease transmission
- Stacked genes in crop plants for resistance to multiple pests
- Non-target impacts
- Enhanced resistance through exposure to chemicals and pathogens
- Cross-protection from exposure to mild pathogen strains

- 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
- Improvements in the regulatory process for natural enemies of arthropods, weeds, and pathogens
- Improved pheromone delivery systems
- Greater transparency in development of genetically modified crops and other biological organisms
- Improved understanding of necessary size and distance of refugia for GMO crops
- Improved assessment of non-target effects of plant immunization (e.g., use of endophytic fungi to confer resistance – toxic to livestock?)

Knowledge Area 216: Integrated Pest Management Systems

KA 216 Introduction

The IPM knowledge area focuses on the development of coordinated strategies for managing pests in agricultural, residential and public areas. Work in this area synthesizes and adapts the discipline-based science developed across Knowledge 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 and also has a significant interface with plant production knowledge areas. 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. IPM offers a multidisciplinary and multi-tactical approach to managing the crop and its pests to optimize plant health and economic advantage for the producer while minimizing the negative impacts of the pests and the control measures on mankind, human society and the environment. IPM implements a process to integrate multiple tactics for managing a pest or pest complex into a system that is in harmony with the production practices.

Research and extension topics supported within KA 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.

While in this context we generally consider IPM a tool in crop production, in fact, there is great application of IPM principles in structural integrity, schools, homes, and other urban settings.

KA 216 Logic Model

KA 216: Integrated pest Management Systems

Situation	Inputs	Activities	Outputs	Outcomes		
				Knowledge	Actions	Conditions
This knowledge area (KA) focuses on the development of coordinated strategies for managing pests of agricultural, residential and public areas. This work synthesizes and adapts the discipline – based science developed in KAs 211-215. It is a system that integrates the management of 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.	**Funding Sources:** - Federal - State or local Some provide funding that contributes to research **Human Capital**: - NPLs - Extension personnel - Teachers - Researchers - Para-professionals - Stake holders - Industry, farmers, etc. - Volunteers	- Educate growers about IPM processes (diagnosis, monitoring, prevention, and making targeted applications of least toxic pesticides) - Develop early detection rapid response educational programs	Expanded knowledgebase about plant protection methods and products - Trained Workforce - Shared knowledge - Exchanged experiences among producers - Research, education and extension findings vetted by scientists - Research, education and extension findings submitted to CSREES - Research findings disseminated - Publications - Citations - Patents - Best management practices - Curricula - Undergraduate and graduate education - Training provided to producers	- Resistance to nematodes was recognized in several important crop-pest combinations, leading to releases of new nematode resistant cultivars. - New wheat varieties produced through a system allowing for more rapid screening, selection, and variety release has enhanced wheat profitability in the Midwest. - Upland cotton growers can reduce pesticide use targeting tarnished plant bugs on upland cotton without sacrificing yield. - 54% of the surveyed Wisconsin alfalfa producers believed that insecticide application 7-10 days after forage harvest regardless of counts was a proper management practice, showing a need for IPM education.	- Resistant chile cultivars and agronomic practices for weed host control have improved root-knot nematode management in New Mexico chile pepper and cotton production, - That resultant adult plum curculio summer feeding was reduced five-fold where hogs were grazed. - Missouri's FHB resistant varieties 'Truman' and 'Bess' have been widely adopted across the soft red winter wheat region, with Truman grown from south-eastern Kansas to New York in 2007.	- Achieved effective and efficient integrated pest management systems - Improved crop resistance to pests - Increased control over invasive species - Improved economic performance of producers - National plant protection-related problems solved

Assumptions - CSREES has the funds, personnel and facilities to accomplish this objective. There is a need to collaborate with lateral partner organizations and agencies.

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.

Key KA 216 Outputs and Outcomes

W1186 - Genetic Variability in the Cyst and Root-Knot Nematodes
Hatch Multi-State Research CRIS accession no. 0199626
Mission Area: Research, Extension

Cyst, root-knot and other nematode species included in this project are the most important groups of plant-parasitic nematodes in the United States. Management of these nematodes has been largely via the application of broadly efficacious nematicides. Nematicidal activity, especially of soil fumigants, does not discriminate between nematode species and genera. So understanding genetic variability and adaptation potential among nematodes can be a critically important tactic for effective nematode control. Alternative nematode management strategies that integrate crop rotation, host plant resistance, cultural manipulations and biological control, may have specific genotype-level interactions with nematodes and are influenced by the production practices and environmental conditions. As such, there is great advantage in considering variability and adaptation in nematode populations and must be considered to successfully develop and deploy alternative management strategies.

The research findings associated with this project reflect the contribution from the eleven participating states and will provide benefits to those states and others.

Impacts

- Nematode virulence and plant resistance gene interactions recognized in several important crop-nematode pest combinations have been implemented by plant breeders and in planning of crop rotations and cultivar selection for reduction of nematode damage.
- Root-knot nematodes were found to frequently adapt their parasitism on resistant host plants and alternative hosts (weeds), as influenced by seasonal climatic differences and soil conditions on grain legumes, common beans, tomato, and potato cultivars and wild relatives. As such, broad-based forms of resistance are needed for crop cultivars, cover crops, and trap crops.
- Root-knot and cyst nematode management systems have been developed or improved for several cropping systems and production areas, such as: Arkansas crop rotation systems that are adopting resistant soybeans to optimize *H. glycines* control; Sugar beet production systems in California, Idaho and Wyoming than have adopted trap crops, green manures and modified rotation sequences to optimize or cyst nematode management; Annual field and vegetable crop systems in California that have enhanced root-knot nematode management with host plant resistance in tomato, cotton, carrot and grain legume crops; Resistant chile cultivars and agronomic practices for weed host control that have improved root-knot nematode management in New Mexico chile pepper and cotton production systems; Better crop rotations and nematicide application timing that is providing better management of *M. hapla* and *M. chitwoodi* root-knot nematodes; and green manures that provide a useful nematode management tool when properly modified for various climatic environments.

Key Outputs

- Root-knot and cyst nematode management systems have been developed or improved for several cropping systems and production areas.
- Nematode virulence and plant resistance gene interactions recognized in several important crop-nematode pest combinations have been implemented by plant breeders and in planning of crop rotations and cultivar selection for reduction of nematode damage.
- Root-knot nematodes were found to frequently adapt their parasitism on resistant host plants and alternative hosts (weeds), as influenced by seasonal climatic differences and soil conditions on grain legumes, common beans, tomato, and potato cultivars and wild relatives.

Outcome

- An improved understanding of nematode genetic variability has resulted in improved nematode management strategies, less damage to agricultural crops, and greater profitability for producers.
- Arkansas crop rotation systems are adopting resistant soybeans to optimize *H. glycines* control.
- Sugar beet production systems in California, Idaho and Wyoming have adopted trap crops, green manures and modified rotation sequences to optimize cyst nematode management.
- Annual field and vegetable crop systems in California have enhanced root-knot nematode management with host plant resistance in tomato, cotton, carrot and grain legume crops.
- Resistant chile cultivars and agronomic practices for weed host control have improved root-knot nematode management in New Mexico chile pepper and cotton production systems.
- Better crop rotations and nematicide application timing is providing better management of *M. hapla* and *M. chitwoodi* root-knot nematodes.
- Green manures provide a useful nematode management tool when properly modified for various climatic environments.

Integrating Benefits of Organic Apple and Pork Production

Integrated Organic Program CRIS accession no. 0210223

Mission Area: Research, Extension

This project is investigating the opportunities to develop and deliver an organic farming system that integrates organic pork and apple production to address pest and pest-related problems while enhancing profitability and environmental sustainability. This project is investigating how rotationally grazed hogs can manage the plum curculio insect pest, by consumption of apples dropped on the orchard floor, while meeting swine nutritional requirements for growth and health. Specific project objectives include: 1) monitor the reproduction and health of orchard-raised swine; 2) monitor the growth and carcass attributes of orchard-raised swine; 3) achieve organic pork production status; 4) determine plum curculio larval survival with swine ingestion; 5) determine percent of apples dropped in June eaten by rotationally grazed hogs; and 6) conduct a fall field day to deliver integrated management practices to grower community.

Key Outputs

- Hogs were shown to effectively consume apples dropped in June, including those infested with apple-plum curculio.
- Plum curculio larvae were found to not be able survive the hog digestive system.

Outcome

- Adult plum curculio summer feeding was reduced five-fold where hogs were grazed.
- Insect pests of apple that are associated with fallen fruit can be effectively managed in an organic system with free-range hogs.

Winter Wheat Breeding Program
Hatch project CRIS accession no. 0211220
Mission Area: Research

Fusarium head blight (FHB or head scab) has caused serious losses in both the yield and quality of wheat in warm and humid regions of the world. The development of scab resistant winter wheat requires identification and genetic characterization of new sources of resistance thereby enabling breeders to put different resistance genes into wheat varieties. This will lead to higher yields and greater economic returns for wheat farmers world-wide.

Conventional breeding procedures are being used to develop improved wheat varieties and germplasm. Bulked early generation populations will be advanced with head selections four years after the initial cross. Desirable types with highly heritable agronomic traits and agronomic value are selected and evaluated in preliminary and regional nurseries. Promising lines are advanced and evaluated for soft wheat milling and baking quality by the USDA-ARS at the Soft Wheat Quality Lab in Wooster, OH. Advanced yield tests (years 3-5 of yield testing). Superior lines are considered for release after three to five years of testing in the breeding program and three years of testing in regional nurseries. Advanced breeding lines are systematically screened for FHB resistance in the greenhouse and field environments and assayed for the deoxynivalenol (DON) mycotoxin levels. Genetic analyses of new sources of FHB resistance are conducted at the USDA/ARS Genotyping facility at North Carolina State University to assess the genetic diversity of FHB resistance alleles. Sources containing potentially novel FHB alleles are being mapped. Wheat populations with recombinant inbred lines and doubled haploid populations are being developed. The presence of these FHB resistance traits is verified in both the greenhouse and field and FHB alleles will be pyramided into Missouri breeding lines using marker assisted selection and incorporated into the conventional breeding program.

Key Outputs

- Conventional breeding procedures are being used to develop improved wheat varieties and germplasm.
- Wheat populations with recombinant inbred lines and doubled haploid populations are being developed.

Outcome

- Improved soft red winter wheat varieties are being developed using novel technologies that have advanced agronomic traits while also showing state of the industry resistance to Fusarium head blight.
- This research has led to the development and release of adapted varieties of soft red winter wheat to Missouri and regional growers.
- New varieties have higher yield potential, excellent test weight, good end use quality and resistance to pathogens relevant in the Missouri wheat growing areas, especially Fusarium head blight.
- New varieties are produced through a system that allows for more rapid screening, selection, and variety release and is enhancing profitability of wheat growers in Missouri and the surrounding states.
- Missouri's FHB resistant varieties ‘Truman’ and ‘Bess’ are widely adopted across the soft red winter wheat region, with Truman grown from south-eastern Kansas to New York in 2007.
- Quantitative Trait Loci (QTL) associated with components of FHB resistance in ‘Ernie’ has led to the identification of selections with reduced FHB severity, lower deoxynivalenol (DON) contamination in harvested grain and fewer *Fusarium* damaged kernels.
- Validated markers associated with these QTL are available to breeding programs using marker-assisted-selection for enhanced efficiency incorporating FHB resistance genes into new varieties.

Revitalizing Potato Leafhopper IPM in Alfalfa through Local Farmer Networks
Regional IPM Competitive Program CRIS accession no. 0211565
Mission Area: Extension, Research

Dairy farmers in Wisconsin and the upper Midwest often apply an insecticide preemptively to alfalfa fields shortly after harvest to protect the crop regrowth from feeding injury by insects, particularly the potato leafhopper. This trend has been coined the "cut, bale and spray system" (CBS) of alfalfa production. This practice is costly to farmers, it can promote pest increase by killing pest natural enemies, the development of pest resistance to the insecticides, and it gives farmers the false sense that they have achieved lasting leafhopper control. In short, the CBS system does not constitute a sound IPM practice. The purpose of this project is to educate farmers about the benefits of practicing sound IPM practices with potato leafhopper management in alfalfa, including scouting for the pest and using economic thresholds to assist in making pest management decisions.

The objectives of this project are to: 1) Increase knowledge of participating farmers and their confidence in scouting methods for potato leafhoppers in alfalfa by forming sweep net clubs; 2) Empower farmers with more knowledge to make pest management decisions independent of their consultants; and 3) Build a local network of sweep net club members that act as local contacts for other farmers on potato leafhopper scouting and management.

Impact Nugget: Baseline data indicate there is great potential to increase adoption of potato leaf hopper IPM by using sweep net counts to trigger insecticide applications; increased adoption of resistant varieties could also play a significant role in reducing insecticide use.

Key Outputs

- Only 23% of the respondents scout early for alfalfa weevil, but 69% scouted for PLH, pea aphid and plant bugs.
- 85% of the respondents did not think spraying an insecticide immediately after forage removal is a proper insect management practice, but 54% believed that delaying the application by 7-10 days, and spraying regardless of sweep net counts, was a proper management practice.
- 46% of the respondents indicated that they spray an insecticide when their neighbors do.
- Only 2% of producers have planted glandular haired alfalfa varieties to manage potato leaf hoppers.

Outcome

- Baseline data indicate there is great potential to increase adoption of potato leaf hopper IPM by using sweep net counts to trigger insecticide applications.
- Increased adoption of resistant varieties could also play a significant role in reducing insecticide use.

Building a Fortress: Surrounding Crops with Perimeter Fools Pests
Northeast SARE project LNE03-177, a subaward under CRIS accession no. 0195223
Full project report is at www.sare.org)
Mission Area: Research and Extension

Nelson Cecarelli of Northford, Connecticut, who often lost an entire season's cucumber crop to voracious cucumber beetles, planted squash around his field perimeter, sprayed minimally, and harvested a bounty of cucumbers in 2003 and 2004. Cecarelli was one of about 30 farmers in New England to adopt a perimeter trap cropping strategy recommended by Jude Boucher of the University of Connecticut who, with a SARE grant, tested the theory over two seasons, with terrific results. The system, popular among growers, encircles a vulnerable vegetable with a crop that can attract and better withstand pest pressure, reducing the need for pesticides.

In 2004, nine New England growers increased yields of crops like cucumbers and summer squash by 18 percent and reduced insecticide use by 96 percent, earning an extra $11,000 each, on average, Boucher said. The research compared a dozen farms using perimeter trap cropping to farms that used typical spray regimens.

Growers planting perimeters applauded the time savings in pest scouting and pesticide spraying—just patrolling and minimally spraying the perimeter —and the improved economics thanks to lower input costs and higher, better-quality yields. Previously, growers had applied up

to four sprays per field. In post-project surveys, farmers said the system not only saved money, but also that planting a perimeter was simpler than applying multiple full-field insecticide sprays.

Key Outputs

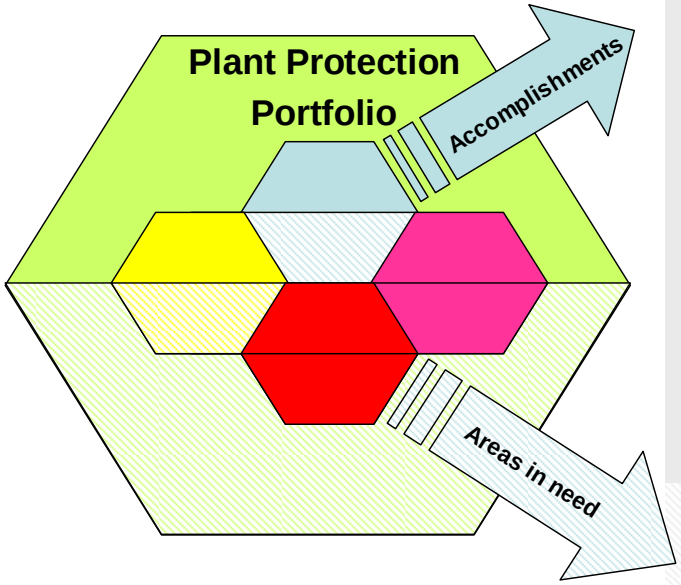
- Thirty New England growers adopted a trap crop strategy to control cucumber beetles on cucumbers

Outcome

- In 2004, nine New England growers increased yields of crops like cucumbers and summer squash by 18 percent
- Pesticide use was reduced by 96 percent
- Earnings on average increased an extra $11,000 each

KA 216 Honeycomb:

Knowledge Area 216: Integrated Pest Management Systems



KA 216 – Major Themes

- **Prevention**
- **Avoidance**
- **Monitoring**
- **Suppression**

- 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 nationally
- ipmPIPE expanded to five high consequence pest systems
- 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 invasive species, including soybean aphid, soybean rust and sudden oak death
- Education of pest managers and the general public
- Crop rotation
- Host plant resistance
- Trap crops
- Pheromone traps
- Sampling protocols for pest complexes
- Predictive models
- Record keeping systems
- Cover crops and mulches
- Mating disruption

- Identify vulnerable cropping systems and vulnerable stages in the pest life cycle
- Training on the use of advanced IPM tactics
- Measurement of effectiveness of
    - Crop rotation
    - Trap crops
    - Buffer strips
    - Refuge for susceptibles
- Pheromone trapping
- 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
- Develop a sustainable model for ipmPIPE
- Low risk biologically-based tactics
- Economical reduced risk pesticides
- Mating disruption technologies for additional crops/pests

Section III: Secondary Knowledge Areas

Secondary knowledge areas were not addressed in the Plant Systems Internal Portfolio Review document due to the fact that this was the first year that the Plant Production and Plant Protection Portfolios were combined into one portfolio.

Section IV: External Panel Recommendations to the Portfolio and Portfolio Responses

RELEVANCE

Scope

Plant Systems

2008 Response: The internal panel raised the 2007 composite score of 2.75 to 3. The 2008 farm bill expanded the scope for work on specialty crops, organic issues, and food safety. Although there were some areas that are not being addressed, the Agency is working within the available budget resources.

Plant Protection

Balance the scope by identifying major issues that are relevant to the portfolio but were not covered.

2007 Response: The internal panel score was 3. The National Program Leaders (NPLs) continue to make strong efforts to achieve balance for all areas of the portfolio.

2006 Response: The Previous external panel and internal panel scores were 3s. The National Program Leaders involved in the direction and management of this portfolio will continue to strive for balance across all areas of the portfolio.

Plant Production

2007 Response: In 2006 this element was scored a 3, whereas in 2007 it was scored a 2.5. This is a result of the stakeholder input process that CSREES has engaged in that has identified new challenges that need solutions in research, education, and extension that the agency has not yet responded to. That response is currently being planned and will be implemented provided that funding is available.

a. Publish portfolio successes to a broad audience. Inform the public about activities and outcomes.

CSREES launched a new web site feature during 2007 that highlights the accomplishments and impacts of projects funded by the agency. Publications, land-grant university web sites, and press releases are also monitored by CSREES to track results from CSREES funding. This “In The News” feature is highlighted on the main page of the CSREES web site. Modifications to the CSREES Newsroom web page are also helping improve recognition of the results and impact of CSREES funding. On this page, the public can easily access News Releases and Features, National Impacts (write-ups of the impacts of CSREES funding), Newsletters, and the Partners

Video Magazine. CSREES also now offers news releases and announcements by e-mail and uses RSS feeds to make available news releases, research results, and other announcements. Project directors are provided specific text and sent reminders regarding proper acknowledgment of CSREES funding in scientific publications and other materials. These reminders are sent at the minimum twice a year.

b. Incorporate studies of return on investment of public funds, with the portfolio reporting approach.

Oklahoma State Economic Return Study

In August, 2007, the Batelle Institute prepared a report for Oklahoma State University's Division of Agricultural Sciences and Natural Resources (DASNR) entitled *DASNR's Agbioscience Activities Deliver Positive Economic Benefits for Oklahoma.* The report estimates the economic impact for three representative program areas (wheat, cattle, and turfgrass) as well as the social impact of the Community Nutrition Education Programs. The report concludes that these and other agbioscience programs are positively impacting the profitability and sustainability of Oklahoma's agricultural economy. The executive summary is available at: http://www2.dasnr.okstate.edu/OSU%20DASNR%20Executive%20Summary.pdf.

Focus

Plant Systems
2008 Response: The internal panel raised the 2007 composite score of 2.25 to 2.5. There has been a push in two KAs (201 & 203), through the request for proposals, to gather measurable information. In other areas, there has been a concerted effort to find the information (vs. an actual increase in activity.)

Plant Protection
To maintain focus, increase the amount of measurable information that can be evaluated across all areas and the number of funding sources for all areas.

2007 Response: The internal panel score was 2.5. There continues to be an effort to achieve a balanced presentation of accomplishments and impacts for the whole Portfolio. Although there are several excellent examples of research and extension accomplishments, such as the honey bee Colony Collapse Disorder (CCD) issue, the National Plant Diagnostic Network (NPDN) examples, and the IPM Training Consortium involving NRCS, there is still a deficit of adequate accomplishments within the realm of education. Future attempts to include more education examples may involve utilizing the Education Knowledge Area (KA 903).

2006 Response: The previous external panel score was 2 and the internal panel score was 2.5. Portfolio personnel are seeking a balanced, uniform representation of accomplishments and impacts from all areas of the Portfolio, including all Knowledge Areas. Balance across funding sources and the primary functions, research, education and extension, are represented in the annual update.

Plant Production
Become proactive, for example, through use of a strategic plan.

2007 Response: The scoring for this element is unchanged. This is because the portfolio team feels that there is ample room for improvement in this area. The development of a strategic plan for the Plant Production Portfolio is being considered as a tool to bring more focus to the portfolio. Additionally, CSREES staff has continued to work with stakeholders to develop action plans that bring sharper focus to the USDA and CSREES strategic plans. In 2007, for example, the National Berry Crop Initiative finished its strategic plan, and a strategic research and extension plan for the National Vegetable Crop Initiative was drafted. Also, the "Engineering Solutions for Specialty Crop Challenges" workshop was used to prioritize industry needs and begin looking at solutions. Follow-up meetings have been used to begin a planning process.

Contemporary and/or Emerging Issues

Plant Systems
2008 Response: The internal panel maintained the 2007 composite score of 3. The Agency continues to demonstrate the ability to quickly identify and support emerging issues. The ability of the agency to respond to the issues, due to less flexibility in agency processes, is considered to be an element of performance not relevance. (See the Performance section, Portfolio Productivity 2008 response.)

Plant Protection
No recommendations from the panel.

2007 Response: The internal panel score was 3. There continues to be a high priority on identifying and supporting new issues important to plant protection/production. However, important critical issues have encountered difficulties in the funding process due to legislative language placing them as competitive programs.

2006 Response: The previous external and internal panel scores were 3s. We are continuing to place a high priority on identification and support for emerging issues that are significant for plant protection.

Plant Production
Enhance coverage of sustainability, green industry, organic farming, agroforestry, link between human health and nutritional value of plants, and homeland security.

2007 Response: The scoring for this element is unchanged. The team remains very responsive to emerging issues. Team members have taken leadership roles in the response of both USDA and CSREES in the areas of bio-energy and bio-products, specialty crops, organic agriculture, food safety, and food security, to name a few. CSREES has reconfirmed its commitment to the sustainability of land management in 2007. This is evidenced in the publication of two documents on its website: "Science and Education for Working Lands and Ecosystems" and "Implementing Research, Education and Extension for Specialty Crops". The approach of the

agency has evolved to look at these issues in a systems-based holistic fashion rather than in a reductionist approach.

Integration

Plant Systems
2008 Response: The internal panel raised the 2007 composite score of 2.1 to 2.5. There has been increased integration within NRI programs. Although there has been some improvement, there are also legislative constraints that restrict full integration. For example, the new Specialty Crop Research Initiative is authorized to provide funding for research and extension efforts but is not authorized to provide funding for education programs.

Plant Protection
- Integrate research and extension more and incorporate higher education in other areas.
- Increase the amount of evidence of extension and higher education in all areas.

2007 Response: The internal panel score was 2.2. Although there are several excellent examples of integration of research and extension as well as disciplines coming from a wide variety of sources (see Appendix C), there is still a paucity of education examples. Remediation of this deficit may be accomplished through the Education KA 903 as well as other active programs such as Ag in the Classroom and Higher Education.

2006 Response: The previous external panel score was 2 and the internal panel score was 2.2. We have provided further and more comprehensive current examples of integration of both functions and disciplines involved in Plant Protection with this update. Reporting through a variety of sources tracks activities that integrated research, education, and extension. Both existing competitive grant programs (such as the NRI and the 406 integrated programs) and proposed Hatch and McIntire-Stennis competitive programs place a high priority on integrated research, education, and extension projects.

Plant Production
2007 Response: The score for this dimension remained unchanged. The team felt that there is room for improvement in this area.

a. Develop structure to help NPLs make the Research Education and Economics (REE) connection.

Correct lack of awareness of NPLs about extension and education. CSREES became proactively involved in a number of REE, USDA and government wide initiatives, providing leadership to the development of inter-agency action plans. These initiatives included: Colony Collapse Disorder, Specialty Crops, Bio-fuels and Bio-products, Food Safety and Security, and Human Health and Nutrition. Internally, NPLs in the Plant Production Portfolio team have become more involved in managing integrated grant programs, which has helped individuals become more aware of the entire range of agency activities. Internal working groups have also been formed to increase communication and foster the integration of research, education, and extension activities and opportunities.

b. Provide data on numbers of students and postdocs, by discipline, associated with formula-funded projects.

CSREES initiated a portfolio review for education in 2007. This is the first time that such a review has been done for a specific function of the agency. It will allow CSREES to define how we approach collecting information on funding and outcomes for education, where there are gaps in our ability to capture the true impact of our funding, and identify improvements in our reporting process. As an outcome of the education portfolio review, we will develop methods to collect the data requested.

c. Establish a position of "chief scientist" responsible for multi-state research and extension and integration of research and extension. CSREES has had a "chief scientist", who consults with the agency on research issues, for a number of years. In 2004, CSREES created the position of "Education Advisor" to complement the existing position. The Education advisor consults with CSREES on issues related to education, extension and integration of the three functions.

Multi-disciplinary Balance

Plant Systems
2008 Response: The internal panel maintained the 2007 composite score of 2.5. The Specialty Crop Research Initiative required multi-disciplinary approaches to address issues as did the Risk Avoidance and Mitigation Program..

Plant Protection
Balance the number of plant professionals among all knowledge areas (KAs), KAs should have an equal distribution of contributing plant researchers, extension professionals, and educators.

2007 Response: The internal panel score was 2.5. Although some hiring for important vacant positions has occurred, there are still several critical positions that remain unfilled due to budgetary constraints. Consequently, this situation negatively affects the balance of expertise in both plant production and protection.

2006 Response: The Previous external panel score was 2 and the internal panel score was 3. With recent retirements and position shifts within the agency and the occurrence of vacancies to be filled at the National Program Leader level we have sought further balance in the senior staff with respect to disciplines involved in both plant production and protection. One entomologist was replaced by a plant pathologist (with particular expertise in plant disease diagnostics and extension and applied IPM). We have added a shared faculty member for organic agriculture to meet a growing need that crosses both plant production and plant protection.

Plant Production
Provide examples of multi-disciplinary projects e.g. engineering + economics + other disciplines.

2007 Response: In 2006 this dimension was scored 3, whereas in 2007 it was scored 2.5. This is a result of recalibration in the self-scoring process. In 2006, half-points were not possible. In 2007, half-points were allowable. If this had been the case in 2006, the scores would have been the same. The portfolio team is committed to continuing to foster multi- and trans-disciplinary

approaches to meeting challenges in plant production. CSREES has made a commitment to promoting the integration of multi-discipline, or trans-discipline, teams into the funding process. This concept is central to both of the concept papers, "Science and Education for Working Lands and Ecosystems" and "Implementing Research, Education, and Extension for Specialty Crops".

QUALITY

Significance of Findings

Plant Systems
2008 Response: The internal panel maintained the 2007 composite score of 2.75.

Plant Protection
Clarify if output and outcome information are being received by end-users.

2007 Response: The internal panel score was 2.5. Notable efforts are made to educate end-users concerning important outputs and outcomes. Certain actions, such as hiring a communications specialist, confirm this commitment. However, the losses of tools such as the web-based Science and Impact site have had negative effects on this effort.

2006 Response: The previous external panel score was 2 and the internal panel score was 2.5. We are focusing on reporting significant impacts of work supported by CSREES on end-users. Measurable impact stories are captured in Plan of Work accomplishments reports, CRIS impact statements and through impact reporting by multi-state research/extension committees. The Science and Impact web page reports impacts of work on issues funded through CSREES that are important at the local level.

Plant Production
Provide more examples and a summary of known outputs and impacts.

2007 Response: The scoring for this element is unchanged. The team continues to provide leadership to ensure that there are many significant outcomes from projects funded in the plant production portfolio. CSREES is using its web site, through the "Newsroom" feature, to more widely publicize known outputs and impacts from agency funded activities.

Stakeholder/Constituent Inputs

Plant Systems
2008 Response: The internal panel maintained the 2007 composite score of 3. Efforts described in the 2007 responses continue. Additional webinars were also held.

Plant Protection
- A systematic method needs to be developed to get information into the hands of end-users.
- Additional end-user workshops need to be conducted.
- Information and input from state partners should be used.

2007 Response: The internal panel score was 3. Efforts to keep stakeholders involved in both providing relevant input and receiving important information critical to their livelihoods is extremely important. Consequently, many staff members contribute to workshops geared toward stakeholders. Within limits of existing funds, staff are trying to engage in additional workshops and information exchange opportunities to maximize interactions with diverse stakeholder interests. As mentioned last year, more cost-effective methods are being employed, including webcasts and video-linked conference calls. Input from state partners is solicited on a regular basis.

2006 Response: The previous external panel score was 2 and the internal panel score was 2.5. Discovery and implementation research gets into the hands of end-users through Cooperative Extension system educational programs and to students through formal academic educational programs of our partner institutions. CSREES facilitates these activities through a variety of funding mechanisms. CSREES NPLs participate in stakeholder sessions that include research, extension and academic faculty, as well as agricultural commodity, community and trade groups. Within the limits of existing funds we are trying to engage in additional workshops and information exchange opportunities to maximize our interactions with diverse stakeholder interests. A number of newer, more cost-effective methods are being employed, including webcasts and video-linked conference calls.

Plant Production
Provide more discretionary funds for workshops and conferences, to enhance two way communication with stakeholders.

2007 Response: The scoring for this element is unchanged. CSREES has developed new ways to encourage stakeholders to provide input for the betterment of its programs. CSREES operated on a year-long continuing resolution (CR) in fiscal year 2007. The CR capped CSREES spending at fiscal year 2006 levels. Without the availability of increased funding, it is not possible to provide more discretionary funds. However, CSREES continues to support workshops and conferences through a variety of mechanisms, including the use of those discretionary funds that do exist and awards for this purpose through competitive programs. In addition to workshops and conferences, CSREES now has a Stakeholder Input web page where stakeholders can submit input and access upcoming and past sources of input.

Alignment with Current State of Science

Plant Systems
2008 Response: The internal panel maintained the 2007 composite score of 3. The new Specialty Crop Research Initiative is a sterling example of the alignment of many science-based goals and objectives with USDA and CSREES strategic plans.

Plant Protection:
Ensure that there is evidence of alignment in other sciences.

2007 Response: The internal panel score was 3. The National Program Leaders (NPLs) involved in the direction and management of this portfolio will continue to seek alignment with other sciences across all areas of the portfolio.

2006 Response: The previous external and internal panel scores were 3s. The NPLs involved in the direction and management of this portfolio will continue to strive for alignment with other sciences across all areas of the portfolio.

Plant Production
Align strategic goals and objectives with actual agricultural practices.

2007 Response: The scoring for this element is unchanged. The team feels that the alignment of the portfolio with contemporary knowledge is excellent. Funding from the portfolio is creating contemporary knowledge.

The USDA and CSREES strategic plans are intended to provide broad guidelines within which agencies conduct their business. Through numerous workshops and similar activities working in collaboration with partners and stakeholders, CSREES has fine tuned those broad guidelines into focused action plans intended to allow producers and consumers to meet real world challenges. One example of this process is the development of strategic plans for clusters of programs within the National Research Initiative. CSREES administration has also encouraged individual portfolios to create strategic plans that link various KAs in meaningful ways to create intended outcomes.

Appropriate and/or Cutting Edge Methodology

Plant Systems
2008 Response: The internal panel maintained the 2007 composite score of 3. A new release of the Leadership Management Dashboard and subsequent training got more program staff involved with using the tool. The PIPE (described below) was expanded in 2008 to include management of the pecan nut casebearer and cucumber downy mildew. The One Solution Initiative continues to be developed and implemented based on feedback from users.

Plant Protection:
Increase evidence that all KAs are using cutting edge technology for generating, gathering, and analyzing data.

2007 Response: The internal panel score was 3. Cutting edge technologies are continually being implemented in a variety of situations. Two such major advancements include the Leadership Management Dashboard (LMD) that allows National Program Leaders to achieve unprecedented management capabilities of their program assignments. Another tool is the Pest Information Platform for Extension and Education (PIPE). The PIPE system originated out of the tracking and dissemination of information about soybean rust through USDA's Web site. Given its effectiveness as a coordinated, real-time national pest management framework, PIPE is expanding into other areas of pest management.

2006 Response: The previous external panel score was 2 and the internal panel score was 2.7. The plant protection portfolio of programs fund activities that include important cutting edge technologies ranging from new applications for applied mission-oriented problems to development of new methods of analysis and discrimination for emerging pests and diseases that might have adverse effects on the Nations agricultural bio-security. Examples included as evidence in this update include GIS/GPS technology used in precision application of pest management tactics, DNA barcoding for high throughput screening and identification of potential pest species, sophisticated and advanced pest modeling, decision support software for end-user pest management programs at the farm or grower level, and rapid forecasting tools for pest prediction.

Plant Production

2007 Response: The scoring for this element is unchanged. Cutting edge methodologies are routinely applied and often developed by portfolio projects.

a. Improve the CSREES reporting system.

The One Solution Initiative is a comprehensive approach to develop a management strategy that CSREES can use to improve the quality and comprehensiveness of reports to OMB and Congress. CSREES will be implementing a One Solution integrated reporting system, referred to as the CSREES Information System (CIS) over the next several years. The goals of One Solution include the ability to reuse and combine existing data from various separate reporting systems; standardize reporting requirements and definitions; and maintain the CRIS legacy database but make it more accessible by migrating it to a new CIS platform.

b. Design metrics for applied projects.

As CSREES redirects focus of some of its major grant programs from strictly fundamental discovery to a more problem-solving focus, there is an increase in the number of projects awarded that might be considered applied. As this number continues to grow, program directors are developing ways to determine the outcomes and impacts of those projects.

c. The research methodologies are based on peer review and therefore, appropriate. The lack of good evidence for extension and education methods is a weakness of the Portfolio.

As Integrated Programs within CSREES mature, individual programs are developing metrics that make sense to the partner and stakeholder communities. The Director of Integrated Programs within the agency has facilitated dialogue among program directors offering integrated projects, which has hastened the adoption of relatively standardized metrics across programs. Interaction within the agency among units offering research, education, extension and/or integrated programs has led to the development of program priorities that address current issues and cut across unit boundaries.

PERFORMANCE

Portfolio Productivity

Plant Systems
2008 Response: The internal panel lowered the 2007 composite score of 2.5 to 2. The availability of funding, both the amount and the timing of distribution, impacts the Agency's ability to deliver program funds in a responsive and timely manner (particularly for Critical and Emerging Pests and Diseases where the RFA and competitive process slows response timeliness). Mandated programs decrease the states' flexibility in finding and implementing solutions for their issues. Decreased funding for travel impairs the ability of the program staff to interact with stakeholders to better understand and manage CSREES programs.

Plant Protection:
Panels should have measures of productivity per dollar spent.

2007 Response: The internal panel score was 3. There will continue to be investigations into measuring the return on investment of Federal dollars.

2006 Response: The previous external and internal panel scores were 3s. We continue to examine ways to measure the productivity of our programs per dollar spent so we continue to maximize the return on the investment of Federal dollars.

Plant Production
2007 Response: The scoring for this element is unchanged. The team feels that productivity is often hard to demonstrate and even harder to improve without increased investment.

Portfolio Comprehensiveness

Plant Systems
2008 Response: The internal panel maintained the 2007 composite score of 2. Although some gaps have been addressed through the Specialty Crop Research Initiative, other gaps still exist and others have widened. Many of the NRI programs have reduced the number of priorities to create more focus and increase the chances of success, but this makes the programs less comprehensive. Significant gaps exist in biobased pest management, microbial control of plant pathogens, and in multi-disciplinary programs that cross taxa; for example, mission-linked systems management of both arthropod and vertebrate pests (e.g., rats, mice, birds, invasive fish, etc.).

Plant Protection:
- Increase evidence of KA comprehensiveness.
- Outputs reporting should be more comprehensive.

2007 Response: The internal panel score was 2. Sub-groups of National Program Leaders (NPLs) are organized reflecting the comprehensiveness of the portfolio by soliciting input from both

within and outside of the Plant and Animal Systems (PAS) unit. These sub-groups are developed along the lines of the Knowledge Areas (KAs). However, participation by members outside of PAS has been lacking. Future efforts will be made to solicit involvement by National Research Initiative (NRI) and Higher Education personnel as well as others. Eventually, this should succeed in output reporting that is more comprehensive.

2006 Response: The previous external and internal panel scores were 2s. For this update, and for all future reporting and evaluation updates, we have established sub-groups of National Program Leaders within the portfolio to ensure that reporting for each Knowledge Area follows the same guidelines and reporting parameters across the portfolio. In this way we will report equally with highly significant accomplishments, outputs, outcomes, and impacts for each area of the portfolio.

Plant Production
2007 Response: In 2006 this element was scored a 3, whereas in 2007 it was scored a 2. Part of the decrease is due to a redefining of the scoring criteria for this dimension. The decrease can be further explained by a better understanding on the part of the team of what the scoring criteria actually mean. The team feels that the portfolio meets expectations but that there is room for improvement.

Portfolio Timeliness:

Plant Systems
2008 Response: The internal panel lowered the 2007 composite score of 2.75 to 2.5. The availability of funding, both the amount and the timing of distribution, impacts the Agency's ability to deliver program funds in a responsive and timely manner (particularly for Critical and Emerging Pests and Diseases where the RFA and competitive process slows response timeliness).

Plant Protection:
Provide adequate evidence for project completion time.

2007 Response: The internal panel score was 2. There is evidence that a significant number of projects are not being finished by the proposed dates. However, with the development of better reporting, tracking and information synthesis capabilities; including the Leadership Management Dashboard (LMD) and the electronic filing of Plans of Work and Annual Reports; there should be more reliable statistics available on project timeliness. Issues concerning legitimate no-cost extensions can complicate the situation.

2006 Response: The previous external and internal panel scores were 2s. While the panel believed that most projects were completed on time, evidence that this is the case was not presented. Over time, with development of better reporting, tracking and information synthesis capabilities that are currently underway, including the Leadership Management Dashboard we will be able to provide more concrete statistics on the percentage of projects meeting this desired objective. (see: Agency Response to Appropriate Methodology, below).

Plant Production
2007 Response: The scoring for this element is unchanged. Most projects achieve closure on time.

Agency Guidance

Plant Systems
2008 Response**:** The internal panel maintained the 2007 composite score of 2.75. Several 2008 activities contributed to a strong score on this element including the Specialty Crop Research Initiative, improvement in the state liaison program, and PACE training.

Plant Protection:
- Provide efficient and comprehensive information concerning the Portfolio's management process.
- Better define NPLs' management responsibilities.

2007 Response: The internal panel score was 2.5. There appears to be a need for additional administrative guidance concerning projects oriented towards non-agricultural issues. For future external PREP reviews more extensive background information on program management and roles of individuals involved in the portfolio will be provided.

2006 Response: The previous external panel score was 2 and the internal panel score was 2.7. Most of the management processes and the management responsibilities of National Program Leaders are the same for all portfolios across the Agency. For future external PREP site reviews more extensive background information on program management and roles of individuals involved in the portfolio will be presented.

Plant Production
2007 Response: The scoring for this element is unchanged. Leadership and management of the portfolio are superior.

Portfolio Accountability:

Plant Systems
2008 Response: The internal panel maintained the 2007 composite score of 2.5. CSREES has made progress in getting awardees to understand the need for clear reporting through NRI Project Director workshops, the encouragement to multi-states to think about outcomes and report them effectively, and the Administrator's messages to the land grant community. The program staff have increased their efforts to find examples of evaluation data although they cannot devote as much time as is necessary to this time consuming process.

Plant Protection:
Increase the amount of sufficient data used for evaluating the Portfolio's accountability.

2007 Response: The internal panel score was 2.5. Progress has been made in improving the reporting of outputs, outcomes/evidence of success. The One-Solution initiative has made it possible for improving the review and oversight of CRIS and Plant of Work reports. Additionally, the development of the Leadership Management Dashboard will allow program staff to readily retrieve accountability data more effectively and efficiently. The only negative issue has been the loss of the Science and Education Impact reporting system.

2006 Response: The previous external panel score was 2 and the internal panel score was 2.2. CSREES is investing significant effort and resources to improve our ability to extract and synthesize data to increase our level of accountability. The One Solution initiative provides the focal point for these efforts. One Solution will incorporate and improve existing databases for reporting currently in use such as the Current Research Information System, the web-based Plan of Work reporting system, and other reporting systems. The Science and Education Impact reporting system search capability is currently being improved. The internal grant reporting and tracking system C-REEMS and the web-based Peer Review System are also improving over time and will enable better reporting and tracking of both competitive and non-competitive grants. CSREES has established an internal group, the Planning and Accountability Team, under the leadership of the Associate Administrator, to guide and oversee development of planning and evaluation activities across the Agency in a systematic manner.

Plant Production
2007 Response: In 2006 this element was scored a 3, whereas in 2007 it was scored a 2.5. This is a result of recalibration in the self-scoring process. In 2006, half-points were not possible. In 2007, half-points were allowable. If this had been the case in 2006, the scores would have been the same. The team feels that there is now a better understanding of what will be needed to raise the quality of project reports to the superior level.

Section V: Self-Assessment
Portfolio Scoring

Since the new Plant Systems portfolio is comprised of the former Plant Production and Plant Protection portfolios, which were assessed previously as separate portfolios, the following table shows the separate scores for the Plant Production and Protection portfolios as well as this year's Plant Systems score.

Plant Systems Portfolio Scores

	Panel Score		2006 Score		2007 Score		2008 Score
	Plant Production	**Plant Protection**	**Plant Production**	**Plant Protection**	**Plant Production**	**Plant Protection**	**Plant Systems**
Relevance							
1. Scope	3	3	3	3	2.5	3	3
2. Focus	2	2	2	2.5	2	2.5	2.5
3. Contemporary and/or Emerging Issues	2	3	3	3	3	3	3
4. Integration	1	2	2	2.2	2	2.2	2.5
5. Multi-disciplinary Balance	2	2	3	3	2.5	2.5	2.5
Quality							
1. Significance of Findings	2	2	3	2.5	3	2.5	2.75
2. Stakeholder/Constituent Inputs	3	2	3	2.5	3	3	3
3. Alignment with Current State of Science	3	3	3	3	3	3	3
4. Appropriate and/or Cutting-Edge Methodology	3	2	3	2.7	3	3	3
Performance							
1. Portfolio Productivity	2	3	2	3	2	3	2
2. Portfolio Comprehensiveness	2	2	3	2	2	2	2
3. Portfolio Timeliness	2	2	3	2	3	2	2.5
4. Agency guidance	3	2	3	2.7	3	2.5	2.75
5. Portfolio Accountability	2	2	3	2.2	2.5	2.5	2.5
Overall Score	81	80	93	89	87	90	90

2008 Portfolio Score Change Discussion

Relevance

- Scope: Increased from 2.5 to 3

Justification: The expansion of the 2008 Farm Bill expanded the scope of work on specialty crops, organic issues, and food safety.

- Focus: Increased from 2.25 to 2.5

Justification: A major new focus for one of the Coordinated Agricultural Projects is to address Colony Collapse Disorder (CCD), which is threatening the honey bee industry and may impact the nation's food supply. The NRI grant program is called the Protection of Managed Bees Coordinated Agricultural Project.

- Emerging Issues: Remained unchanged at 3.

Justification: The Agency continues to demonstrate its ability to quickly identify and support emerging and support issues.

- Integration: Increased form 2.1 to 2.5

Justification: Due to an increase in NRI programs the integration score improved for this portfolio, although integration is limited by legislative constraints. For example, the Specialty Crop Research Initiative only includes research and extension funding authorization. Education funding is not authorized for this initiative.

- Multi-disciplinary: Remained unchanged at 2.5.

Justification: The implementation of the Specialty Crop Research Initiative requires a multi-disciplinary approach in order to properly address the issues as does the Risk Avoidance and Mitigation Program.

Quality

- Significance: Remained unchanged at 2.75.

Justification: Coordinated Agricultural Projects (CAPs) will help bridge the gap between genome researchers and plant breeders enabling the U.S. to be at the forefront of applied plant genomics, genetics, and breeding research, education, and extension.

- Stakeholder: Remained unchanged at 3.

Justification: CSREES continues to make a concerted effort to obtain feedback from stakeholders through workshops, symposia, multi-state committees, advisory boards, webcasts and video-linked conference calls, grant panel members, and grant applicants, and other means.

- Alignment: Remained unchanged at 3.

Justification: The Specialty Corp Research Initiative is a sterling example of the alignment of many science-based goals and objectives with the USDA and CSREES strategic plans.

- Methodology: Remained unchanged at 3.

Justification: The release of the new Leadership Management Dashboard, as well as, the training for this system played an important role in increasing Agency's utilization of this tool. The ipmPIPE was expanded in 2008 to include management of pecan nut casebearer and cucumber downy mildew. The One Solution Initiative continues to be developed and implemented based on feedback from users.

Performance

- Productivity: Decreased form 2.5 to 2.

Justification: One factor that has played a role in the decreased productivity of this portfolio is the availability of funding and the timing of the distribution of funds. This factor impacts the Agency's ability to deliver program funds in a responsive and timely manner (particularly for Critical and Emerging Pests and Diseases where the RFA and competitive process slows response timeliness). Also, decreased funding for travel impairs the ability of program staff to interact with stakeholders to better understand and manage CSREES programs. Mandated programs decrease the states' flexibility in finding and implementing solutions for their issues.

- Comprehensiveness: Remained unchanged at 2.

Justification: Although some gaps have been addressed through the Specialty Crop Research Initiative, other gaps still exist and others have widened. Many of the NRI programs have reduced the number of priorities to create more focus and increase the chances of success, but this makes the programs less comprehensive. Significant gaps exist in biobased pest management, microbial control of plant pathogens, and in multi-disciplinary programs that cross taxa; for example, mission-linked systems management of both arthropod and vertebrate pests (e.g., rats, mice, birds, invasive fish, etc.).

- Timeliness: Decreased from 2.75 to 2.5.

Justification: The availability of funding, both the amount and the timing of distribution, impacts the Agency's ability to deliver program funds in a responsive and timely manner (particularly for Critical and Emerging Pests and Diseases where the RFA and competitive process slows response timeliness).

- Agency Guidance: Remained unchanged at 2.75.

Justification: There are several activities which contributed to the strong score of this element, including the Specialty Crop Research Initiative, improvement in the state liaison program, and PACE training.

- Accountability: Remained unchanged at 2.5.

Justification: CSREES has made progress in getting awardees to understand the need for clear and concise reporting through NRI Project Director workshops, encouraging multi-states to report outcomes more effectively, and the Administrator's messages to the land-grant community. The Agency has increased its efforts to find examples of evaluation data, although it is a time consuming process.

Appendix A – External Panel Recommendations to the Agency

In response to directives from the Office of Management and Budget (OMB) of the President, CSREES implemented the Portfolio Review Expert Panel (PREP) process to systematically review its progress in achieving its mission. Since this process began in 2003, fourteen expert review panels have been convened and each has published a report offering recommendations and guidance. These external reviews occur on a rolling five-year basis. In the four off years an internal panel is assembled to examine how well CSREES is addressing the expert panel's recommendations. These internal reports are crafted to specifically address the issues raised for a particular portfolio. Electronic versions of both external and internal reviews for all portfolios are located on the Agency's website (http://www.csrees.usda.gov/about/strat_plan_portfolio.html).

Even though the expert reports were all written independent of one another on portfolios comprised of very different subject matter, several themes common to the set of review reports have emerged. This set of issues has repeatedly been identified by expert panels and requires an agency-wide response. The agency has taken a series of steps to effectively respond to those overarching issues.

- **Issue 1: Getting Credit When Credit is Due**

For the most part panelists were complimentary when examples showing partnerships and leveraging of funds were used. However, panelists saw a strong need for CSREES to better assert itself and its name into the reporting process. Panelists believed that principal investigators who conduct the research, education and extension activities funded by CSREES often do not highlight the contributions made by CSREES. Multiple panel reports suggested CSREES better monitor reports of its funding and ensure that the agency is properly credited. Many panelists were unaware of the breadth of CSREES activities and believe their lack of knowledge is partly a result of CSREES not receiving credit in publications and other material made possible by CSREES funding.

Issue 1: Agency Response:

To address the issue of lack of credit being given to CSREES for funded projects, the Agency implemented several efforts likely to improve this situation.

First CSREES developed a standard paragraph about CSREES's work and funding that project managers can easily insert into documents, papers and other material funded in part or entirely by CSREES.

Second, the Agency is in the process of implementing the "One Solution" concept. One Solution will allow for the better integration, reporting and publication of CSREES material on the web. In addition, the new Plan of Work (POW), centered by a logic model framework, became operational in June 2006. Because of the new POW requirements and the POW training conducted by the Office of Planning and Accountability (OPA), it will be simpler for state and local partners to line up the work they are doing with agency expenditures. This in turn will make it easier for project managers to cite CSREES contributions when appropriate.

The Agency has started the process of upgrading the Current Research Information System (CRIS), once upgraded it will be named the CSREES Information System (CIS). The CIS will allow users to access information from the Plan of Work (POW) and new Standard Report in a more effective and efficient manner. In addition to the CIS, the new Annual Reporting system that is based on activities discussed in the POW was launched in 2008.

- **Issue 2: Partnership with Universities**
  Panelists felt that the concept of partnership was not being adequately presented. Panelists saw a need for more detail to be made available. Panelists asked a number of questions revolving around long-term planning between the entities they also asked how the CSREES mission and goals were being supported through its partnership with universities and vice versa.

  Issue 2: Agency Response:
  CSREES has taken several steps to strengthen its relationship with university partners. During the November 2005 National Association of State University and Land Grant Colleges (NASULGC) meeting in Washington, D.C., Dr. Colien Hefferan announced a new cooperative program entitled the new NPL Institutional Liaison program. The primary goal of this program is to strengthen the relationship between CSREES and its state partners, thus enhancing the effectiveness of the work done by CSREES. Through teleconferences, campus visits, e-mails and other meeting opportunities; CSREES's knowledge and understanding of institutional interests and needs will increase. CSREES is committed to learning more about state research, extension and education activities, strategic plans, and goals.

  NPL Liaisons have the following duties:
  - Become knowledgeable about the administrative structure budget sources and major program commitments of your institution
  - Meet regularly with the CSREES deputy administrator liaison with your region
  - Make quarterly phone calls or teleconferences to appropriate university officials in order to create ongoing dialogue of shared interests and needs
  - Schedule campus visit/s in order to enhance the partnership
  - Serve as the joint reviewers of your integrated annual plans of work from cooperative extension and research
  - Identify partnership opportunities within CSREES and other federal agencies to strengthen your programs and assist in meeting your goals

  Finally, several trainings that focused on the POW were conducted by CSREES in geographic regions throughout the country. A major goal of this training was to better communicate CSREES goals to state leaders which will facilitate better planning between the universities and CSREES.

- **Issue 3: National Program Leaders**
  Without exception the portfolio review panels were complimentary of the work being done by NPLs. They believe NPLs have significant responsibility, are experts in the field and do a difficult job admirably. Panelists did however mention that often times there

are gaps in the assignments given to NPLs. Those gaps leave holes in programmatic coverage.

Issue 3: Agency Response:
CSREES values the substantive expertise that NPLs bring to the Agency and therefore requires all NPLs to be experts in their respective fields. Given the budget constraints often times faced by the agency, the agency has not always been able to fund needed positions and had to prioritize its hiring for open positions. In addition, because of the level of expertise CSREES requires of its NPLs, quick hires are not always possible. Often, CSREES is unable to meet the salary demands of those it wishes to hire. It is essential that position not only be filled but filled with the most qualified candidate.

Operating under these constraints and given inevitable staff turnover, gaps will always remain. However, establishing and drawing together multidisciplinary teams required to complete the portfolio reviews has allowed the Agency to identify gaps in program knowledge and ensure that these needs are addressed in a timely fashion. To the extent that specific gaps are mentioned by the expert panels, the urgency to fill them is heightened.

- **Issue 4: Integration**
  Lack of integration has been highlighted throughout the panel reviews. While review panelists certainly noted in their reports where they observed instances of integration, almost without fail panel reports sought more documentation in this regard.

  Issue 4: Agency Response:
  Complex problems require creative and integrated approaches that cut across disciplines and knowledge areas. CSREES has recognized the need for these approaches and has undertaken steps to remedy this situation. CSREES has recently mandated that up to twenty-six percent of all NRI funds be put aside specifically for integrated projects. These projects cut across functions as well as disciplines and ensure that future Agency work will be better integrated. Integration is advanced through the portfolio process which requires cooperation across units and programmatic areas.

- **Issue 5: Extension**
  While most panels seemed satisfied at the level of discussion that focused on research, the same does not hold true for extension. There was a call for more detail and more outcome examples based upon extension activities. There was a consistent request for more detail regarding not just the activities undertaken by extension but documentation of specific results these activities achieved.

  Issue 5: Agency Response:
  Conferences have been conducted to increase the awareness of improved methodologies and reporting systems for documenting outcomes and impacts for the Agency. A CSREES Planning and Evaluation Mini-Conference was held April 23-24, 2007, in conjunction with the Administrative Officers' Conference in Seattle, WA. This mini-conference was designed for those planning programs or engaged in performance measurement and program evaluation. Participants learned about Plan of Work reporting,

what CSREES has learned from the 2007-2011 Plans submitted, and how CSREES has used and expects to use information from annual reports and plans.

In addition to the CSREES Planning and Evaluation Mini-Conference, CSREES, in partnership with Texas A&M University, started a bi-monthly CSREES Reporting Web Conference Series (RWC) in February 2008. This series originated from requests for more information on various topics identified at the 2007 CSREES Planning and Accountability Mini-Conference. Topics for the series include:

- Agricultural Research, Extension, and Education Reform Act (AREERA);
- Plans of Work (POW);
- Annual Reports;
- One Solution;
- CRIS (soon to become CSREES Information System (CIS)); and
- Outcome reporting.

The AREERA Plan of Work and Annual Reporting system (POW) made extension-based results and reporting a priority. The new POW includes program descriptions and progress reports limited to four legislatively prescribed lines of funding. POW includes descriptions and annual accomplishments for each subject program. POW is a database application containing a combination of structured data and unstructured text box fields. These reports provide state level documentation of extension outcomes and impacts not previously captured in Agency wide reporting systems. Approved state plans of work and annual reports will be available in the Research, Education, and Economics Information System (REEIS) in the fall of 2008.

- **Issue 6: Program Evaluation**
  Panelists were complimentary in that they saw the creation of OPA and portfolio reviews as being the first steps towards more encompassing program evaluation work; however, they emphasized the need to see outcomes and often stated that the scores they gave were partially the result of their own personal experiences rather than specific program outcomes documented in the portfolios. In other words, they know first hand that CSREES is having an impact but would like to see more systematic and comprehensive documentation of this impact in the reports.

  Issue 6: Agency Response:
  The effective management of programs is at the heart of the work conducted at CSREES and program evaluation is an essential component of effective management. In 2003, the PREP process and subsequent internal reviews were implemented. Over the past four years 14 portfolios have been reviewed by expert panel members and continue to be self-assessed annually. Each year this process improves, including reconfiguration of several portfolios to become better structured for planning and assessment. NPLs are now familiar with the process and the staff of the Office of Planning and Accountability (OPA) has implemented a systematic process for pulling together the material required for these reports.

  Simply managing the process more effectively is not sufficient for raising the level of program evaluations being done on CSREES funded projects to the highest standard.

Good program evaluation is a process that requires constant attention by all stakeholders and the agency has focused on building the skill sets of stakeholders in the area of program evaluation. The OPA has conducted training in the area of evaluation for both NPLs and for staff working at Land-Grant universities. This training is available electronically and the OPA will be working with NPLs to deliver training to those in the field.

The OPA is working more closely with individual programs to ensure successful evaluations are developed, implemented and the data analyzed. Senior leadership at CSREES has begun to embrace program evaluation and over the coming years CSREES expects to see state leaders and project directors more effectively report on the outcomes of their programs as they begin to implement more rigorous program evaluation. The new POW system ensures data needed for good program evaluation will be available in the future.

The newly formatted annual review document has encouraged the discussion of program evaluations conducted regarding programs funded by the Agency for the particular portfolio being highlighted.

- **Issue 7: Logic Models**
  Panelists were consistently impressed with the logic models and the range of their potential applications. They expressed the desire to see the logic model process used by all projects funded by CSREES and hoped not only would NPLs continue to use them in their work but, also, that those conducting the research and implementing extension activities would begin to incorporate them into their work plans.

  Issue 7: Agency Response:
  Logic models have become a staple of the work being done at CSREES and the Agency has been proactive in promoting the use of logic models to its state partners.

  Two recent initiatives highlight this. First, in 2005, the POW reporting system into which states submit descriptions of their accomplishments was completely revamped. The new reporting system now closely matches the logic models being used in portfolio reports. Beginning in fiscal year 2007, states will be required to enter all of the following components of a standard logic model. These components include describing the following:
  - Program Situation
  - Program Assumption
  - Program Long Term Goals
  - Program Inputs which include both monetary and staffing
  - Program Output which include such things as patents
  - Short Term Outcome Goals
  - Medium Term Outcome Goals
  - Long Term Outcome Goals
  - External Factors
  - Target Audience

A series of training workshops were conducted by the OPA for staff from CSREES and from the land grant partnership. OPA senior staff traveled to regional conferences attended by Project Directors and Principal Investigators funded by CSREES. They conducted workshops on budget and performance integration and logic models. These sessions helped our partners understand the full picture and emphasized the need for our partners to report their accomplishments. Senior staff presented the logic model as a conceptual as well as an application tool useful for planning and reporting. Partners have now begun to use logic model in their work as well as report their accomplishments. In fact the Competitive Program unit of the Agency has made the inclusion of logic models a requirement for Integrated Programs.

Appendix B - Detailed Funding Tables for Primary KAs – CSREES Funding

KA 201: Plant Genome, Genetics, and Genetic Mechanisms CSREES Funding						
Combined Research and Extension Funding						
Funding Source	**$ in the thousands**					
	FY 2003	**FY 2004**	**FY 2005**	**FY 2006**	**FY 2007**	**Total**
PROJ No.	759	772	794	783	768	3,876
Hatch	$5,411.00	$6,217.00	$6,211.00	$5,919.00	$8,023.00	$31,781.00
McIntire-Stennis	$328.00	$192.00	$284.00	$375.00	$721.00	$1,900.00
Evans Allen	$1,201.00	$1,206.00	$1,246.00	$1,172.00	$931.00	$5,756.00
Animal Health	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Special Grants	$4,807.00	$5,145.00	$4,595.00	$6,185.00	$0.00	$20,732.00
NRI Grants	$10,810.00	$9,625.00	$11,160.00	$15,042.00	$13,547.00	$60,184.00
SBIR Grants	$296.00	$248.00	$470.00	$56.00	$710.00	$1,780.00
Other CSREES	$3,080.00	$2,708.00	$2,236.00	$1,644.00	$1,753.00	$11,421.00
Total Reported in CRIS	$25,933.00	$25,341.00	$26,202.00	$30,393.00	$25,685.00	$133,554.00
Smith-Lever 3(b) and (c)	n/a	n/a	n/a	n/a	$1,346.69	$1,346.69
1890 Extension	n/a	n/a	n/a	n/a	$153.01	$153.01
Total Extension Reported in POW	n/a	n/a	n/a	n/a	$1,499.70	$1,499.70
Total	$25,933.00	$25,341.00	$26,202.00	$30,393.00	$27,184.70	$135,053.70

KA 202: Plant Genetic Resources CSREES Funding						
Combined Research and Extension Funding						
	$ in the thousands					
Funding Source	**FY 2003**	**FY 2004**	**FY 2005**	**FY 2006**	**FY 2007**	**Total**
PROJ No.	498	498	503	504	506	2509
Hatch	$5,787.00	$5,811.00	$5,889.00	$5,760.00	$6,912.00	$30,159.00
McIntire-Stennis	$205.00	$189.00	$175.00	$186.00	$179.00	$934.00
Evans Allen	$813.00	$817.00	$870.00	$969.00	$730.00	$4,199.00
Animal Health	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Special Grants	$2,149.00	$3,048.00	$3,129.00	$4,443.00	$30.00	$12,799.00
NRI Grants	$740.00	$1,033.00	$783.00	$1,523.00	$1,845.00	$5,924.00
SBIR Grants	$0.00	$289.00	$0.00	$16.00	$0.00	$305.00
Other CSREES	$1,091.00	$746.00	$826.00	$170.00	$800.00	$3,633.00
Total Reported in CRIS	$10,785.00	$11,933.00	$11,672.00	$13,067.00	$10,496.00	$88,173.00
Smith-Lever 3(b) and (c)	n/a	n/a	n/a	n/a	$1,051.19	$1,051.19
1890 Extension	n/a	n/a	n/a	n/a	$67.85	$67.85
Total Extension Reported in POW	n/a	n/a	n/a	n/a	$1,119.04	$1,119.04
Total	$10,785.00	$11,933.00	$11,672.00	$13,067.00	$11,615.04	$59,072.04

KA 203: Plant Biological Efficiency and Abiotic Stresses Affecting Plants CSREES Funding						
Combined Research and Extension Funding						
	$ in the thousands					
Funding Source	**FY 2003**	**FY 2004**	**FY 2005**	**FY 2006**	**FY 2007**	**Total**
PROJ No.	692	668	654	635	612	3,261
Hatch	$5,699.00	$5,364.00	$6,248.00	$5,563.00	$7,275.00	$30,149.00
McIntire-Stennis	$484.00	$329.00	$380.00	$358.00	$491.00	$2,042.00
Evans Allen	$1,360.00	$943.00	$536.00	$331.00	$335.00	$3,505.00
Animal Health	$3.00	$0.00	$0.00	$0.00	$0.00	$3.00
Special Grants	$2,229.00	$2,154.00	$2,822.00	$2,859.00	$0.00	$10,064.00
NRI Grants	$3,044.00	$3,890.00	$3,999.00	$4,271.00	$4,170.00	$19,374.00
SBIR Grants	$83.00	$376.00	$0.00	$0.00	$80.00	$539.00
Other CSREES	$512.00	$621.00	$1,091.00	$1,344.00	$271.00	$3,839.00
Total Reported in CRIS	$13,414.00	$13,677.00	$15,076.00	$14,727.00	$12,622.00	$69,515.00
Smith-Lever 3(b) and (c)	n/a	n/a	n/a	n/a	$1,058.86	$1,058.86
1890 Extension	n/a	n/a	n/a	n/a	$232.99	$232.99
Total Extension Reported in POW	n/a	n/a	n/a	n/a	$1,291.85	$1,291.85
Total	$13,414.00	$13,677.00	$15,076.00	$14,727.00	$13,913.85	$70,806.85

KA 204: Plant Product Quality and Utility (Preharvest) CSREES Funding						
Combined Research and Extension Funding						
	$ in the thousands					
Funding Source	**FY 2003**	**FY 2004**	**FY 2005**	**FY 2006**	**FY 2007**	**Total**
PROJ No.	454	465	477	468	434	2,298
Hatch	$3,163.00	$2,849.00	$3,003.00	$2,843.00	$3,503.00	$15,361.00
McIntire-Stennis	$103.00	$96.00	$69.00	$93.00	$96.00	$457.00
Evans Allen	$282.00	$508.00	$665.00	$472.00	$530.00	$2,457.00
Animal Health	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Special Grants	$1,615.00	$3,848.00	$3,457.00	$1,657.00	$0.00	$10,577.00
NRI Grants	$599.00	$553.00	$757.00	$1,362.00	$772.00	$4,043.00
SBIR Grants	$496.00	$378.00	$296.00	$199.00	$104.00	$1,473.00
Other CSREES	$391.00	$1,492.00	$957.00	$338.00	$391.00	$3,569.00
Total Reported in CRIS	$6,649.00	$9,724.00	$9,203.00	$6,964.00	$5,396.00	$37,936.00
Smith-Lever 3(b) and (c)	n/a	n/a	n/a	n/a	$1,934.13	$1,934.13
1890 Extension	n/a	n/a	n/a	n/a	$166.21	$166.21
Total Extension Reported in CRIS	n/a	n/a	n/a	n/a	$2,100.34	$2,100.34
Total	$6,649.00	$9,724.00	$9,203.00	$6,964.00	$7,496.34	$40,036.34

KA 205: Plant Management Systems CSREES Funding						
Combined Research and Extension Funding						
	$ in the thousands					
Funding Source	**FY 2003**	**FY 2004**	**FY 2005**	**FY 2006**	**FY 2007**	**Total**
PROJ No.	883	895	921	933	826	$4,458.00
Hatch	$8,027.00	$8,584.00	$8,544.00	$8,222.00	$10,167.00	$43,544.00
McIntire-Stennis	$92.00	$76.00	$67.00	$50.00	$113.00	$398.00
Evans Allen	$1,874.00	$1,430.00	$1,986.00	$2,557.00	$2,201.00	$10,048.00
Animal Health	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Special Grants	$10,032.00	$7,385.00	$8,156.00	$9,074.00	$30.00	$34,677.00
NRI Grants	$1,543.00	$116.00	$1,069.00	$1,513.00	$1,670.00	$5,911.00
SBIR Grants	$322.00	$709.00	$580.00	$708.00	$65.00	$2,384.00
Other CSREES	$2,991.00	$2,177.00	$4,196.00	$4,696.00	$4,931.00	$18,991.00
Total Reported in CRIS	$24,881.00	$20,477.00	$24,597.00	$26,820.00	$19,176.00	$115,953.00
Smith-Lever 3(b) and (c)	n/a	n/a	n/a	n/a	$13,650.74	$13,650.74
1890 Extension	n/a	n/a	n/a	n/a	$1,000.76	$1,000.76
Total Extension Reported in POW	n/a	n/a	n/a	n/a	$14,651.50	$14,651.50
Total	$24,881.00	$20,477.00	$24,597.00	$26,820.00	$33,827.50	$130,604.50

KA 206: Basic Plant Biology CSREES Funding						
Combined Research and Extension Funding						
	$ in the thousands					
Funding Source	**FY 2003**	**FY 2004**	**FY 2005**	**FY 2006**	**FY 2007**	**Total**
PROJ No.	667	672	671	611	597	3218
Hatch	$4,102.00	$4,253.00	$4,755.00	$5,194.00	$5,376.00	$23,680.00
McIntire-Stennis	$261.00	$225.00	$195.00	$235.00	$284.00	$1,200.00
Evans Allen	$249.00	$388.00	$480.00	$245.00	$235.00	$1,597.00
Animal Health	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Special Grants	$757.00	$745.00	$531.00	$651.00	$0.00	$2,684.00
NRI Grants	$10,567.00	$9,138.00	$11,969.00	$8,381.00	$10,685.00	$50,740.00
SBIR Grants	$0.00	$200.00	$40.00	$0.00	$80.00	$320.00
Other CSREES	$274.00	$561.00	$638.00	$1,288.00	$467.00	$3,228.00
Total Reported in CRIS	$16,210.00	$15,510.00	$18,609.00	$15,995.00	$17,126.00	$83,450.00
Smith-Lever 3(b) and (c)	n/a	n/a	n/a	n/a	$1,062.77	$1,062.77
1890 Extension	n/a	n/a	n/a	n/a	$53.99	$53.99
Total Extension Reported in POW	n/a	n/a	n/a	n/a	$1,116.76	$1,116.76
Total	$16,210.00	$15,510.00	$18,609.00	$15,995.00	$18,242.76	$84,566.76

KA 211: Insects, Mites, and Other Arthropods Affecting Plants CSREES Funding						
Combined Research and Extension Funding						
	$ in the thousands					
Funding Source	**FY 2003**	**FY 2004**	**FY 2005**	**FY 2006**	**FY 2007**	**Total**
PROJ No.	851	848	870	833	795	4197
Hatch	$7,046.00	$7,114.00	$6,420.00	$7,320.00	$7,817.00	$35,717.00
McIntire-Stennis	$322.00	$410.00	$271.00	$335.00	$396.00	$1,734.00
Evans Allen	$442.00	$531.00	$540.00	$636.00	$429.00	$2,578.00
Animal Health	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Special Grants	$5,928.00	$5,858.00	$6,531.00	$6,274.00	$3,061.00	$27,652.00
NRI Grants	$3,381.00	$4,686.00	$6,764.00	$5,802.00	$6,996.00	$27,629.00
SBIR Grants	$198.00	$200.00	$205.00	$144.00	$861.00	$1,608.00
Other CSREES	$2,462.00	$1,066.00	$1,089.00	$2,526.00	$3,189.00	$10,332.00
Total Reported in CRIS	$19,779.00	$19,865.00	$21,820.00	$23,036.00	$22,750.00	$107,250.00
Smith-Lever 3(b) and (c)	n/a	n/a	n/a	n/a	$2,896.37	$2,896.37
1890 Extension	n/a	n/a	n/a	n/a	$354.55	$354.55
Total Extension Reported in POW	n/a	n/a	n/a	n/a	$3,250.92	$3,250.92
Total	$19,779.00	$19,865.00	$21,820.00	$23,036.00	$26,000.92	$110,500.92

KA 212: Pathogens and Nematodes Affecting Plants CSREES Funding						
Combined Research and Extension Funding						
	$ in the thousands					
Funding Source	**FY 2003**	**FY 2004**	**FY 2005**	**FY 2006**	**FY 2007**	**Total**
PROJ No.	1,117	1,180	1,184	1,163	1,102	5746
Hatch	$10,632.00	$9,671.00	$10,118.00	$10,284.00	$12,295.00	$53,000.00
McIntire-Stennis	$351.00	$274.00	$270.00	$377.00	$500.00	$1,772.00
Evans Allen	$453.00	$254.00	$297.00	$466.00	$498.00	$1,968.00
Animal Health	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Special Grants	$7,928.00	$7,220.00	$7,895.00	$8,499.00	$987.00	$32,529.00
NRI Grants	$4,078.00	$12,840.00	$11,990.00	$15,168.00	$15,399.00	$59,475.00
SBIR Grants	$337.00	$222.00	$191.00	$512.00	$161.00	$1,423.00
Other CSREES	$1,817.00	$2,741.00	$2,887.00	$1,744.00	$6,514.00	$15,703.00
Total Reported in CRIS	$25,596.00	$33,222.00	$33,648.00	$37,050.00	$36,355.00	$165,871.00
Smith-Lever 3(b) and (c)	n/a	n/a	n/a	n/a	$3,610.27	$3,610.27
1890 Extension	n/a	n/a	n/a	n/a	$308.34	$308.34
Total Extension Reported in POW	n/a	n/a	n/a	n/a	$3,918.60	$3,918.60
Total	$25,596.00	$33,222.00	$33,648.00	$37,050.00	$40,273.60	$169,789.60

KA 213: Weeds Affecting Plants CSREES Funding						
Combined Research and Extension Funding						
	$ in the thousands					
Funding Source	**FY 2003**	**FY 2004**	**FY 2005**	**FY 2006**	**FY 2007**	**Total**
PROJ No.	399	382	425	445	385	2036
Hatch	$3,270.00	$3,255.00	$3,446.00	$3,121.00	$3,818.00	$16,910.00
McIntire-Stennis	$126.00	$70.00	$67.00	$54.00	$74.00	$391.00
Evans Allen	$192.00	$251.00	$268.00	$251.00	$22.00	$984.00
Animal Health	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Special Grants	$3,567.00	$3,449.00	$3,343.00	$3,832.00	$1,211.00	$15,402.00
NRI Grants	$1,866.00	$0.00	$2,383.00	$2,291.00	$446.00	$6,986.00
SBIR Grants	$208.00	$31.00	$80.00	$174.00	$46.00	$539.00
Other CSREES	$822.00	$1,644.00	$1,531.00	$1,651.00	$2,333.00	$7,981.00
Total Reported in CRIS	$10,051.00	$8,700.00	$11,119.00	$11,374.00	$7,950.00	$49,194.00
Smith-Lever 3(b) and (c)	n/a	n/a	n/a	n/a	$2,499.50	$2,499.50
1890 Extension	n/a	n/a	n/a	n/a	$140.30	$140.30
Total Extension Reported in POW	n/a	n/a	n/a	n/a	$2,639.80	$2,639.80
Total	$10,051.00	$8,700.00	$11,119.00	$11,374.00	$10,589.80	$51,833.80

KA 214: Vertebrates, Mollusks, and Other Pests Affecting Plants CSREES Funding						
Combined Research and Extension Funding						
	$ in the thousands					
Funding Source	**FY 2003**	**FY 2004**	**FY 2005**	**FY 2006**	**FY 007**	**Total**
PROJ No.	25	27	23	21	18	114
Hatch	$84.00	$56.00	$88.00	$64.00	$65.00	$357.00
McIntire-Stennis	$27.00	$7.00	$16.00	$8.00	$41.00	$99.00
Evans Allen	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Animal Health	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Special Grants	$534.00	$927.00	$360.00	$427.00	$0.00	$2,248.00
NRI Grants	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
SBIR Grants	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Other CSREES	$0.00	$0.00	$0.00	$0.00	$129.00	$129.00
Total Reported in CRIS	$645.00	$990.00	$464.00	$499.00	$234.00	$2,832.00
Smith-Lever 3(b) and (c)	n/a	n/a	n/a	n/a	$304.95	$304.95
1890 Extension	n/a	n/a	n/a	n/a	$11.13	$11.13
Total Extension Reported in POW	n/a	n/a	n/a	n/a	$316.08	$316.08
Total	$645.00	$990.00	$464.00	$499.00	$550.08	$3,148.08

KA 215: Biological Control of Pests Affecting Plants CSREES Funding						
Combined Research and Extension Funding						
	$ in the thousands					
Funding Source	**FY 2003**	**FY 2004**	**FY 2005**	**FY 2006**	**FY 2007**	**Total**
PROJ No.	546	550	526	474	423	2519
Hatch	$5,040.00	$4,700.00	$4,113.00	$3,835.00	$3,894.00	$21,582.00
McIntire-Stennis	$260.00	$114.00	$122.00	$116.00	$177.00	$789.00
Evans Allen	$782.00	$591.00	$508.00	$691.00	$789.00	$3,361.00
Animal Health	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Special Grants	$756.00	$1,223.00	$1,204.00	$1,539.00	$582.00	$5,304.00
NRI Grants	$2,984.00	$1,453.00	$2,077.00	$2,583.00	$1,906.00	$11,003.00
SBIR Grants	$29.00	$376.00	$592.00	$64.00	$32.00	$1,093.00
Other CSREES	$54.00	$1,038.00	$440.00	$1,726.00	$1,364.00	$4,622.00
Total Reported in CRIS	$9,905.00	$9,495.00	$9,055.00	$10,554.00	$8,744.00	$47,753.00
Smith-Lever 3(b) and (c)	n/a	n/a	n/a		$1,131.35	$1,131.35
1890 Extension	n/a	n/a	n/a	n/a	$34.43	$34.43
Total Extension Reported by POW	n/a	n/a	n/a	n/a	$1,165.77	$1,165.77
Total	$9,905.00	$9,495.00	$9,055.00	$10,554.00	$9,909.77	$48,918.77

KA 216: Integrated Pest Management Systems CSREES Funding						
Combined Research and Extension Funding						
	$ in the thousands					
Funding Source	**FY 2003**	**FY 2004**	**FY 2005**	**FY 2006**	**FY 2007**	**Total**
PROJ No.	657	663	688	686	665	3359
Hatch	$3,624.00	$3,718.00	$3,256.00	$3,475.00	$4,628.00	$18,701.00
McIntire-Stennis	$222.00	$158.00	$117.00	$135.00	$176.00	$808.00
Evans Allen	$551.00	$360.00	$430.00	$525.00	$486.00	$2,352.00
Animal Health	$0.00	$0.00	$0.00	$0.00	$8.00	$8.00
Special Grants	$4,527.00	$3,924.00	$3,796.00	$3,846.00	$5,314.00	$21,407.00
NRI Grants	$925.00	$1,160.00	$947.00	$1,828.00	$988.00	$5,848.00
SBIR Grants	$0.00	$0.00	$48.00	$296.00	$32.00	$376.00
Other CSREES	$5,150.00	$5,739.00	$5,857.00	$7,835.00	$6,632.00	$31,213.00
Total Reported in CRIS	$14,999.00	$15,059.00	$14,451.00	$17,940.00	$18,264.00	$80,713.00
Smith-Lever 3(b) and (c)	n/a	n/a	n/a	n/a	$6,589.81	$6,589.81
1890 Extension	n/a	n/a	n/a	n/a	$187.33	$187.33
Total Extension Reported in POW	n/a	n/a	n/a	n/a	$6,777.14	$6,777.14
Total	$14,999.00	$15,059.00	$14,451.00	$17,940.00	$25,041.14	$87,490.14

Appendix C - Detailed Funding Tables for Primary KAs – All Known Funding

KA 201: Plant Genome, Genetics, and Genetic Mechanisms Overall Funding						
Combined Research and Extension Funding						
Funding Source	**$ in the thousands**					
	FY 2003	**FY 2004**	**FY 2005**	**FY 2006**	**FY 2007**	**Total**
NO. Proj	759	772	894	783	872	4,080
CSREES Admin	$25,933.00	$25,340.00	$26,202.00	$30,393.00	$27,184.70	$135,052.70
Other USDA	$3,618.00	$4,083.00	$5,048.00	$3,639.00	$6,486.00	$22,874.00
Other Federal	$25,472.00	$38,896.00	$53,049.00	$42,411.00	$52,592.00	$212,420.00
State Appr.	$41,888.00	$44,291.00	$51,618.00	$45,137.00	$54,974.00	$237,908.00
Self-Gen	$3,268.00	$3,293.00	$6,077.00	$4,307.00	$6,426.00	$23,371.00
Ind/Gr Agrmt	$10,667.00	$11,653.00	$17,443.00	$12,655.00	$15,239.00	$67,657.00
Other Non-Fed	$5,825.00	$5,887.00	$9,618.00	$5,668.00	$10,645.00	$37,643.00
Total	$116,672.00	$133,444.00	$169,055.00	$144,211.00	$173,546.70	$736,928.70
SYS	255.6	250.8	301.2	281.4	320.6	1,410
OYS	1,014.30	1,056.60	1,372.60	1,104.80	1,362.80	5,911

KA 202: Plant Genetic Resources Overall Funding						
Combined Research and Extension Funding						
Funding Source	**$ in the thousands**					
	FY 2003	**FY 2004**	**FY 2005**	**FY 2006**	**FY 2007**	**Total**
Proj. No.	498	498	602	504	601	2,703
CSREES Admin	$10,784.00	$11,932.00	$11,672.00	$13,067.00	$11,615.04	$59,070.04
Other USDA	$2,474.00	$2,254.00	$3,186.00	$2,173.00	$3,805.00	$13,892.00
Other Federal	$5,945.00	$6,418.00	$8,134.00	$6,621.00	$6,622.00	$33,740.00
State Appr.	$23,470.00	$22,231.00	$31,394.00	$24,668.00	$35,545.00	$137,308.00
Self-Gen	$1,341.00	$1,610.00	$5,659.00	$2,135.00	$7,613.00	$18,358.00
Ind/Gr Agrmt	$4,834.00	$4,927.00	$6,506.00	$4,774.00	$7,222.00	$28,263.00
Other Non-Fed	$3,312.00	$3,416.00	$5,779.00	$3,777.00	$5,696.00	$21,980.00
Total	$52,161.00	$52,788.00	$72,329.00	$57,214.00	$78,118.04	$312,610.04
SYS	130.1	123.6	157.5	126.4	179.8	717.4
OYS	524.7	517.5	662.6	477.2	690.5	2,872.5

KA 203: Plant Biological Efficiency and Abiotic Stresses Affecting Plants Overall Funding						
Combined Research and Extension Funding						
	$ in the thousands					
Funding Source	**FY 2003**	**FY 2004**	**FY 2005**	**FY 2006**	**FY 2007**	**Total**
Proj. No.	692	668	784	635	727	3,506
CSREES Admin	$13,413.00	$13,677.00	$15,076.00	$14,727.00	$13,913.85	$70,806.85
Other USDA	$2,069.00	$1,876.00	$2,356.00	$2,018.00	$3,856.00	$12,175.00
Other Federal	$9,105.00	$8,751.00	$13,591.00	$9,495.00	$12,575.00	$53,517.00
State Appr.	$34,952.00	$33,692.00	$40,464.00	$34,105.00	$43,975.00	$187,188.00
Self-Gen	$3,348.00	$2,087.00	$3,982.00	$2,873.00	$5,274.00	$17,564.00
Ind/Gr Agrmt	$8,489.00	$7,157.00	$7,495.00	$7,245.00	$9,229.00	$39,615.00
Other Non-Fed	$3,847.00	$4,422.00	$8,074.00	$5,280.00	$7,216.00	$28,839.00
Total	$75,223.00	$71,660.00	$91,038.00	$75,743.00	$96,038.85	$409,702.85
SYS	193.1	191.3	213.8	191.5	221.2	1,010.9
OYS	725.3	626.6	789.6	607.5	804.1	3,553.1

KA 204: Plant Product Quality and Utility (Preharvest) Overall Funding						
Combined Research and Extension Funding						
	$ in the thousands					
Funding Source	**FY 2003**	**FY 2004**	**FY 2005**	**FY 2006**	**FY 2007**	**Total**
Proj. No.	454	465	576	468	531	2,494
CSREES Admin	$6,647.00	$9,724.00	$9,203.00	$6,964.00	$7,496.34	$64,448.34
Other USDA	$1,931.00	$2,059.00	$2,425.00	$1,845.00	$2,034.00	$10,294.00
Other Federal	$1,045.00	$1,517.00	$4,227.00	$2,129.00	$4,136.00	$13,054.00
State Appr.	$21,329.00	$20,679.00	$26,858.00	$22,080.00	$24,453.00	$115,399.00
Self-Gen	$1,873.00	$1,749.00	$2,869.00	$2,462.00	$3,808.00	$12,761.00
Ind/Gr Agrmt	$3,486.00	$3,909.00	$5,239.00	$3,571.00	$4,595.00	$20,800.00
Other Non-Fed	$3,812.00	$3,393.00	$4,613.00	$3,239.00	$5,054.00	$20,111.00
Total	$40,123.00	$43,029.00	$55,434.00	$42,290.00	$49,476.00	$230,352.00
SYS	103.5	99.5	117.3	90.8	121.3	532.4
OYS	420	418.9	516	385.5	480.4	2,220.8

KA 205: Plant Management Systems Overall Funding						
Combined Research and Extension Funding						
Funding Source	$ in the thousands					
	FY 2003	FY 2004	FY 2005	FY 2006	FY 2007	Total
Proj. No.	883	895	1,110	933	1,003	4824
CSREES Admin	$24,880.00	$20,476.00	$24,597.00	$26,820.00	$33,827.50	$130,600.50
Other USDA	$2,371.00	$3,077.00	$3,313.00	$2,860.00	$4,387.00	$16,008.00
Other Federal	$4,968.00	$3,700.00	$7,255.00	$5,108.00	$6,576.00	$27,607.00
State Appr.	$42,973.00	$41,534.00	$58,956.00	$46,792.00	$69,329.00	$259,584.00
Self-Gen	$4,582.00	$4,173.00	$8,306.00	$5,572.00	$9,981.00	$32,614.00
Ind/Gr Agrmt	$6,988.00	$6,862.00	$10,015.00	$8,030.00	$10,143.00	$42,038.00
Other Non-Fed	$5,949.00	$6,038.00	$9,599.00	$6,423.00	$10,135.00	$38,144.00
Total	$92,712.00	$85,861.00	$122,042.00	$101,606.00	$144,378.50	$546,599.50
SYS	224.6	216.2	270.8	223.7	286.8	1,222.10
OYS	910.8	853.6	1,267.00	920.6	1,307.90	5,259.90

KA 206: Basic Plant Biology Overall Funding						
Combined Research and Extension Funding						
	$ in the thousands					
Funding Source	FY 2003	FY 2004	FY 2005	FY 2006	FY 2007	Total
Proj. No.	667	672	759	611	689	3398
CSREES Admin	$16,211.00	$15,508.00	$18,609.00	$15,995.00	$18,242.76	$84,565.76
Other USDA	$1,344.00	$1,122.00	$1,346.00	$1,211.00	$1,252.00	$6,275.00
Other Federal	$25,610.00	$21,997.00	$34,848.00	$24,074.00	$32,844.00	$139,373.00
State Appr.	$26,296.00	$28,820.00	$36,105.00	$32,554.00	$37,228.00	$161,003.00
Self-Gen	$1,192.00	$2,108.00	$2,693.00	$2,209.00	$3,216.00	$11,418.00
Ind/Gr Agrmt	$7,800.00	$8,940.00	$9,349.00	$5,797.00	$6,007.00	$37,893.00
Other Non-Fed	$2,642.00	$3,104.00	$4,683.00	$3,388.00	$5,001.00	$18,818.00
Total	$81,095.00	$81,600.00	$107,632.00	$85,227.00	$103,790.76	$459,344.76
SYS	170.1	182.8	221.7	184.5	225.8	984.9
OYS	660.2	610.7	873.5	561.6	782.7	3488.7

KA 211: Insects, Mites, and Other Arthropods Affecting Plants Overall Funding						
Combined Research and Extension Funding						
	$ in the thousands					
Funding Source	**FY 2003**	**FY 2004**	**FY 2005**	**FY 2006**	**FY 2007**	**Total**
Proj. No.	851	848	965	833	888	4385
CSREES Admin	$19,779.00	$19,866.00	$21,820.00	$23,036.00	$26,000.92	$110,501.92
Other USDA	$3,637.00	$4,378.00	$6,722.00	$6,422.00	$7,032.00	$28,191.00
Other Federal	$8,432.00	$10,111.00	$14,118.00	$10,954.00	$13,228.00	$56,843.00
State Appr.	$38,133.00	$39,011.00	$43,453.00	$38,002.00	$43,142.00	$201,741.00
Self-Gen	$2,017.00	$2,135.00	$3,682.00	$3,739.00	$4,319.00	$15,892.00
Ind/Gr Agrmt	$6,222.00	$6,627.00	$7,438.00	$7,054.00	$8,618.00	$35,959.00
Other Non-Fed	$4,912.00	$5,066.00	$7,653.00	$6,479.00	$6,717.00	$30,827.00
Total	$83,133.00	$87,193.00	$104,886.00	$95,685.00	$109,056.92	$479,953.92
SYS	235.4	221	254.4	224.3	244.2	1,179.3
OYS	765.9	787.4	900.6	769.9	849.1	4072.9

KA 212: Pathogens and Nematodes Affecting Plants Overall Funding						
Combined Research and Extension Funding						
Funding Source	$ in the thousands					
	FY 2003	**FY 2004**	**FY 2005**	**FY 2006**	**FY 2007**	**Total**
Proj. No.	1,117	1,180	1,323	1,163	1,248	6031
CSREES Admin	$25,597.00	$33,222.00	$33,648.00	$37,050.00	$40,273.60	$169,790.60
Other USDA	$7,391.00	$9,267.00	$11,135.00	$9,004.00	$12,877.00	$49,674.00
Other Federal	$15,937.00	$15,561.00	$20,489.00	$19,600.00	$17,095.00	$88,682.00
State Appr.	$60,829.00	$63,033.00	$70,469.00	$63,025.00	$72,740.00	$330,096.00
Self-Gen	$3,840.00	$3,893.00	$6,736.00	$7,957.00	$7,015.00	$29,441.00
Ind/Gr Agrmt	$14,726.00	$14,913.00	$17,915.00	$14,858.00	$21,696.00	$84,108.00
Other Non-Fed	$7,664.00	$8,150.00	$15,201.00	$9,765.00	$12,107.00	$52,887.00
Total	$135,983.00	$148,039.00	$175,592.00	$161,258.00	$183,803.60	$804,675.60
SYS	353	359.1	414	375.6	424	1,925.7
OYS	1,336.20	1,393.80	1,535.70	1,289.10	1,487.90	7,042.70

KA 213: Weeds Affecting Plants Overall Funding						
Combined Research and Extension Funding						
	$ in the thousands					
Funding Source	**FY 2003**	**FY 2004**	**FY 2005**	**FY 2006**	**FY 2007**	**Total**
Proj. No.	399	382	494	445	460	2180
CSREES Admin	$10,051.00	$8,701.00	$11,119.00	$11,374.00	$10,589.80	$51,834.80
Other USDA	$1,287.00	$1,242.00	$1,172.00	$1,094.00	$2,086.00	$6,881.00
Other Federal	$2,003.00	$1,965.00	$2,342.00	$2,115.00	$2,328.00	$10,753.00
State Appr.	$18,227.00	$18,113.00	$22,113.00	$17,520.00	$22,500.00	$98,473.00
Self-Gen	$2,040.00	$2,908.00	$2,880.00	$2,814.00	$3,615.00	$14,257.00
Ind/Gr Agrmt	$4,141.00	$4,279.00	$4,777.00	$4,854.00	$5,068.00	$23,119.00
Other Non-Fed	$3,226.00	$2,970.00	$4,513.00	$3,719.00	$4,969.00	$19,397.00
Total	$40,976.00	$40,178.00	$48,916.00	$43,491.00	$51,155.80	$224,716.80
SYS	90.4	85.7	104.5	79.1	97.8	457.5
OYS	406.8	400.4	456.8	345.2	400.9	2010.1

KA 214: Vertebrates, Mollusks, and Other Pests Affecting Plants Overall Funding						
Combined Research and Extension Funding						
	$ in the thousands					
Funding Source	**FY 2003**	**FY 2004**	**FY 2005**	**FY 2006**	**FY 2007**	**Total**
Proj. No.	25	27	28	21	23	124
CSREES Admin	$644.00	$990.00	$464.00	$499.00	$550.08	$3,147.08
Other USDA	$58.00	$5.00	$279.00	$5.00	$143.00	$490.00
Other Federal	$65.00	$34.00	$128.00	$42.00	$200.00	$469.00
State Appr.	$573.00	$428.00	$395.00	$138.00	$275.00	$1,809.00
Self-Gen	$206.00	$235.00	$272.00	$49.00	$80.00	$842.00
Ind/Gr Agrmt	$44.00	$1.00	$25.00	$3.00	$84.00	$157.00
Other Non-Fed	$21.00	$46.00	$92.00	$55.00	$61.00	$275.00
Total	$1,612.00	$1,739.00	$1,656.00	$791.00	$1,393.08	$7,191.08
SYS	3.2	2.2	7.1	3.8	3	19.3
OYS	8.9	6.5	19.1	5.6	14.3	54.4

KA 215: Biological Control of Pests Affecting Plants Overall Funding						
Combined Research and Extension Funding						
	$ in the thousands					
Funding Source	**FY 2003**	**FY 2004**	**FY 2005**	**FY 2006**	**FY 2007**	**Total**
Proj. No.	546	550	565	474	460	2595
CSREES Admin	$9,906.00	$9,495.00	$9,055.00	$10,554.00	$9,909.77	$48,919.77
Other USDA	$2,349.00	$2,264.00	$3,121.00	$2,850.00	$2,279.00	$12,863.00
Other Federal	$4,434.00	$5,103.00	$4,424.00	$3,681.00	$3,942.00	$21,584.00
State Appr.	$21,331.00	$22,828.00	$22,039.00	$17,831.00	$19,952.00	$103,981.00
Self-Gen	$1,361.00	$1,294.00	$1,353.00	$1,454.00	$1,804.00	$7,266.00
Ind/Gr Agrmt	$2,999.00	$3,015.00	$4,002.00	$2,686.00	$3,129.00	$15,831.00
Other Non-Fed	$1,679.00	$1,751.00	$3,274.00	$2,019.00	$3,157.00	$11,880.00
Total	$44,059.00	$45,749.00	$47,268.00	$41,074.00	$44,172.77	$222,322.77
SYS	136.4	137.8	131	113	115.2	633.4
OYS	457.3	416.1	452.3	326.9	372	2024.6

KA 216: Integrated Pest Management Systems Overall Funding						
Combined Research and Extension Funding						
	$ in the thousands					
Funding Source	**FY 2003**	**FY 2004**	**FY 2005**	**FY 2006**	**FY 2007**	**Total**
Proj. No.	657	663	757	686	742	3505
CSREES Admin	$14,999.00	$15,060.00	$14,451.00	$17,940.00	$25,041.14	$87,491.14
Other USDA	$2,975.00	$3,966.00	$5,085.00	$4,121.00	$4,765.00	$20,912.00
Other Federal	$2,973.00	$3,873.00	$3,707.00	$1,997.00	$2,094.00	$14,644.00
State Appr.	$22,634.00	$22,594.00	$26,793.00	$24,082.00	$30,093.00	$126,196.00
Self-Gen	$1,565.00	$3,269.00	$2,622.00	$2,756.00	$3,456.00	$13,668.00
Ind/Gr Agrmt	$5,011.00	$5,303.00	$7,225.00	$6,687.00	$7,284.00	$31,510.00
Other Non-Fed	$2,755.00	$2,813.00	$4,076.00	$3,220.00	$3,963.00	$16,827.00
Total	$52,911.00	$56,878.00	$63,959.00	$60,803.00	$76,696.14	$311,247.14
SYS	121.3	123.6	133.5	126.5	153.4	658.3
OYS	541.3	530.8	623	517.1	592.7	2804.9

Appendix D - List of Programs Supporting the Plant Systems Portfolio

Portfolio: Programs Related to Plant Systems	
Name of Related Program	**Contribution to the Portfolio**
Hatch	Formula research grant program to the 1862 land grant universities that provides broad funding, including support for this portfolio
Evans-Allen	Formula research grant program to the 1890 land grant universities that provides broad funding, including support for this portfolio
National Research Initiative	Broad competitive research grants program that provides broad funding, including support for this portfolio
Small Business Innovation Research	Broad competitive research grants programs to small businesses that provides broad funding, including support for this portfolio
McIntire-Stennis	Formula grant program that broadly supports forestry and related research
Smith-Lever 3(b) and (c)	Formula extension grant program to the 1862 land grant universities that provides broad funding, including support for this portfolio
1890 Extension	Formula extension grant program to the 1890 land grant universities that provides broad funding, including support for this portfolio
Special Grants	Congressional Earmarks
Regional IPM Centers	The IPM Centers promote the development and implementation of IPM by facilitating collaboration across states, disciplines, and purposes. They serve as focal points for regional pest management information networks, collaborative team building, and broad-based stakeholder participation. The end result is increased coordination of IPM research, education and extension efforts and enhanced responsiveness to critical pest management challenges.
National Plant and Animal Diagnostic Laboratory Networks	The safety of our plant production systems is contingent upon our ability to rapidly identify foreign pathogens and other pests, whether introduced intentionally through bio-terrorism or unintentionally. To this end, CSREES has established national networks of existing diagnostic laboratories to rapidly and accurately detect and report pathogens of national interest and provide timely information and training to state university diagnostic labs.
Integrated Pest Management Pest Information Platform for Extension and Education (ipmPIPE)	ipmPIPE is a system for managing pest and disease information flow via the Web. Provides real-time useful information to US crop producers, and a “one stop shopping” center for timely, unbiased, national, and local pest information Fosters good farming practices by encouraging growers to: o Avoid unnecessary or ill-timed chemical applications o Use the proper control tactics with the proper timing to manage crop loss risk

	o Document practices for crop insurance purposes
Integrated Pest Management (IPM) Training Consortium	Integrated Pest Management (IPM) 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. CSREES is facilitating the development of an IPM Training Consortium to provide Integrated Pest Management training to federal workers involved in pest management issues and activities. Increased IPM education and training will help federal agency personnel better address elements of the National Invasive Species Management Plan. Increasing the quality and consistency of IPM training and implementation among federal agencies will help ensure that the most economically feasible and sustainable programs are developed for the management of pests on federal lands in the future
IR-4 – Inter-regional Project Number 4	The mission of the IR-4 Project is to provide safe and effective pest management solutions for specialty crop growers. To achieve this mission, the IR-4 Project provides domestic growers of specialty crops with safe and effective crop protection tools to economically produce crops that enhance the diet and lifestyle of the public, while respecting the environment.
National Clean Plant Network (NCPN)	**NCPN Mission** The National Clean Plant Network provides high quality asexually propagated plant material free of targeted plant pathogens and pests that cause economic loss to protect the environment and ensure the global competitiveness of specialty crops producers. **Vision** The National Clean Plant Network's regional centers of excellence are recognized leaders in the introduction of the highest quality regionally adapted propagative plant materials that are free of targeted pathogens and pests and are true to type; thus supporting/*promoting* a vigorous commercial environment (*and opportunities for safe trade***)* while protecting the environment. Translational research, education and outreach initiatives are fully funded to maintain the network's high quality collections and strengthen its services; industry, research and regulatory communities collaborate to ensure an abundant supply of healthful fruits, vegetables and other specialty crops.

	The economic and social sustainability of specialty crop industries and the improved economies of the communities that depend on these industries are the ultimate outcomes of the network's robust/*dynamic* service delivery.
National Invasive Species Council (NISC)	The National Invasive Species Council is an inter-Departmental council that helps to coordinate and ensure complementary, cost-efficient and effective Federal activities regarding invasive species
Federal Interagency Committee on the Management of Noxious and Exotic Weeds (FICMNEW**)**	Federal coordination of weed management
Management of Invasive Terrestrial Animals and Pathogens (ITAP)	Federal coordination of invasive terrestrial animals and pathogens.
NASA/USDA Focus Area Working Group on Invasive Species	Remote sensing of weed distributions and management strategy impacts.
Aquatic Nuisance Species Task Force (ANSTF)	Federal coordination of aquatic pest species
Federal IPM Coordinating Committee (FIPMCC)	Federal coordination of IPM efforts
Technical Advisory Group (TAG) for the Biological Control of Weeds. **CSREES**	Federal agency review of petitions for the biological control of weeds.
Ad Hoc Working Group for Registration of Pesticides for Aquatic Weeds. (WGRPAW)	Working group to help facilitate registration of pesticides for aquatic weeds.
APHIS-PPQ Permitting Board of Advisors (BOA)	The BOA is currently working on improving the regulatory process and commercial carrier issues regarding the importation and shipment of living organisms, including biocontrol agents.
eXtension	eXtension is an Internet-based collaborative environment where Land Grant University content providers exchange objective, research-based knowledge to solve real challenges in real time. Communities of Practice relevant to the Plant Systems Portfolio: Gardens, Lawns and Landscapes; Imported Fire Ants; Cotton; and Wildlife Damage Management
Interagency Working Group on Metabolic Engineering (MEWG)	Metabolic Engineering is a new approach to understanding and using metabolic processes. As the name implies, ME is the targeted and purposeful alteration of metabolic pathways found in an organism in order to better understand and use cellular pathways for chemical transformation, energy transduction, and supramolecular assembly. Knowledge acquired from this research will benefit society in a number of ways, including the ability to modify biological pathways to produce biological

	substitutes for less desirable chemical processes; allowing greater agricultural production, permitting more efficient and safer energy production, and; providing better understanding of the metabolic basis for some medical conditions that could assist in the development of new cures.

Appendix E - Partnering Agencies and Other Organizations:

Portfolio: Plant Systems Partnering Agencies and Organizations		
USDA Agencies	**Non-USDA Federal Agencies**	**External Organizations**
Agricultural Research Service Animal and Plant Health Inspection Service (Plant Protection and Quarantine) Economic Research Service Natural Resources Conservation Service US Forest Service National Agricultural Library National Agricultural Statistical Service Agricultural Marketing Service Farm Service Administration USDA Sustainable Development Council	National Park Service US Fish and Wildlife Service Department of Homeland Security Environmental Protection Agency National Science Foundation National Aeronautics and Space Administration	USDA Invasive Species Coordinating Committee Regional IPM Centers National Plant Diagnostic Laboratory Networks Pest Information Platform for Extension and Education (ipmPIPE) Integrated Pest Management Training Consortium National Grape and Wine Initiative National Berry Crop Initiative National Vegetable Crop Initiative Specialty Crop Research Team Specialty Crop Engineering Working Group Federal Interagency Committee on the Management of Noxious and Exotic Weeds Management of Invasive Terrestrial Animals and Pathogens. NASA/USDA Focus Area Working Group on Invasive Species Aquatic Nuisance Species Task Force Federal IPM Coordinating Committee Technical Advisory Group for the Biological Control of Weeds Ad Hoc Working Group for Registration of Pesticides for Aquatic Weeds APHIS-PPQ Permitting Board of Advisors. The BOA is currently working on improving the regulatory process and commercial carrier issues regarding the importation and shipment of living organisms, including biocontrol agents.

Appendix F - Program Evaluations:

Portfolio: Plant Systems Program Evaluations				
Date	**Type of Evaluation/Analyses**	**Brief Description**	**Evaluation Recommendations**	**What Was the Effect**
3/3-4/2004	Post-Award Peer Review of IFAFS/RAMP Grants	The purpose of this mid-project peer review was to gain a more complete understanding of the progress and accomplishments of the Berkeley RAMP Grant and its relationship to the IFAFS Grant.	Continue area-wide IGR pest management effort against pests of pears IFAFS/RAMP participants should compile information on the efficacy of IGRs and other alternative pesticides and data on "windows of opportunity", effects on natural enemies, regional variabilities and pest density requirement in order to develop a general bio-based plan for pest management in pears and apples.	A more complete understanding of the progress and accomplishments of the Berkeley RAMP Grant and its relationship to the IFAFS Grant. Greater accountability. Emphasis on more productive aspects of the two projects.
4/20/2006 4/26/2007 4/24/2008	PMAP (Pest Management Alternatives Program) Post-Panel Review	Provide opportunity to critique PMAP while issues are fresh	Improvements to RFA, Issues such as duplicate applications to other CSREES grant programs, uniformity of relevance reviews by Regional IPM Centers	Improved understanding of the RFA by applicants, mitigation of duplicate submission issues, enhanced cooperation with Regional IPM Centers, greater accountability