Portfolio Annual Report 2009: Plant Systems

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Portfolio Annual Review

Executive Summary

Agriculture exports create a positive trade balance in the U.S. economy, and plant-based agriculture and forestry products comprise nearly 80% of the value of all agricultural export products from the U.S. The Plant Systems Portfolio of the National Institute of Food and Agriculture (NIFA) in Fiscal Year 2009 (Oct 1, 2008 through Sept 30, 2009) supported research, education, and extension activities to improve plant production and protection to help meet domestic and global needs for nutritious and safe foods, fuels, and fibers.

Accomplishments from this portfolio support the Agency's strategic goals. In support of these strategic goals, five over-arching areas that provide context for the Plant Systems efforts during FY 2009 were selected by the Portfolio Review team. The first, Crop Production for a Hungry World describes the global context of food security and human nutrition. The second, position of U.S. Agriculture in the World Market is an aspect of the production side of agriculture in which the economics of trade is a high priority for the Department of Agriculture and the country. The third area, Healthy Crops and Ecosystems, describes the challenges facing researchers and extension partners as they strive to develop strategies for controlling invasive and endemic pests. The fourth, Environmental Sustainability and Resources for the Implementation of Regulatory Rules describes NIFA programs available to its university partners to conduct research and outreach activities to assist the farm sector to adjust and adapt to regulatory rules that restrict chemical pesticide use to protect the environment and consumers. The fifth and final section describes Education of Future Generations. This has become a critical issue since all sectors of plant production and protection will face an acute shortage of trained practitioners within the next 10 years.

Plant Systems Portfolio activities contribute to these issues by supporting research, education, and extension activities in the areas of plant production and protection. The portfolio supports efforts to increase the production of and access to quality foods to reduce hunger in the U.S. and abroad and to sustain economic gains from agriculture. Efforts to improve plant protection supported by the portfolio are critical to maintain healthy crops and ecosystems and to assist the farm sector to adjust to regulatory rules that restrict chemical pesticide use to protect the environment and consumers. Efforts to train the next generation of agricultural scientists spans the portfolio areas of plant production and protection.

These portfolio activities are organized and administered by programs across the agency. There are 23 different funding authorities, and a greater number of programs, that support the efforts of the Plant Systems Portfolio. For example, the 2009 Agriculture and Food Research Initiative (AFRI) provided 25 competitive grant programs, of which 15 are represented within this portfolio in the areas of plant biology, plant biosecurity, plant genomics, arthropod and nematode biology and management, and microbial biology. In

2008, the predecessor of AFRI, the National Research Initiative, awarded approximately $52 million to support research, education, and/or extension within these areas. The Specialty Crop Research Initiative is another program that supports priorities spanning many of these five issues. In 2008, approximately $30 million was awarded to 27 research projects designed to improve and promote specialty crop research, education, and extension across the U.S.

Notable accomplishments supported by Plant Systems programs are presented in this review. These include publications in peer-review journals; development of education curricula and research experiences to attract and teach the next generation of agricultural scientists; Web sites to share information; new and improved varieties of plants to meet production and protection needs; and novel plant protection techniques to help minimize impact of pesticides and herbicides. Plant Systems activities will continue to be vital to improve competitiveness and sustainability of farm economies and protect the Nation's food supply. Through stakeholder involvement, and in collaboration with other agencies' efforts, Plant Systems activities will also be critical to successfully address future challenges.

This portfolio was assembled under the old agency (CSREES) which has since been reorganized and renamed National Institute for Food and Agriculture (NIFA). NIFA is divided into four sub-institutes including: Food Production and Sustainability, Bioenergy, Climate Change and Environment, Food Safety and Nutrition, and Youth and Community Development. NIFA also includes a Center for International Programs. The Plant Systems Portfolio will carry out programs to support the new configuration. These programs will be aligned and consistent with the Administration's priorities in Global Food Security and Hunger, Climate Change, Sustainable Energy, Childhood Obesity, and Food Safety. Support for these priorities is described in more details in this document.

Section I: Portfolio Overview

The Plant Systems Portfolio is broad and reflects the mission of the Institute, as well as the needs of the land grant and non land grant partners and stakeholders. The portfolio encompasses basic and applied research, education, and extension activities across the areas of plant production and protection. The portfolio encourages multi-disciplinary approaches to addressing the needs of plant agriculture and the American consumer.

Portfolio Planning

Plant Systems Portfolio Vision
Improved and sustained supply of nutritious and safe foods, fibers, and fuels for the U.S. and the world.

Plant Systems Portfolio Mission
To support high quality, relevant research, extension, and education programs, in partnership with universities, the private sector, and other Federal agencies for an improved and sustainable agriculture that provides superior and safe plant products.

Plant Systems Portfolio Functions

- Increase fundamental knowledge and understanding of plant agriculture through basic research at the frontiers of biological, physical, and social sciences related to plant production and pest/disease management.
- Promote application and adoption of research-based knowledge to plant agriculture via partnerships with the Cooperative Extension Service and others.
- Provide developmental research and technology transfer to promote effective adoption and commercialization of sustainable plant production and pest/disease management.

Plant Systems Portfolio Team Roles

- Provide leadership in the development of national research priorities.
- Provide leadership and facilitate coordination in the development of national extension and outreach needs relative to plant production and protection.
- Provide leadership, jointly with the Science and Education Resources Development unit of NIFA, in educating the next generation of plant scientists.
- Provide leadership and program oversight across the spectrum of integrated research, education, and extension activities supported by NIFA.

Plant Systems Goal Statement
The goal of Plant Systems is three-fold:

(1) to support the production of nutritious and safe foods, fiber, and fuel products,
(2) to enhance the competitiveness and sustainability of farm economics, and
(3) to protect the nation's food supply and enhance its natural resources and environment.

Portfolio Strategic Plan
A strategic plan will be developed consistent with the NIFA framework once it is put in place in 2010.

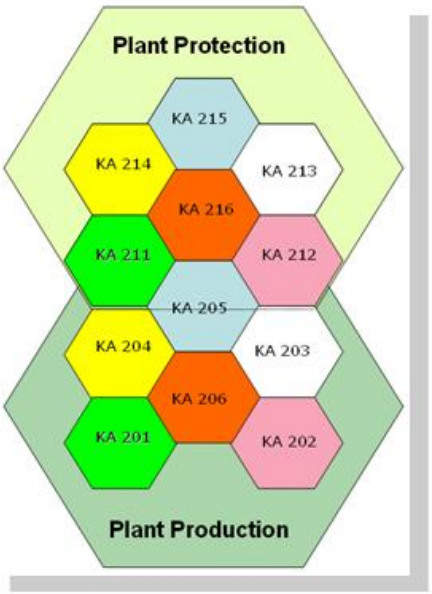
Portfolio Introduction
The Plant Systems Portfolio represents the largest component of NIFA funding and programming reported by partner institutions. The NIFA Plant Systems Portfolio's research, education and extension programs include two key components: *Plant Production* and *Plant Protection***.**

- *Plant Production* programs encompass basic plant biology, plant breeding (plant genomics and genetics), agricultural and natural resource management systems, quality and utility of plant products, plant growth efficiency particularly in the face of abiotic stresses, and genetic resources and biodiversity.

- *Plant Protection* programs support research and development of suites of extension programs that offer resources to control emerging and reemerging plant pests, including but not limited to weeds, pathogens, arthropods, vertebrates, mollusks. These suites of extension programs also include integrated pest management, biological control, and plant biosecurity.

The Plant Systems Portfolio is represented by 12 Knowledge Areas (KAs) (Figure 1). In many cases, Plant Systems' research, education and extension efforts are also supported by one or more KAs included in other portfolios (e.g., Natural Resources and Environment).

Figure 1. Knowledge Areas of the Portfolio.



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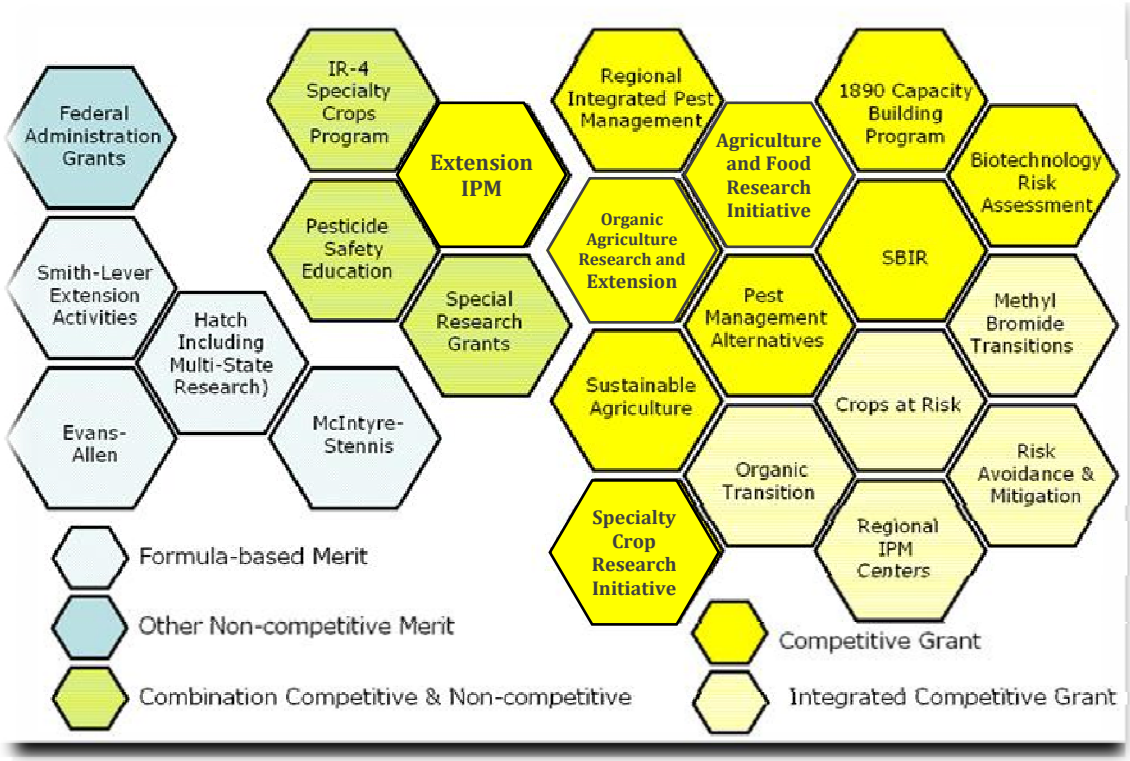
204 Plant Product Quality and Utility (Preharvest)
203 Plant Biological Efficiency and Abiotic Stresses Affecting Plants
202 Plant Genetic Resources and Biodiversity
201 Plant Breeding, Genome, Genetics and Genetic Mechanisms

Plant systems programs, like most program areas that support NIFA strategic goals, are funded from a wide range of funding mechanisms and legislation. Major support for the Plant Systems Portfolio comes from competitive grants, congressionally directed special grants, and formula funding (Figure 2). There is considerable integration and cross-cutting among funded programs within this portfolio.

Figure 2. Plant Systems Funding Authorities



The programs and activities of the portfolio evolve to respond to global events. The portfolio review team selected five over-arching areas that describe the context for the Plant Systems efforts during 2008-2009. Those five over arching areas and the partnership responses are discussed below.

<u>(1) Crop Production for a Hungry World</u>

Globally, almost one billion people regularly suffer from hunger; most of them are women and children. One child dies every six seconds from hunger-related causes. Hunger is reported as the cause of death for more people each year than from AIDS, malaria, and tuberculosis combined. (Source: 2009 Hunger Map: http://documents.wfp.org/stellent/groups/public/documents/liaison_offices/wfp185786.jpg)

The prevalence of hunger in the U.S. has also risen (The U.S. Conference of Mayors' 2008 Report: http://www.stwr.org/united-states-of-america/homelessness-and-hunger-on-the-rise-in-us.html). According to statistics from the U.S. Department of Agriculture, 12.4 million children in the U.S. are food insecure. Food insecurity is defined as not

being able to get enough food to maintain a healthy and active life. Ironically, food insecurity and obesity (and related health consequences) are not mutually exclusive. Food-insecure families tend to consume low-cost, calorie-dense foods rather than diets balanced in nutrients.
(http://www.frac.org/html/hunger_in_the_us/hunger&obesity.htm).

Plant Systems and Partnership Response: The Plant Systems Portfolio contributes by increasing the production of and access to quality foods to reduce hunger in the U.S. and abroad. Specific examples of NIFA activities are as follows:

- Master Gardeners: NIFA provides leadership for the Extension Master Gardeners Program. According to the 2009 Extension Master Gardeners survey, a total of 94,865 Extension Master Gardener's volunteers contributed 5,197,573 hours educating the public, providing youth programs, and facilitating produce donations to food banks, thus improving access to nutritious food. These efforts are estimated to have contributed 101.4 million dollars in value to the public. (http://www.extension.org/pages/Extension_Master_Gardener_National_Survey)

- Plant Breeding Coordinating Committee: This Committee (http://nimss.umd.edu/homepages/home.cfm?trackID=7536) was approved by the Southern Association of Agricultural Experiment Station Directors in 2006 to operate through September 2015. It is a forum to address issues, problems, and opportunities of long-term strategic importance to the national crop production goals. The committee is the only regular mechanism used to provide such leadership across all crops and has established subcommittees to help meet USDA strategic goals.

(2) Position of U.S. Agriculture in the World Market

In 2008, U.S. agricultural export was valued at $115 billion, creating a $35 billion trade surplus. Plant products comprise nearly 80% of the value of all agricultural export products from the U.S. (http://www.ers.usda.gov/Data/FATUS/#calendar).

A few initiatives have begun in addition to traditional agriculture. For example, organic farming has become one of the fastest growing segments of U.S. agriculture. U.S. producers are turning to certified organic farming systems as a potential way to lower input costs, decrease reliance on non-renewable resources, capture high-value markets and premium prices, and boost farm income. According to USDA's most recent Census of Agriculture, the total value of organic product sales reported by organic farming operations in 2007 was $1.7 billion dollars. (See http://www.agcensus.usda.gov/Publications/2007/Full_Report/Volume_1,_Chapter_1_US/st99_1_048_048.pdf, Table 48.). (http://www.ers.usda.gov/Briefing/Organic/)

Specialty crops have also seen a significant increase in the U.S. The National Association of State Departments of Agriculture (NASDA) estimates that the specialty crop industry accounts for more than $53 billion in annual cash receipts--close to 54% of the total cash receipts for crops. Given that the specialty crop industry is more likely to be impacted by pests, diseases, low prices, labor shortages, it is critically important to

secure funds to support research, education and extension that promote the industry (http://www.nasda.org/cms/7196/9017/9350/7969.aspx).

Plant Systems and Partnership Response: Plant production is a critical component for sustained economic growth from agriculture. It is addressed by many of the programs within the Plant Systems Portfolio. Specifically, organic farming and specialty crop production are supported by two major NIFA initiatives:

- Organic Research and Extension Initiative: The 2008 Farm Bill included a provision for organic agriculture by including $15 million in FY 2009. This resulted in nearly $19 million in grant funding for the Integrated Organic Program (comprised of the Organic Agriculture Research and Extension Initiative and Organic Transitions). A new National Program Leader was hired and joined the staff of the Plant Systems unit in August 2009 to lead NIFA's efforts to support organic production.

- Specialty Crop Research Initiative: The 2008 Farm Bill established significant mandatory funding for a new Specialty Crop Research Initiative managed by NIFA. Over $28 million in FY 2008 and nearly $47 million in FY 2009 was made available to address five legislatively mandated 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.

(3) Healthy Crops and Ecosystems

Approximately one third of the potential yield of the world's primary staples: wheat, rice, maize, potatoes, and soybeans is lost to weeds, animal pests (arthropods, nematodes, rodents, birds, slugs, and snails), and plant pathogens (fungi, bacteria, viruses, etc.) (Pimental, Ed.., Encyclopedia of Pest Management, Vol 2). Up to 50,000 non-indigenous plant species have been introduced into the U. S., many of which have become invasive and cause significant damage and costs to agriculture and natural ecosystems. Most invasive plant species are escapes from intentional introductions for food or ornamental purposes. In the U.S., losses to plant pathogens alone total approximately $33 billion per year with over 65% of these attributable to non-indigenous pathogens. In forests, more than 20 non-indigenous plant pathogens are active, with massive landscape changes having been brought about by Dutch Elm Disease and Chestnut Blight. (Pimental, Ed.., Biological Invasions: Economic and Environmental Costs of Alien Plant, Animal, and Microbe Species. CRC Press)

In addition to the cost of lost yields and landscapes, the economic and environmental costs of trying to control pests, whether exotic or endemic, are significant. Due to the toxic nature of many pesticides, care must be taken to avoid mis-management of

pesticides and to protect the applicator as well as the environment. Food-borne pesticide residues are of concern because of potential human health hazards; therefore regulatory limits are established for all pesticides.

Alternative pest management strategies are constantly being sought through research on host-parasite interface, host crop resistance, population biology of insects, biological control, and integrated pest management (IPM) tools. In addition, IPM practitioners and extension specialists know that early detection and pathway analyses can help target and fine-tune control practices to improve precision and efficacy of control measures.

Plant Systems and Partnership Response: To maintain healthy crops and healthy ecosystems, several NIFA Plant Systems programs are offered:

- AFRI Microbial Biology: Microbial Associations with Plants Program: This competitive grants program supports research aimed at improved resistance to high-impact plant diseases based on knowledge of plant pathogens, their plant hosts, and host-pathogen interactions.

- AFRI Microbial Genomics Program (genomic sequencing and functional genomics): The genome sequencing element of this competitive grants program is a partnership with the National Science Foundation to sequence genomes of agriculturally important microorganisms. The functional genomics element of the program seeks to increase the understanding of the biological role of gene sequences in agriculturally important microorganisms and to link these sequences to physiological functions or agricultural and food processes involving microbes.

- AFRI Plant Biosecurity Program: This competitive grants program focuses on integrated approaches to the diagnosis and detection of high-consequence pathogens and pests, as well as on monitoring and mitigation of diseases caused by these pathogens and pests. An extension-only priority within the program supports the development of extension materials to address common needs for first detector training for multiple federal and state agencies.

- Extension Integrated Pest Management Coordination and Support Program (eIPM-CS): This program helps agricultural producers and other pest managers adopt alternative pest management practices through training, demonstration, and evaluation of methods and strategies.

- National Plant Diagnostic Network (NPDN): This network is led by 5 regional labs and one support lab. NIFA administers the funding and provides leadership for the network. NPDN provides First Detector Training, which promotes awareness and early detection of exotic pests in the field.

- Pesticide Safety Education Program (PSEP): This program supports educational programs for pesticide applicators in the proper use of pest management technologies.

(4) Environmental Sustainability and Resources for the Implementation of Regulatory Rules

The Food Quality Protection Act (FQPA) of 1996 (Public Law 104-170, Aug. 3, 1996) and the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) (P.L. 110–246, May 22, 2008) are the regulatory conditions under which agriculturalists control insects, diseases, weeds, and other pests (http://agriculture.senate.gov/Legislation/Compilations/Fifra/FIFRA.pdf and http://www.epa.gov/opp00001/regulating/laws/fqpa/gpogate.pdf). The FQPA was implemented based on the concern that pesticide residues could end up in the food supply at unhealthy levels. The FIFRA significantly strengthened not only the human health risk analysis, but also established stringent environmental impact assessment for agrochemicals. The net result of the two laws has been a significant reduction in the arsenal of pest control products available to protect farm and forest.

The Montreal Protocol (on Substances that Deplete the Ozone Layer of 2000; http://www.unep.org/OZONE/pdfs/Montreal-Protocol2000.pdf) was developed in response to scientific evidence that methyl bromide, a very efficacious soil fumigant, was actually an atmospheric ozone depleter. The U.S., being the country with most reliance on methyl bromide, adopted the protocol with the most stringent and accelerated time-line to decrease its use. Aggregate methyl bromide inventory data for the 2008 calendar year continue to show a steady decline. The existence of the inventory provides a safety net for the transition to ozone-safe alternatives, and these data continue to demonstrate that the inventory held by U.S. companies is being managed appropriately (http://www.epa.gov/Ozone/mbr/otherreginfo.html).

Plant Systems and Partnership Response: Several Plant Systems programs are available to its university partners to conduct research and outreach activities to assist the farm sector adjust and adapt to regulatory rules that restrict chemical pesticide use to protect the environment and food consumers:

- Crops at Risk (CAR): This program addresses short-term, applied research, education, and extension in IPM for crop and cropping systems. The goal of this program is to modify multiple-tactic IPM systems and strategies focused on specific crop production systems.

- Methyl Bromide Transitions (MBT): This program supports the discovery and implementation of alternatives to methyl bromide through commercial/field scale research on short- to medium-term solutions. Comprehensive economic information on the impact of alternatives on crop yields and profitability is required to assess both the economics and technical feasibility of alternatives. This economic assessment is required for critical use nominations, which are used in global negotiations regarding domestic exceptions to the complete worldwide phase-out of the compound. For these exceptions, the complete lack of methyl bromide would represent a tremendous production hardship that is difficult to calculate.

- Minor Crop Management (IR 4): This is the principal public program supporting the registration of pesticides and biological control agents for use on specialty crops. The program is jointly funded by NIFA and the Agricultural Research Service and provides coordination, funding, and scientific guidance for both field and laboratory research to develop data in support of registration packages to be submitted to the U.S. Environmental Protection Agency (EPA). In 2008, IR-4 data led to EPA reviewing a record 41 chemistries for IR-4 Food Use Program tolerance petitions compared with the 2007 record of 33. EPA established 241 permanent pesticide tolerances on these chemicals that could result in 999 new specialty crop use registrations, many of which are considered reduced risk. The IR-4 Ornamental Horticulture Program supported 7 new registrations and 1 registration amendment from EPA, as well as 4 California registrations. Six of the 8 EPA submissions contained efficacy data to support the new registrations/amendments. These IR-4 supported successes impacted 3,095 ornamental plant species. IR-4's efforts supported 18 new or modified products which could provide 128 new biopesticide uses.

- Pesticide Safety Education Program (PSEP): PSEP provides educational programs that support the proper use of pest management technologies. A central focus is to provide pesticide applicators with the knowledge and training needed to safely and effectively use pesticides. Education is provided by land-grant university extension programs in conjunction with state regulatory agencies that certify and license applicators. NIFA manages the program through funds allocated by EPA (Comprehensive Report for 4/30/01-9/30/07.).

- Risk Avoidance and Mitigation Program (RAMP): RAMP supports the development and implementation of innovative IPM systems on an area-wide or landscape scale. It is designed to maintain crop productivity and profitability and, at the same time, address environmental quality and human health issues. The program provides support for major acreage crops, as well as key fruit and vegetable production systems and other agroecosystems. Projects funded by this program are medium-term, involving systems approaches targeted at eliminating or minimizing pesticide residues in key foods, soil, and surface/ground water. Funded projects tend to be multi-state or regional in scale, and typically involve multiple pest species in multiple cropping systems with emphasis on enhanced stability and sustainability of IPM systems.

(5) Education of Future Generations

The number of students trained in agricultural plant sciences has been declining nationwide, especially those with both laboratory and field expertise. For example, those trained in plant pathology graduate without field and diagnostic experience. Several scientific societies (e.g., The Crop Science Society of America, Soil Science Society of America, and the American Phytopathological Society) share this concern and have focused much attention on this issue. This was the subject of a recent publication by the National Academy of Sciences, entitled "Transforming Agricultural Education for a Changing World" (http://dels.nas.edu/dels/rpt_briefs/ag_education_final.pdf). This concern has been elevated in a recent (November 5-7, 2008) meeting of the American

Association of Agricultural Scientific Societies, which represents approximately 50,000 scientists from academia, government and industry, where "education concerns" was listed among the five priorities for focused attention.

The recent workshop convened by the American Phytopathological Society on the future of education in plant pathology and related disciplines (http://www.apsnet.org/online/proceedings/EducationWorkshop/program/WorkshopReport.pdf), highlighted, among other things: declining numbers of qualified applicants for graduate school (which is seen as a problem in the undergraduate "pipeline" of students interested in plant science); declining numbers of faculty with applied- or field-research interests; and grant programs perceived to favor basic biology over applied research, thereby directing faculty research and narrowing the opportunities for student support and training. These factors have combined to alter the face of graduate education affecting the balance or breadth of training it once had. This state of affairs has raised concern amongst academic, government, and private sector employers.

The challenges facing education in the agricultural sciences are not limited to graduate education and training. There are also difficulties related to the poor understanding of science amongst the general public, declining performance and interest in the STEM (science, technology, engineering and math) disciplines in the K-12 system, and correspondingly smaller numbers of undergraduate students prepared for or attracted to the agricultural sciences. These issues deserve serious attention by the nation's Land Grant colleges and universities.

Plant Systems and Partnership Response: The Competitive Programs (CP) unit administers the Agriculture and Food Research Initiative (AFRI), with several integrated competitive grant programs that include an education component. In 2009, AFRI also offered single function education-only or extension-only priorities in some programs responding to challenges and opportunities provided by the 2008 Farm Bill:

- AFRI Applied Plant Genomics Coordinated Agricultural Project (CAP): This integrated program has a strong education and extension component associated with its research projects. The ultimate goal of the program is to contribute knowledge related to the biology of agriculturally important plant processes and traits. This knowledge can be used to develop plants with enhanced value and expanded utilities through a combination of research, extension and education.

- AFRI Microbial Genomics - Functional Genomics of Microorganisms: This competitive grant program includes an education-only priority to develop innovative, research-based graduate education and training activities in the application of knowledge gained from microbial genome sequencing and/or microbial functional genomics to solving problems facing U.S. agriculture.

- AFRI Plant Biosecurity: The Plant Biosecurity program is an integrated program with an extension-only priority to identify common training and extension needs for first-

detectors for multiple federal and state agencies and to develop training curricula to meet these needs.

- AFRI Plant Breeding and Education: This competitive grant program emphasizes education and training in an academic setting to build expertise in plant breeding combined with research projects that focus on germplasm enhancement for specific traits.

Linkage to *CSREES Strategic Plan

**On October 1, 2009, Cooperative State Research, Education and Extension Service (CSREES) became the National Institute of Food and Agriculture (NIFA). Even though CSREES no longer exists, NIFA has not installed a strategic plan. Therefore, this portfolio continues to align itself with CSREES' strategic plan.*

The Plant Systems Portfolio supports two CSREES strategic goals aligned with the USDA department-wide strategic goals.

<u>Strategic Agency Goal 2: Enhance the Competitiveness and Sustainability of Rural and Farm Economies.</u>
This portfolio supports numerous research and extension activities to enhance the competitiveness and sustainability of rural and farm economies. They range 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 by training the next generation of scientists and educators.

Support for this goal is linked to *Strategic Objective 2.2: Provide research, education, and extension to increase the efficiency of agricultural production and marketing systems*. This portfolio funds research, education, and extension programs to develop and transfer technology, practices, and skills to support economic viability of farms and ranches of various size and scale. This work reduces overall production costs and improves quality and yields, reduces environmental impact, 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 genomics to developing plant varieties that will require fewer chemical inputs to agricultural systems to new precision technology and nanotechnology to improve management of crops and pests.

<u>Strategic Goal 4: Enhance Protection and Safety of the Nation's Agriculture and Food Supply.</u>
This portfolio, in partnership with other portfolios, supports the development and distribution of science-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 systems and training the next generation of scientists and educators.

This portfolio's activities support this goal through *Strategic Objective 4.2: Develop and deliver research, education, and extension to reduce the number and severity of agricultural pest and disease outbreaks.* Under this strategic objective, this portfolio supports research, extension and education activities that provide information on pests and diseases that impact the food, fiber, and fuel system. Methods and practices to prevent or control outbreaks of exotic, native and foreign pests and disease, including invasive pests, also result from work completed under this objective.

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

CSREES Strategic Plan Performance Measures Progress Table

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 systems 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) increasing 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, and 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 (KA 201).
- Identify, preserve, characterize, and develop genetic resources for plant production or protection (KA 202).
- Understand and improve plant productivity and quality as affected by reduced inputs or stresses (KA 203).
- Improve biological quality before harvest (KA 204).
- Develop and implement comprehensive plant production management systems (KA 205).
- Improve understanding of fundamental processes and mechanisms basic to plant life (KA 206).

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 wealth 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.
-

Actionable Strategies Cont…

- Support research, education, and extension to 1) better understand and address consumer needs, tastes, and preferences; 2) inform consumers; and 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 laboratories.

Performance Criteria:

- Reduce adverse impacts of indigenous and exotic pathogens, toxins, plants, and pests on plant yield and quality (KA 211).
- Reduce adverse impacts of indigenous and exotic bacteria, fungi, nematodes, viruses, and other pathogens on plant yield and quality (KA 212).
- Reduce adverse impacts of competition from indigenous and exotic weeds, including aquatic weeds and parasitic plants, on plant yield and quality (KA 213).
- 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 (KA 214).
- Improve and enhance the use of natural enemies, including microbial biological control agents, to manage plant pests (KA 215).
- Develop and improve integrated control tactics and systems to manage plant pests or pest complexes in an economically, socially, and environmentally sound manner (KA 216).

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.

Actionable Strategies Cont…

- 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 U.S.
- Support development and increase capacity and capability of national diagnostic laboratory networks for crops and livestock that can rapidly detect pathogen outbreaks.
- 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 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 to isolate and contain potential outbreaks.
- Sponsor research using traditional breeding and biotechnology to develop new or enhanced varieties and germplasm with enhanced disease 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; and
  - the development of knowledge to support approval and licensing 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.

The performance measure for the objective: *Develop and deliver research, education, and extension to reduce the number and severity of agricultural pest and disease outbreaks* is presented below. 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 broadly supports 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 towards the agency's mission.

Performance Measures Progress Table

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

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 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 • Some provide funding that contributes to research **Human Capital**: • National Program Leaders • Program Specialists • Extension personnel • Faculty • Researchers • Paraprofessionals • Stake holders (Industry, etc.) • Volunteers	Conduct research on important agronomic traits of wheat Develop technologies to reduce spoilage of fruit and vegetables Train students in advanced plant breeding and plant pathology Provide Extension services to producers In the management of rodents and other animal pests	• Research findings disseminated Developed new organic production system • Developed best management practices • Developed Curricula • Trained undergraduate and graduate students • Trained producers •Developed new plant varieties	• Expanded knowledge-base Developed new knowledge in marker assisted selection technology Utilized germplasm to develop new plant varieties New plant production and protection approaches First responders acquired new knowledge to combat devastating diseases	Changes in: • knowledge • attitudes • skills • motivation • decisions regarding New wheat varieties adopted by US producers First responders were better prepared for citrus greening diseases and 16 other high consequence pests	• Improved economic performance of producers • National plant production and protection- related problems solved • Long term protection of food and plant biosecurity IR-4 impacted more than 3000 ornamental plant species Improved wheat quality resulted in monetary increase of more than $20 million/year in one state

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

Table 1a displays Institute portfolio funding that is reported in the Current Research Information System (CRIS) and Plan of Work – Annual Report (POW-AR). Agency extension [Smith-Lever 3(b) & (c) and 1890 Extension] funding data were first captured in FY 2007; previous year data are not available. Non-NIFA funding, any funding provided outside of the Institute, are reported in CRIS. Individual knowledge area (KA) funding charts are found in appendices B and C.

Portfolio Level Funding Table and Bar Chart

Table 1a: Plant Systems Portfolio Summary Funding Table Combined Research and Extension Funding in Actual Dollars ($ in the Thousands)						
Funding Sources	**FY 2004**	**FY 2005**	**FY 2006**	**FY 2007**	**FY 2008**	**Total**
NIFA Funding Reported in CRIS	183,993	195,917	208,418	184,799	248,847	1,021,974
NIFA Funding Reported in POW Annual Report	NA	NA	NA	39,847	40,474	80,321
All non-NIFA Funding	664,169	687,767	700,976	699,999	723,406	3,476,317
Total Funding	848,162	883,684	909,394	924,645	1,012,727	4,578,612
Percentage of NIFA Funding	22%	22%	23%	24%	29%	24%

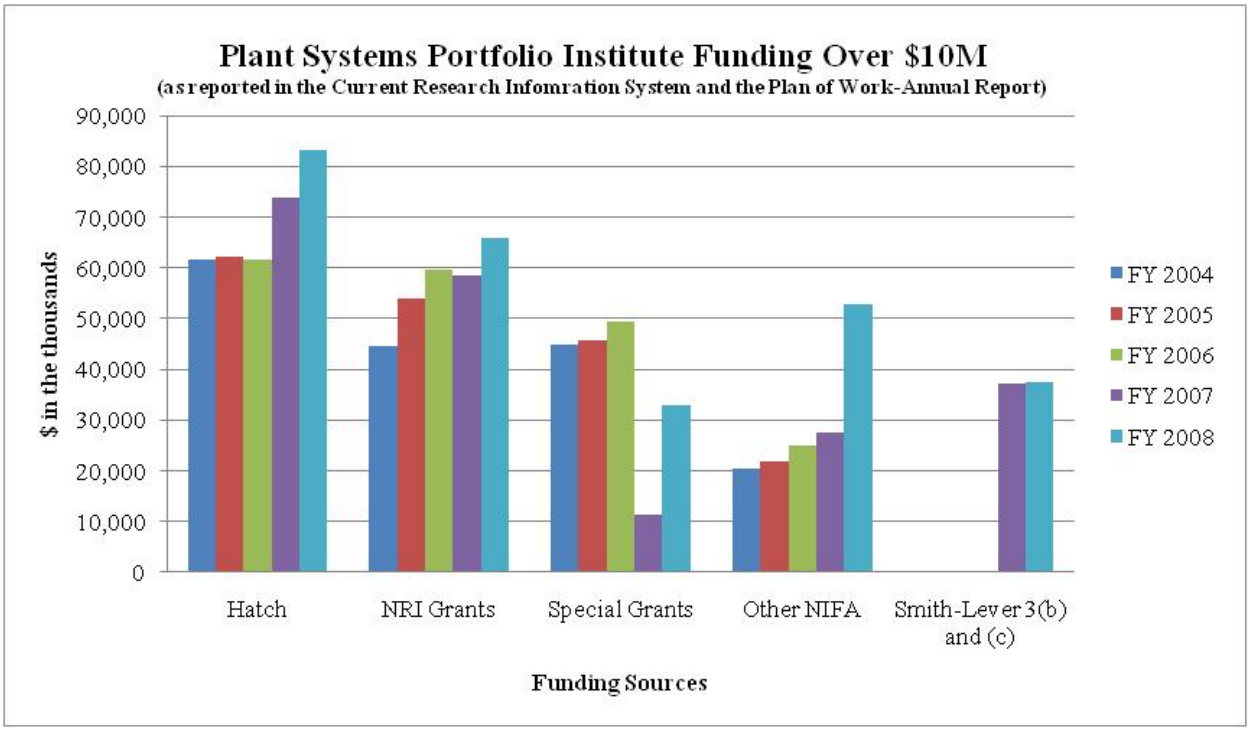
NA - data aren't available

Table 1b shows portfolio level funding in constant dollars. These figures were configured to show changes in funding while controlling for inflation using the Consumer Price Index (CPI) calculator, which is located at http://data.bls.gov/cgi-bin/cpicalc.pl. For accurate calculations, the inflation calculator uses the average Consumer Price Index for a selected calendar year. These data represent changes in prices of all goods and services purchased for consumption by urban households. Table 1b's figures were calculated using 2008 as the base comparative year.

Table 1b: Plant Systems Portfolio Summary Funding Table Combined Research and Extension Funding in Constant Dollars ($ in the Thousands)						
Funding Sources	**FY 2004**	**FY 2005**	**FY 2006**	**FY 2007**	**FY 2008**	**Total**
NIFA Funding Reported in CRIS	209,710	215,983	222,584	191,895	248,847	1,089,020
NIFA Funding Reported in POW Annual Report	NA	NA	NA	41,377	40,474	81,851
All non-NIFA Funding	757,001	758,209	748,622	726,876	723,406	3,714,115
Total Funding	966,711	974,192	971,206	960,148	1,012,727	4,884,986

NA - data aren't available

Figure 3: Portfolio Institute Funding Over $10M



Definitions for all of the above funding sources may be found in Appendix B.

Figure 3 illustrates NIFA portfolio funding with an annual amount over $10M. Overall, Hatch contributed the largest amount of NIFA funding for this portfolio. Over $342.3M were expended by Hatch for this portfolio during FY 2004- FY 2008. Hatch funding increased in FY 2007 while Special Grants did not receive any funding during the same fiscal year. Funds normally allocated to Special Grants were allocated to Hatch, at the same time earmarks were not funded.

The National Research Initiative (NRI) Grants program was not reauthorized in the Food, Conservation, and Energy Act of 2008, but the Agriculture and Food Research Initiative (AFRI) Competitive Grants Program was authorized in 2009 in place of the NRI. This funding chart identified NRI obligated dollars because dollars received were under this funding category during the reporting timeframe. Information regarding the AFRI program may be found on the Institute's website at http://www.NIFA.usda.gov/funding/afri/afri_synopsis.html. The total budget of AFRI under the 2008 Farm Bill increased by about $10 million over its predecessor, the National Research Initiative (NRI); however, the budget for the plant programs within AFRI remained more or less unchanged. The new Farm Bill requires that no less than 30% of the AFRI budget be used in integrated programs. This is an increase from 28% in FY 2008. In order to meet this new requirement, some funds from a research program were reallocated to an integrated program. This resulted in moving funds from KAs 206 and 201 to KA 202. It also increased the portfolio's investment in education in the plant breeding area. Another change that contributed to increased education activity in the portfolio was the creation of an education-only priority within the Microbial Functional Genomics Program.

Smith-Lever 3(b) and (c) dollars were first reported through the Plan of Work-Annual Report in 2007. Since FY 2007, Smith-Lever 3(b) and (c) expended a total of $74.6M.

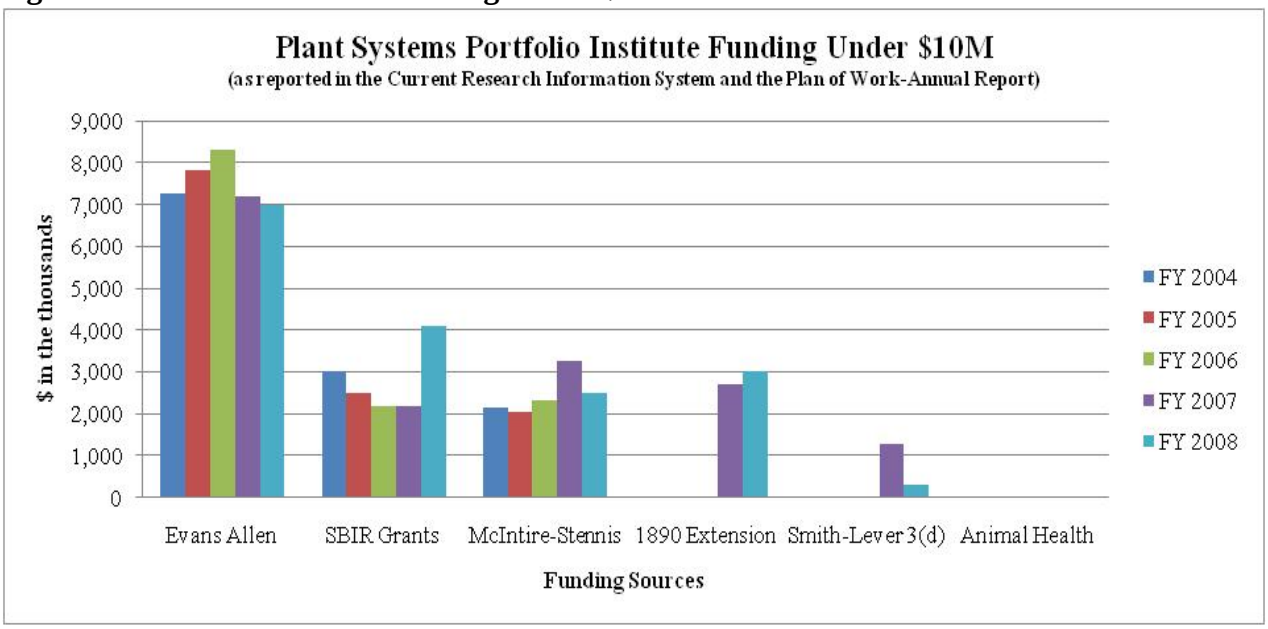
Other NIFA funding increased by $25.3M between fiscal years 2007 and 2008, this primarily due to an increase in the number of programs reporting into CRIS. The following funding sources are reported through CRIS, but are reported under the Other NIFA funding category.

Organic Production:
NIFA efforts in organic production have been greatly expanded primarily due to provisions in the Research Title (http://www.ers.usda.gov/Briefing/Organic/ProgramProvisions.htm) of the 2008 Farm Bill that provided mandatory funding for the Organic Agriculture Research and Extension Initiative (OREI). OREI funds increased from $15 million over the life of the previous 2002 legislation, to $78 million for FY 2009-12. An additional $25 million annually for FY 2009-12 is authorized, subject to appropriations. Two new priorities have also been added to the purpose of this initiative: (1) to study conservation and environmental outcomes of organic practices, and (2) to develop new and improved seed varieties for use in organic production systems.

Specialty Crops:
The 2008 Farm Bill also established significant mandatory funding for a new Specialty Crop Research Initiative that is managed by NIFA. Over $28 million in FY 2008 and nearly $47 million in FY 2009 was available to address five legislatively mandated 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.

Extension IPM:
State IPM programs had been established and funded by Smith-Lever 3(d) funds on a formula basis, since the late 1970's. The 2008 Farm Bill directed that the funds be distributed on a competitive basis. The funding levels remain the same, but the funds formerly dedicated to cotton IPM and other general IPM funds are now combined in a program that was first competed in FY 2009. The bill also expanded the edibility requirements.

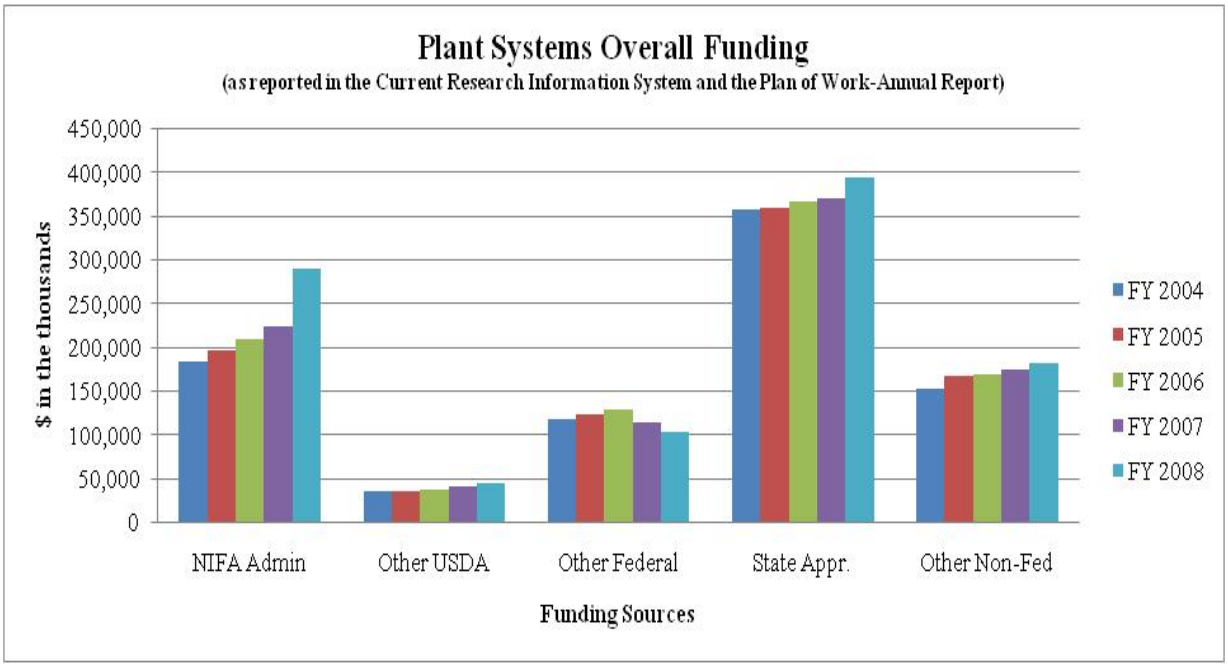
Figure 4: Portfolio Institute Funding Under $10M



Definitions for all of the above funding sources may be found in Appendix B.

Figure 4 illustrates NIFA portfolio funding totaling under $10M annually. 1890 Extension dollars were first reported through the Plan of Work-Annual Report in 2007. Since FY 2007, 1890 Extension expended a total of $5.7M. Smith-Lever 3(d) dollars started being reported in FY 2007. Animal health expended a total of $36,000 in this portfolio, $8,000 in FY 2007 and $28,000 in FY 2008.

Figure 5: Portfolio Overall Funding



Definitions for all of the above funding sources may be found in Appendix C.

Figure 5 illustrates overall portfolio funding; this is a combination of NIFA and non-NIFA funding. The majority of the portfolio's funding comes from state appropriations. As indicated in Table 1a, NIFA contributed 24% of the portfolio's funding for FY 2004-FY 2008.

Figure 6: Portfolio Overall Funding by Knowledge Area

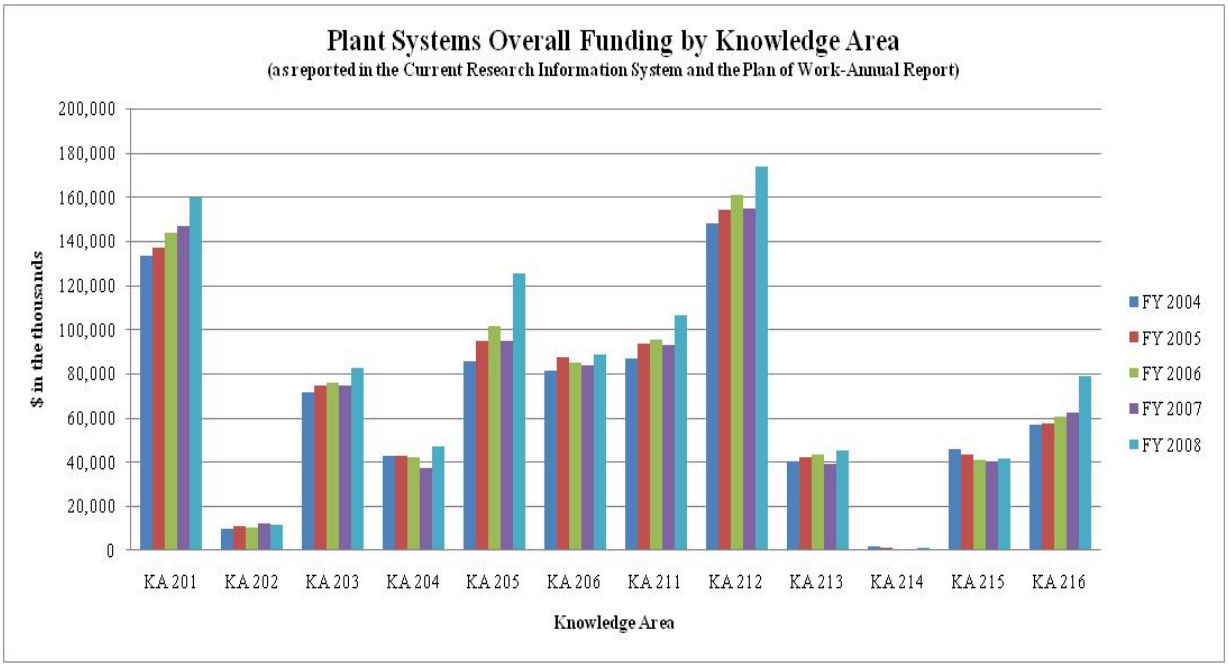


Figure 6 illustrates overall portfolio funding by KA. Individual KA NIFA funding tables are located in Appendix B and KA overall funding tables are located in Appendix C. The majority of portfolio funding comes from KA 201 (Plant Genome, Genetics, and Genetic Mechanisms) and KA 212 (Pathogens and Nematodes Affection Plants). KA 214 (Vertebrates, Mollusks, and Other Pests) contributes the least amount of portfolio funding, a total of $5.2M for fiscal years 2004 – 2008.

Portfolio Results

Highlights and examples reported within this portfolio emanate mainly from the 12 KAs that make up this portfolio.

Major Portfolio Highlights and Outcomes

<u>New technologies help selection of important agronomic traits in wheat – Funded through NRI competitive grant program</u>
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 of important agronomic traits. Since public wheat varieties account for 78% of the wheat production in the U.S., developing improved varieties can have a significant economic impact. The incorporation of modern marker assisted selection techniques has produced 37 germplasm varieties released to growers, including two varieties resistant to the new virulence race of stem rust UG 99. The project has empowered 20 U.S. public wheat breeders to incorporate modern marker assisted selection techniques into their programs. Project participants have published 20 papers, organized 6 educational field trips for students and held more than 120 field days for growers and industry.

<u>Juvenile loblolly pine with improved wood properties will help to meet growing demand – Funded through Other Grants</u>
The Southern U.S. is losing its position as the world's major supplier of industrial wood. To meet future demands for wood and to remain competitive, more wood will have to be produced on less land. To remedy this, rapidly growing short rotation juvenile loblolly pine with greatly improved wood properties was developed through a project integrating research on wood properties, tree breeding, propagation, and genomics. Researchers gained a fundamental understanding of the complex pathways controlling wood characteristics using microarray analysis of gene expression and metabolic profiling. These and other techniques were utilized to understand the formation of compression wood – a major defect-type in juvenile wood. The research results from this project have been transmitted to numerous industry and state agency partners in a number of technology transfer meetings and conferences. The information gained has been or is being published to allow forest practitioners to grow better wood on their forest plantations. Five graduate students also benefited from this project and completed their degrees, adding to the pool of qualified scientists.

Establishing a viable organic goldenseal production system for small family farms – Funded through SBIR

Many small, limited resource farms are only marginally profitable and their owners are seeking ways of increasing farm income and financial stability through diversification. Goldenseal (*Hydrastis canadensis*) is a popular medicinal herb that is primarily collected from the wild and has become endangered or threatened in many areas. Its annual market value exceeds $18 million and demand exceeds supply. A viable organic production system for cultivated goldenseal allows supplemented income without disturbing natural populations. The new goldenseal planting systems were projected to effectively double the amount of certified organic goldenseal in the U.S. and account for approximately 20% of all currently cultivated goldenseal in 2008.

Hard white wheat added as new, value-added crop for U.S. agriculture

White wheat produces the bright noodles in demand in Asian markets. It also makes an attractive, tastier, less-bitter whole wheat loaf than the "red" wheat currently used in the U.S. However, plant physiological barriers prevented the development of white wheat with quality characteristics necessary for bread making (known as "hard wheat"). A collaborative state-federal research which began more than 12 years ago, involving hundreds of wheat and related species, selection, quality testing, and research on underlying genetics, has developed new knowledge and new genotypes that resolve these barriers. Starting in 2004, seven varieties of hard white wheat have been released by five states, adding a new, value-added crop for U.S. agriculture. In Colorado, improved wheat quality has resulted in an increase of approximately $20 million/year. Over 50 scientific publications, multiple graduate theses or dissertations, and numerous extension and outreach publications have also resulted from this work.

eXtension wildlife damage management community of practice: A new public resource for pest control

eXtension is an educational partnership of more than 70 universities. It's established in every state and territory throughout the U.S., providing 24/7/365 access to dynamic and evolving objective, research-based information and educational opportunities. 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.

New technology prolongs produce freshness – Funded through Small Business Grant

Postharvest losses due to spoilage, estimated at 30 to 40 percent worldwide, affect the economic success of growers, packers, storage houses, and distributors of produce. This spoilage is caused by ethylene, a plant hormone produced by fruits and vegetables as they ripen. When fruits and vegetables are packaged for long trips, the air in the confined container circulates and the concentration of ethylene gas accelerates the ripening of stored produce. NIFA support has enabled new technology to help reduce postharvest losses through the development and use of a compact sensor to accurately measure low concentrations of ethylene on transport containers.

Preparing for high consequence pests and diseases
The National Plant Diagnostic Network (NPDN) prepares to detect, diagnose, and report new high consequence organisms each year. In 2008, NPDN laboratories not only prepared for Huanglongbing, the devastating citrus greening disease, but were also vigilant and prepared for 16 other high consequence pests.

2008: The most productive year yet for IR-4
The mission of the IR-4 Project is to provide safe and effective pest management solutions for specialty crop growers. In 2008, IR-4 data led the U.S. Environmental Protection Agency (EPA) to review 41 chemicals for IR-4 Food Use Program tolerance petitions. This was a new record high compared with the 2007 record of 33, making 2008 one of the most productive years for IR-4. IR-4 Ornamental Horticulture Program data supported 7 new registrations and 1 registration amendment from EPA, as well as 4 California registrations. These IR-4 supported successes impacted 3,095 ornamental plant species.

Integrated Pest Management Pest Information Platform Extension and Education (*ipm*PIPE) used by farmers to protect soybean
The Integrated Pest Management Pest Information Platform Extension and Education is a web-based monitoring and early-warning system developed in 2004 to advice farmers and others of the status of soybean rust. This system, referred to as *imp*PIPE, has greatly enhanced the ability of soybean growers and advisors to manage this and other risks in the maintenance of their crop. In a 2007 survey, 74% of soybean growers and their advisors responded that they used the *ipm*PIPE website to make decisions about whether and when to spray to control soybean rust and aphids. A single application of fungicide by 74% of the U.S. soybean growers is equivalent to an estimated cumulative decision worth $866 million. The ipmPIPE in 2008 grew to include monitoring and extension information for integrated pest management of downy mildew of cucurbits, viewable at: http://www.ces.ncsu.edu/depts/pp/cucurbit/.

Portfolio Considerations

Plant Systems Portfolio Leadership and Management
Plant systems activities and programs are managed by or with direction and support from NIFA National Program Leaders (NPLs). Plant systems NPLs develop and update programs using extensive stakeholder input.

NIFA 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. NIFA 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 NIFA seek stakeholder input for its programs through a variety of mechanisms. Recent examples include:

Extension Integrated Pest Management Coordination and Support Program Listening Session October 2008 & March 2009. The 2008 Farm Bill instituted changes to Smith-Lever 3(d) funding including: 1) the requirement for a competitive program delivery model as opposed to a long-standing formula delivery model; and 2) the inclusion of 1890 Institutions and the University of the District of Columbia as eligible entities to receive 3(d) funds. The primary intent of the listening sessions was to gather stakeholder input on program focus and design.

Genes to Products Project Director Meeting,2009. Project directors supported through the National Research Initiative or Agriculture and Food Research Initiative are required to attend an annual meeting. The Genes to Products Meeting, held in Bethesda, MD on May 4-6, 2009, brought together awardees from six different NRI programs including 1) Plant Biology: Biochemistry, 2) Plant Biology: Environmental Stress, 3) Plant Biology: Gene Function and Regulation, 4) Plant Biology: Growth and Development, 5) Microbial Biology: Microbial Associations with Plants, and 6) Biobased Products and Bioenergy Production Research. Awardees presented their research activities and provided invaluable input on program priorities to the agency's staff.

Methyl Bromide Alternatives Organization Conference. All methyl bromide transition program awardees are required to present their findings at the annual Methyl Bromide Alternatives Organization conference. This meeting is a gathering of government regulators and scientists, academia, industry, and other stakeholders where the most up-to-date science is shared with methyl bromide transition scientists and educators. Proceedings for the past 14 annual conferences can be viewed at: http://www.mbao.org/.

NRI Plant Genome Project Directors Meeting. NIFA held a meeting for project directors supported through the National Research Initiative or Agriculture and Food Research Initiative Plant Genome program. This meeting precedes the Plant and Animal Genome Conference in San Diego, CA, January 2009. Awardees shared their research, education, and extension activities through oral and poster presentations and provided input on program priorities.

Slug and Snail IPM Workgroup Meeting. The Western Integrated Pest Management sponsored this meeting held March 26, 2009 in Portland, Oregon. The working group made presentations on damage caused by a number of snail/slug species; the economic losses to commodities from these pests; and on research priorities, coordination of research and outreach, and future plans to managing snails and slugs in ornamentals.

Plant Systems Programmatic or Management Shortcomings
Programmatic shortcomings identified by the portfolio team are as follows:

- Duplication of effort and activities across agencies (e.g., early detection and rapid response systems for APHIS-PPQ, NIFA/LGU's, USFS, USGS). Interagency National Science and Technology Council (NSTC) committees could address aspects of this issue.
- Lack of coordination/duplication of research, education and/or extension activities across units/programs within NIFA. Regular team meetings held quarterly will help to address this issue.
- Lack of strategic planning for research across federal agencies. Revival of currently inactive NSTC committees could address this issue.

Key Future Activities and Changes in Direction
The Plant Systems Portfolio is responsive to world issues and changes in the legislation. The flexibility of including single function priorities within AFRI programs allows the portfolio to support future activities in response to emerging needs such as global food security, development of biofuels, climate change, childhood obesity and nutrition, and food safety.

Single Function Priorities in AFRI Programs
The new Farm Bill allows AFRI programs to include single function education-only or extension-only priorities with a program. Several AFRI programs have taken advantage of this opportunity to expand program scopes. For example, the Microbial Genomics: Functional Genomics of Microorganisms program has an education-only priority to develop innovative, research-based graduate education and training activities in the application of knowledge gained from microbial genome sequencing and/or microbial functional genomics to solving problems facing U.S. agriculture. The integrated Plant Biosecurity Program has an extension-only priority on identifying common training and extension needs for first-detectors for multiple federal and state agencies, and developing training curricula to meet these needs.

Plant Systems and Global Food Security:
Globally, almost one billion people regularly suffer from hunger; most are women and children and one child dies every six seconds from hunger-related causes. USDA 2008 statistics show that 12.4 million children in the U.S. are food insecure. Further, it has been estimated that by 2025, food production in the developing world must increase by 40% to keep up with demands created by population growth.

Contributing to this hunger problem are yield losses due to weeds, animal pests (arthropods, nematodes, rodents, birds, slugs and snails) and plant pathogens (fungi, oomycetes, bacteria, viruses, etc.). These losses have been a constant constraint of agricultural productivity and annually claim approximately one third of the world's supply of the primary staples: wheat, rice, maize, potato and soybeans. Losses to plant pathogens alone total approximately $33 billion per year in the U.S., with over 65% of these attributable to non-indigenous pathogens. Controlling pests has always been and remains an integral part of the strategy to increased yields and productivity.

The Plant Systems research, extension, and education activities are uniquely positioned to provide leadership to address these challenges in global food security, by increasing crop productivity and yields, and reducing losses caused by plant pathogens and pests Plant Systems programs in plant production, such as basic plant biology, plant genome, genetics and breeding, all contribute to yield increase, while programs in plant protection, such as plant/microbe interactions, National Plant Diagnostic Network, and integrated pest management, contribute to avoiding yield losses. Education activities prepare next generation plant scientists for the future, and effective extension programs that deliver research knowledge to crop producers are significant components in increasing yield potential and protecting food production for a hungry world.

Plant Systems and Bioenergy:

The USDA Research, Education, and Economics (REE) mission area promotes an integrated regional systems approach to the development of sustainable production of bioenergy from primarily plant-derived biomass. Development of crops and cropping systems with high value for biofuel stocks will have important ramifications for food production systems. Increased biofuel crop production on a large scale will challenge food production systems. We can also expect new pests, resurgent of "old" pests, changes in thresholds, and tolerance for pest damage as fields of biofuels crops are grown adjacent to fields of food crops.

Within the Plant Systems, basic plant biology, genomics, and genetic mechanisms programs provide basic knowledge of bioenergy crops, while programs in breeding and genetic resources generate new varieties that are able to produce more biomass for biofuels. Plant protection programs provide knowledge and tools for reducing energy crop losses caused by plant pathogens and pests. Education programs prepare next generation scientists for careers in bioenergy, while extension programs educate producers for effective management of bioenergy crops.

Plant Systems and Climate Change:

Global climate change will have profound implications for the growth, development, and productivity of crop and forest species. Severe drought, flooding, and sea level rise caused by climate change may reduce total arable acreage, severely limit the growth of traditional agricultural plants, cause a shift in growing zones, and require external inputs not previously required. Susceptibility of plants to pathogens and pests are likely to change as a result of climate change and may negatively impact agricultural productivity. Further, elevated levels of greenhouse gases associated with climate change can trigger changes in plant metabolism that may affect plant yield.

The Plant Systems research, education and extension portfolio is uniquely positioned to provide the leadership and design programs that meet the production and pest management challenges likely to arise from climate change. Plant systems priorities such as basic plant biology, genomics, genetic mechanisms and resources, breeding, production, protection, and integrated pest management are essential for adapting agriculture to climate change. Education activities prepare plant science practitioners for the future, and extension activities translate knowledge learned through research into agricultural practices that allow producers to minimize detrimental effects of environmental stresses and increase crop yield and profitability.

Plant Systems and Childhood Obesity and Nutrition:
Diet and prevention tactics may be most effective to combat increasing obesity trends. Fruits, vegetables, and whole grains may affect obesity through their relatively low-caloric values, high water content, palatability, and fiber content. Fruit and vegetable intake is affected by accessibility issues such as socioeconomic status. Socioeconomic status directly relates to consumption of fruits and vegetables. In addition, lower prices of fruit and vegetable have been linked with significantly lower gains in body mass indices for elementary schoolchildren.

Plant systems priorities such as integrated specialty crop and organic research programs, basic plant biology, genomics, genetic mechanisms and resources, breeding, production, protection, and pest management help to increase plant yield. Abundant and readily available food can help lower the cost of fruits and vegetables, making them available to people across all socioeconomic groups to improve nutrition and help to combat childhood obesity.

Plant Systems and Food Safety:
The long term sustainability of U.S. food production systems relies on consumer confidence that the products they purchase and eat are safe. Plant Systems activities have a role for both components of food safety:1) reducing the risk that food products are contaminated with pathogens and 2) reducing the risk that food products contain unsafe residues of materials used in the production and processing of that product.

Plant Systems research, extension and education programs can help to improve production and processing systems and contribute to knowledge and prevention strategies to address plant-pathogen interactions. The development of cultural and harvest practices that reduce human contact with plant products will reduce the potential that soil- and water-borne human pathogens are transferred to consumers. The development of sensor technology for detection of pathogens and allergens is also critical for reducing the risk of food-borne illnesses and contamination.

Integrated crop management and integrated pest management are fundamental to insuring that minimum amounts of external inputs are used in crop production, thereby reducing the potential that consumers will be exposed to unsafe residues. A holistic approach to the interface of food safety with plant production systems, covering production, transportation, distribution, and consumer handling is needed to ensure that application of preventive strategies for cross-contamination of residues at pre-/post-harvest and consumer levels will have desired outcomes.

What Others Are Doing in Plant Systems

This portfolio values the contributions others are making to plant agriculture, and this section identifies and describes other federal agencies' and private organizations' research, education and extension activities that are responding to similar needs as those addressed by the Plant Systems Portfolio. A few examples from other agencies and organizations are listed below:

United States Department of Agriculture – Animal Health and Inspection Service (APHIS)
The *Plant Protection and Quarantine (PPQ)* program (http://www.aphis.usda.gov/plant_health/) safeguards agriculture and natural resources from the risks associated with the entry,

establishment, or spread of animal and plant pests and noxious weeds to ensure an abundant, high-quality, and varied food supply.

The following PPQ programs respond to needs similar to those of this portfolio:

- *Plant Pest Program Information* responds to new introductions of plant pests to eradicate, suppress, or contain them through various programs in cooperation with state departments of agriculture and other government agencies.
- *Pest Detection* program protects America's agricultural and ecological resources by insuring the early detection of harmful or economically significant plant pest and weeds.
- *Pest Identification* - The National Identification Services coordinates the identification of plant pests in support of USDA's regulatory programs.
- *Crop Biosecurity and Emergency Response* - PPQ is the Federal response agency for plant health emergencies. This response team develops and delivers strategic science-based regulatory programs designed to protect U.S. crops and natural resources.

United States Department of Agriculture – Agricultural Research Service (ARS)

ARS' Crop Production and Protection National Programs (NP) cover intramural research in the plant production and protection areas. These intramural research projects of ARS complement the extramural research or integrated projects supported through NIFA programs. A brief description of these programs is provided below:

- *Plant Genetic Resources, Genomics, and Genetic Improvement*, NP 301 supports research that expands, maintains, and protects our genetic resource base; increases our knowledge of genes and genomes; and through novel tools and approaches, manages and delivers vast amounts of genetic and phenotypic information. The ultimate goals of this program are to improve the production efficiency and the health and value of our nation's crops.
- *Plant Biological and Molecular Processes,* NP 302 supports fundamental research that creates a knowledge base and research tools that will contribute to greater crop productivity and efficiency, better product quality and safety, improved protection against pests and diseases, enhanced tolerance to abiotic stress, and sustainable practices that maintain or enhance environmental quality.
- *Plant Diseases*, NP 303 includes the overall goal of the Plant Diseases National Program to develop and improve ways to reduce crop losses caused by plant diseases. The program focuses on developing effective disease control strategies that are not environmentally harmful, do not threaten the safety of consumers, and are compatible with sustainable and profitable crop production.
- *Crop Production and Quarantine,* NP 304 conducts fundamental and applied research that will result in improved strategies for the cost-effective management and control of native and invasive insect, mite, and weed pests while minimizing impacts on the environment and human health.
- *Crop Production*, NP 305 supports research and technologies that contribute to greater cropping efficiency, productivity, quality, marketability, and protection of annual, perennial, greenhouse, and nursery crops while increasing environmental quality and worker safety.
- *Methyl Bromide Alternatives,* NP 308 supports research in soil borne plant pathology, post-harvest entomology, plant pathology, and plant physiology in a national research

program to develop alternatives to the agricultural uses of methyl bromide, a widely used fumigant and known ozone depleter.

ARS' *Plant Science Institute* (http://www.ars.usda.gov/Main/site_main.htm?modecode=12-75-00-00) research programs seek to:

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

U.S. Forest Service

The *Invasive Species Program* (http://www.fs.fed.us/invasivespecies/) aims to reduce, minimize, or eliminate the potential for introduction, establishment, spread, and impact of invasive species across all landscapes and ownerships.

National Science Foundation (NSF)

Basic Research to Enable Agricultural Development (BREAD) Program (http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=503403&org=DBI) has the goal to build on the accomplishments of the National Plant Genome Initiative (NPGI), extending the opportunities to include international partners in efforts to generate sustainable, science-based solutions to problems of smallholder agriculture in developing countries. This program because a component of the NSF Plant Genome Research Program (PGRP) that began in Fiscal Year 1998 as part of the National Plant Genome Initiative (NPGI).

Interagency Efforts

National Plant Genome Initiative (NPGI) is under the National Science and Technology Council (NSTC). This is an interagency activity involving NSF, NIH, DOE, and USDA. The focus of the NPGI is on plants of agricultural importance and plant processes of potential agronomic value. A five-year (2009-2013) plan of the NPGI was published in January 2009 (http://www.ostp.gov/galleries/NSTC/NPGI%20Five-Year%20Plan%202009-2013.pdf).

Plant Sciences, Inc.

Plant Sciences, Inc. (http://www.plantsciences.com/index_flash.html) is an agricultural consulting, research, and production company. This company's research programs include breeding and propagation of fruit and vegetable varieties, development of crop management practices, and applied biotechnology techniques.

Donald Danforth Plant Science Center

The Danforth Plant Science Center (http://www.danforthcenter.org/default.asp) is a non-profit research institute that focuses on providing research with a global impact. The Plant Science Center's 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.

Section II: Primary Knowledge Areas

This section presents work conducted under all primary knowledge areas (KAs) that make up this portfolio.

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

KA 201 Introduction

The Knowledge Area (KA) focuses on work that uses mapping, sequencing, and analysis of the complete genetic makeup of plants, and their genomes, to determine the function of genes and translation for plant improvement. Research, education and extension topics supported within KA 201 include **long-term goals** encompassing development and implementation of molecular markers for breeding; utilization of functional genomics methods, resources, and knowledge; identification of genomic intervals carrying genetic traits of interest (e.g., yield, quality, disease and pest resistance, stress tolerance, biomass, etc.); implementation of informatics-based tools for breeding; development and use of extension tools to provide appropriate audiences with information on advances in genomics and genetics and; educational opportunities for genomic and genetic technology use and transfer.

Mission-oriented **short and medium term goals** are addressed through work focused on understanding genome structure and function, statistical approaches to estimate genetic effects, experience in both laboratory molecular methods and field-based breeding practice and, development of informatics capacity to manage large datasets with diverse data types.

Key priorities include work addressing methods to create high-resolution genetic maps that exploit linkage between markers and agronomic traits, QTL discovery, positional cloning, and comparative genomics; structural genomic research to develop or improve physical linkage maps to advance knowledge of the gene space; functional genomics research to increase understanding of the biological role of genomic sequence, including coding, regulatory and repeated sequences, and to link these sequences to physiological function; informatics and computational methods to enable breeder-centric views of map and trait data that best serve their needs; training of researchers broadly to reach full mastery in a combination of key areas such as bioinformatics, quantitative genetics and breeding to develop educated, highly skilled, and motivated students, the human resources of the future.

Public benefit from the work conducted includes increasing plant production and health utilizing sustainable methods that minimize negative environmental impacts, global climate change, evolving plant pests and pathogens and changing social needs to provide food, fiber, shelter, and medicines.

This KA contributes to overarching goals of the agency by advancing discovery, application and educational opportunities to address the challenges of increasing population, decreasing agricultural land area, global food security, bioenergy and climate change. The current portfolio **is moving in the right direction** to accelerate plant production and protection by expanding our fundamental knowledge about the genetic makeup of plants, facilitating applications of new

knowledge and innovative approaches to meet growing food and energy needs while contributing to overall economic growth.

KA 201 Plant Genome, Genetics, and Genetic Mechanisms Logic Model

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 and climate change. 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**: - NIFA 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, and -submitted to NIFA. Research findings disseminated Publications Citations Disclosures Patent 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. NIFA accomplishes work on genomics, genetics, & genetic mechanisms by collaborating with partner organizations & agencies. NIFA 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 NIFA; 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).

KA 201 Outputs and Outcomes

Wheat Applied Genomics CAP
NRI Competitive Grant CRIS accession no. 0205761

The Wheat Applied Genomics Coordinated Agricultural Project (CAP) is a multi-state, multi-institutional, and multi-disciplinary network of public wheat breeding programs and high-throughput genotyping laboratories working together to validate and map valuable QTL, to rapidly deploy them into adapted varieties throughout the U.S. wheat growing regions using Marker Assisted Selection (MAS) strategies.

Key Outputs

- 57 germplasm have been released.
- 37 peer-reviewed articles (including 3 in Science) have been published.
- 20 high-school students, 106 undergraduate students, and 93 graduate students have been trained on MAS.
- MAS talks were conducted at 176 field days and 135 presentations to growers and industry.
- 16 hands-on MAS workshops and 10 “Combine to Kitchen” educational tours completed.

Outcomes

- The work has transferred new developments in genomics to wheat improvement by combining the expertise of genomics researchers, wheat breeders, and end users.
- Improved germplasm is made available to other public and private wheat breeders multiplying the benefits of NIFA funding and transferring the value of genomic research directly to the wheat growers and the wheat industry.
- Numerous new collaborations among breeding and genomic research programs would not have been possible without funding from NIFA.

KA 201: Wheat Applied Genomics CAP Logic Model

Participants: Jorge Dubcovsky (UC Davis) and 19 Co-project directors **Dollars Invested:** $5,000,000

Situation	Activities	Outputs		Outcomes		
		Product	Metric	Change in Knowledge	Change in Actions	Change in Conditions
Coordinated Agricultural Project 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.	Activities focused on developing a collaborative network of public wheat-breeding programs to accelerate the transfer of valuable genes into locally adapted wheat varieties.	Marker assisted selection (MAS) data points, germplasm, publications, students trained, extension presentations, and mapping populations. All populations have been deposited in the USDA-ARS-NPGS-National Small Grains Collection and are publicly available.	700,000 MAS data points, 57 release germplasm, 37 publications, (3 in Science), 19 mapping populations (exceeding the original target of 17) with 300 markers per population. Also trained 20 high-school students, 106 undergraduate students, and 93 graduate students, and delivered 16 hands-on MAS workshops and 10 "Combine to Kitchen" educational tours	Increased understanding of new genomic tools and high throughput capacities. Growers and industry gained knowledge in marker assisted selection through multiple extension presentation.	Researchers successfully implement forward breeding MAS strategies in public wheat breeding programs. MAS data is used to deploy favorable alleles in public wheat breeding programs, taking advantage of the of four regional genotyping laboratories.	Public wheat breeding programs improve the competitiveness of U.S. wheat by accelerating the deployment of valuable alleles in a broad set of germplasm.

Assumptions: Funding for the public wheat breeding programs is typically provided by wheat grower associations. However, the grower's funding is not sufficient to implement and test new technologies and to develop new molecular markers for important agronomic traits. The most efficient way to couple the growers' investment in public wheat breeding with the value of new genomic technologies is to fund public sector translational genomics research.	**External Factors:** A change in conditions to significantly reduce the breeding cycle time and cost of phenotypic evaluations for wheat improvement depends upon sustained funding beyond the duration of this project.

Barley Coordinated Agricultural Project: Leveraging Genomics, Genetics, and Breeding for Gene Discovery and Barley Improvement

NRI Competitive Grant CRIS accession no. 0206216

The barley Coordinated Agricultural Project (CAP) is a community effort of scientists working to integrate and utilize state-of-the-art genomic tools and approaches in barley breeding, thereby facilitating the development of superior cultivars. The work is leveraging genomic tools and datasets to educate breeders and students in translational genomics for crop improvement.

Key Outputs

- The work has developed a 2,943 marker SNP map, integrated these markers with the physical map, and linked them to expression patterns.
- Used the SNPs to genotype germplasm from 10 barley-breeding programs and described linkage disequilibrium.
- Phenotyped the breeding program germplasm for 40 traits.
- Developed "The Hordeum Toolbox" database.
- Used the data to conduct association genetics-based studies to detect marker-trait associations; and begun to use these marker-trait associations to develop improved germplasm.
- In addition, an extension program has been instrumental in delivering current information about MAS to growers, extension educators, and industry personnel resulting in enhanced dialog with scientists.

Outcomes

- The work has integrated genetic and trait data to gain access to the genes that control important biological, agronomic, and quality traits.
- Marker-trait associations are enabling breeders to manipulate important traits and develop improved varieties.
- To enhance the discovery of marker-trait associations and ensure the use of the information generated is publicly available and useful to barley breeding in the future, "The Hordeum Toolbox" database has been developed to host the genotype and phenotype data generated. The data will be transitioned to the ARS GrainGenes database for long term storage and future public access and will add tremendous value to existing genetic maps.

KA 201: Barley CAP Logic Model

Participants: Gary Muehlbauer (U Minnesota) and 3 Co-project directors

Dollars Invested: $5,000,000

Situation	Activities	Outputs		Outcomes		
		Product	Metric	Change in Knowledge	Change in Actions	Change in Conditions
Genomics tools have not been integrated in barley breeding programs for two major reasons including: (1) genomics tool development has been independent of breeding programs; and (2) breeding programs have not had access to these tools and knowledge to utilize the new tools. Therefore, the overall research goal of the project is to integrate genomics tools in barley breeding programs to more efficiently develop varieties and conduct gene discovery.	***Extension:*** Workshops for breeders and students (e.g., MAS, experimental design, malting quality); Talks at grower meetings; Talks and symposia at scientific meetings; Support for extension teams; Combine to Kitchen tours. ***Education:*** Course curriculum, Powerpoint presentations, posters, brochures, factsheets, newsletters. ***Research:*** to develop the information and tools (e.g., SNP maps, marker-trait associations, THT database, etc.) to conduct modern plant breeding and genetics.	***Electronic:*** QTL Miner Software, THT Database/Web portal, eXtension Plant Breeding CoP, *Hordeum* information resources, Podcasts. ***Data generation and analysis:*** SNP maps, SNP genotypes of CAP germplasm, Phenotypes of CAP germplasm, LD defined in U.S. germplasm, Marker-trait associations, Simulate genome wide selection, Design next generation genotyping Platform.	Better linkages between growers, extension educators, industry personnel and scientists to help shape the future barley research and breeding agenda.	***Students:*** educated on modern plant breeding and the food system. ***Extension educators:*** increased understanding of genomics and breeding, better linkage to barley researchers, and increased knowledge of barley.	***Breeders/Geneticists:*** more efficiently develop new varieties with superior traits, characterize gene function, discover new genes, establish new targets for molecular breeding, curriculum for use in graduate level plant breeding courses. ***Growers and industry personnel:*** understand the value and characteristics of varieties developed by the Barley CAP, grower and end user input help to drive barley research, increased knowledge of barley.	***Breeders/Geneticists:*** release of superior varieties using genomics tools, new plant breeding targets will be used in breeding programs, enhanced delivery of modern plant breeding concepts in graduate level plant breeding courses. ***Students:*** next generation of modern plant breeders, enhanced understanding of the food system. ***Extension educators:*** enhanced knowledge and outreach to growers, provide research direction. ***Growers and industry personnel:*** grow and process Barley CAP varieties, provide research direction.

Assumptions: Growers, extension educators and industry personnel recognize that an integrated research, education and extension focused on translational genomics will result in the development of new barley varieties.	**External Factors:** The database is a critical resource that houses pedigree, genetic and phenotypic data from breeding lines. A change in condition depends upon long term funding beyond the life of the project to ensure that the database and other critical resources developed can be sustained and made available for future agricultural research, education and extension opportunities.

Conifer Translational Genomics Network (CTGN)
NRI Competitive Grant CRIS accession no. 0211940

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 U.S**.** The activities will be conducted in partnership with four major conifer breeding programs that oversee nearly 100% of the non-private tree breeding activities in the U.S.

Key Outputs

- Over 2500 foliage samples collected for DNA extraction and SNP genotyping.
- The establishment of the Atlantic Coastal Elite (ACE) clonally replicated test population consists of progeny from parents that are being genotyped through the CTGN, and will be the first NCSU operational population to test the implementation of marker-trait associations identified in the CAP.
- RNA from Douglas-fir tissues have been collected and submitted to the DOE Joint Genome Institute for transcriptome sequencing.
- Two courses were developed, "Genomics of Tree Breeding and Forest Ecosystems, short-course (3 credit hrs) was conducted at UC Davis and a special topics course "Association Genetics and Breeding" conducted at Oregon State University.
- Co-PDs delivered over 40 outreach presentations about MAS and MAB, including invited talks, class lectures, posters, talks to professional societies, and conference talks.

Outcomes

- A powerful extension tool has been the interaction among forestry cooperative directors in which each shares particular knowledge or expertise with one another to implement MAS and MAB technology/strategies in their programs.

KA 201: Conifer CAP Logic Model

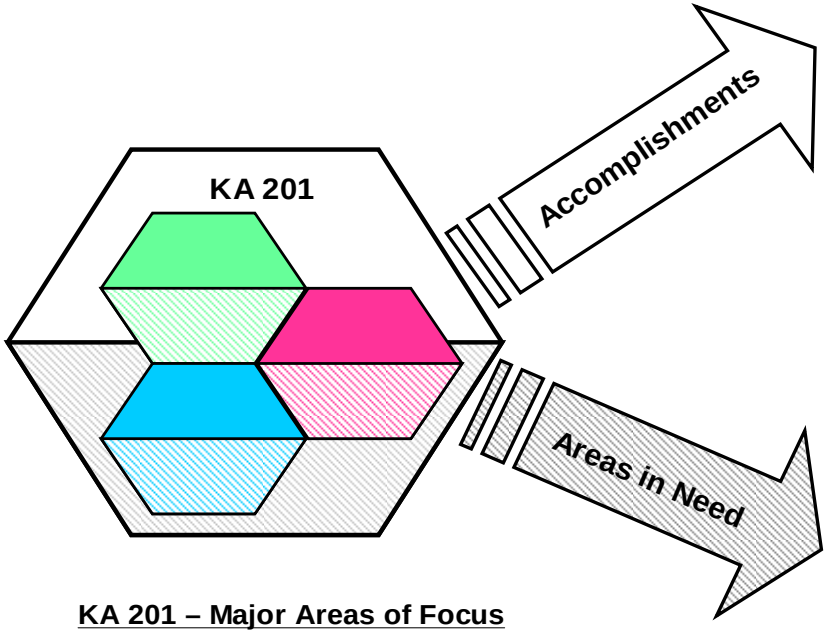
Participants: David Neale (UC Davis) and 6 Co-project directors **Dollars Invested:** $6,000,000

Situation	Activities	Outputs		Outcomes		
		Product	Metric	Change in Knowledge	Change in Actions	Change in Conditions
Coordinated Agricultural Project (CAP) 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:** define MAS and MAB strategies by identifying and defining the statistical association between DNA sequence and economic trait variation in tree breeding populations. Develop extensive database and web based tools to serve the tree genetics community and build an international genomics stock center. **Education:** targeted at undergraduate and graduate level curriculum development and instruction will be developed and implemented. In addition, this curriculum will be used to train practicing tree breeders in genomic-based breeding through an extension program. **Extension:** training given for/by Co-op Directors on MAS and MAB strategies.	Genotype and phenotype analysis is underway. The first operational population identified and tested that implements marker-trait associations. PhD student completed course work including lab and field experience on MAS and MAB. Creation and delivery of two courses, "Genomics of Tree Breeding and Forest Ecosystems, and "Association Genetics and Breeding."	MAS and MAB strategies are used by tree breeding cooperatives. Database and genetic stock center is developed or enhanced and used by the tree genetics community. Undergraduate and graduate curriculum developed and implemented. Tree Co-ops adopt MAS and MAB strategies.	Increased knowledge and skills of Co-op Directors and members in MAS and MAB strategies and changed attitudes about value of new technology. Increased student knowledge and skills in using MAS and MAB technology in tree breeding.	Co-op Directors and members implement MAS and MAB technology/strategies in their programs. Scientific community conducts future research on genome based breeding strategies. Increased number of students who plan to use MAS and MAB in their professional practice.	Higher yields and improved quality of wood fiber. Enhanced rural economies and human well being in forest dependent communities.

Assumptions: Cooperative participation provides the leverage of past industry/government commitment and investment, and insures a seamless integration of newly discovered technologies into their breeding programs.	**External Factors:** A change in condition depends upon long term funding beyond the life of the project to ensure that the database and other critical resources developed can be sustained and made available for future agricultural research, education and extension opportunities.

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 Knowledge Area (KA) focuses on discovery, acquisition, preservation, characterization, evaluation, and development of plant genetic resources. Since 2005, KA 202 has also been used to include plant breeding that is, use of plant germplasm resources to develop elite germplasm or varieties which become, in turn, germplasm resources for the next generation.

Converging trends are making plant genetic resources increasingly valuable. These include climate change, food security, and international restrictions on access, new findings in nutrition and health, and new tools from genomics research. Some are serious challenges; others are welcome opportunities. The **long-term goal** of KA 202 is to manage and use plant genetic resources to meet national and global challenges and opportunities successfully, now and into the future.

Short-term goals include acquiring, protecting, and sharing genetic resources that are well-characterized and safely preserved. **Medium-term goals** include developing experimental lines and farm-ready ("elite") varieties; and equipping future scientists with knowledge and skills to advance understanding and use of plant genetic resources. **Priorities** include acquisition; seed biology; and identification and development of germplasm that responds to changing needs and opportunities of plant production, protection, and end-use. Recurring top priorities include pre-harvest quality (ranging from flavor to bioenergy conversion efficiency) and resistance to biotic or abiotic stresses (such as diseases or drought).

A few examples of **public benefits** include: wide range of good seed choices every year, helping farmers keep up with disease pressures, weather patterns, and quality requirements--whether their market is local or global; plant resources for an expanding range of healthful and appetizing fruits, vegetables, and grains for the diets of the future; and security for response to unknown future challenges, in the form of readily-accessible genetic diversity and the know-how for using it.

This knowledge area could benefit from enabling commitments over longer periods of time. Outputs and outcomes in KA 202 require commitment over a decade or longer. But capacity funds that can support long-term work are becoming an ever-smaller proportion of the agency budget. The agency may consider working with relevant experts to review the roles, costs and benefits, and possible strategies associated with each funding type, and consider how they might be balanced to carry out plant genetic resources work.

KA 202 is central to achieving the mission and goals of the Plant Systems Portfolio because plant genetic resources –wild, experimental, and elite -- are the physical resources through which Plant Systems Portfolio research, extension, and education reach public benefit. The KA in plant genetic resources **contributes to overarching goals of the agency** by supporting availability, quality, and responsiveness of plant genetic resources as the material starting points (with soil, water, and air) for provision of food and fiber.

KA 202: Plant Genetic Resources

Participants:
Land-grant colleges and agricultural experiment stations, USDA's Agricultural Research Service, other universities, farmers' and producers' organizations, private sector seed companies, non-profit organizations. Researchers, extension specialists, educators, students, farmers. Collaborators in other countries including international centers; national plant germplasm and agricultural research systems; farmers.

Funding Hatch, Evans-Allen and Smith-Lever formula (capacity) funds; competitive grants from AFRI, SCRI, OREI, and other programs; special grants; state funding sources; private sector; private foundations; farm-and producer groups.

Situation	Activities	Outputs	Outcomes		
			Change in Knowledge	Change in Actions	Change in Conditions
Converging trends are making plant genetic resources increasingly valuable. These include climate change, security, and international restrictions on access, new findings in nutrition and health, and new tools from genomics research. Some are serious challenges; others are welcome opportunities. The long-term goal of KA 202 is to manage and use plant genetic resources to meet national and global challenges and opportunities successfully, now and into the future.	Discovery, acquisition, preservation, characterization, evaluation, and development of plant genetic resources. Use of plant germplasm resources through plant breeding to develop elite germplasm or varieties. These become, in turn, germplasm resources for the next cycle. Extension outreach to learn farmer and consumer needs, to inform producers about varieties available, and to follow the adoption and results with released genetic resources. Education of future researchers, educators, and extension specialists.	Plant accessions from a wide range of species acquired, preserved, characterized and shared. Research findings disseminated through experimental germplasm lines and new varieties, and through publications, reports, presentations, citations, PVP certificates and patents; and used by researchers, extension specialists, and farmers; and appreciated by consumers. Undergraduate and graduate students trained.	New knowledge of: - Geographic distribution, relationships, and extent of diversity of species likely to have desired traits; -Biological processes implicated in long-term preservation of viability, and seed multiplication, for a wide range of genetically diverse materials - Unique plant traits and their genetic and environmental interactions - Unique new genetic combinations (genotypes) that result in desirable phenotypes (outward characteristics) - Germplasm and varieties expressing pre-harvest quality such as flavor, food value, or bioenergy conversion efficiency, resistance to biotic or abiotic stresses such as diseases or drought, and other traits.	- Researchers from basic scientists to plant breeders, in both public and private sectors, make use of a wide range of plant genetic diversity to investigate, innovate, and meet needs. - A wide range of good seed choices available for farmers - Farmers have genetic resource for keeping up with disease pressures, weather patterns, and quality requirements - whether their market is local or global. - Markets and consumers have available a range of diverse foods and fibers at reasonable cost and with qualities they require or prefer.	- Reliable, abundant, high-value harvests, able to cope with year to year variation in weather, pest, and disease pressures. - Healthier population due to synergy between nutrition education and availability of affordable, appetizing, and nutritious fruits, vegetables, and grains. - Abundant, high-quality materials for the bioeconomy. - Security for response to unknown future challenges, in the form of readily-accessible genetic diversity and the know-how for using it. - Support to other countries through sharing and exchange of germplasm, experimental lines, and varieties; and through training.

Assumptions: Adequate funding, ability to correctly assess challenges and opportunities, appropriates and effective public-private cooperation, collaboration between researchers in germplasm, genetics, genomics, plant breeding and other disciplines such as pathology, entomology, physiology, food science, etc., and between research, extension, and education.	**External Factors:** Funding levels, as influenced by the economy and relative national priorities; national science policy; and cooperation and coordination with other government agencies and with other countries.

KA 202 Outputs and Outcomes

Development of Hard White Wheat

Hatch funds to South Dakota State University, Idaho, Nebraska, Colorado, Kansas	CRIS accession no 0188023, 0189717, 0195704, 0152769, 0200138

White wheat produces bright noodles demanded by Asian markets. It also makes an attractive, tastier, less-bitter whole wheat loaf than the "red" wheat currently used in the U.S. However, plant physiological barriers prevented the development of white wheat with quality characteristics necessary for bread making (known as "hard wheat"). Over 12 years of collaborative state-federal research, involving hundreds of wheat and related species, selection, quality testing, and research on underlying genetics, has developed new knowledge and new genotypes that resolve these barriers. Starting in 2004, five states have released a total of seven varieties of hard white wheat for the West and Midwest.

Key Outputs

- Hard white wheat has been developed as a new, value-added crop for U.S. agriculture.
- Seven varieties of hard white wheat have been released by five states, starting in 2004.
- There are now 16 publicly-available near-isogenic wheat lines (8 +/- sets).
- Over 50 scientific publications, multiple graduate theses or dissertations, and numerous extension and outreach publications have resulted from this work.

Outcomes

- New domestic and export markets for U.S. agricultural products have been developed for hard white wheat.
- Societal conditions have been improved through higher farm income and market diversification. For example, approximately $20 million/yr has been added for Colorado wheat growers from improved wheat quality.
- Momentum from on-farm and export success of the new hard white wheat is speeding up incorporation of DNA marker applications in these breeding programs, for faster addition of needed traits, in particular, improved resistances to biotic and environmental stresses.

KA 202: Development of Hard White Wheat Logic Model

Participants: Researchers at SDSU, OK, ID, NE, CO, ARS, UMN, KSU, WSU, NDSU, Montana SU, Westbred LLC **Dollars Invested:** Not available

Situation	Activities	Outputs		Outcomes		
		Product	Metric	Change in Knowledge	Change in Actions	Change in Conditions
Hard white wheat produces bright noodles and is in demand in Asian markets. It also makes an attractive, tastier, less-bitter whole wheat loaf than the "red" wheat currently used in the U.S. However, white wheat grown in the U.S. until the 21st century has been soft wheat, not hard. Soft wheat is low in protein, good for cakes and biscuits but unsuitable for bread baking. This work aimed to develop hard white wheat varieties for US agriculture.	Interspecific and intraspecific crosses, selection, quality testing, and research on underlying genetics of key plant physiological traits in wheat. Field evaluations, greenhouse assays, and laboratory and commercial testing. Conduct extension field days.	New experimental wheat lines for breeding and research on genetics of high-grain protein. New wheat varieties including: Wendy 2004 (SD), Guymon 2005 (OK), UI-Lochsa 2006 (UI), UI-Darwin 2006 (UI), Alice 2006 (SD + NE), OK Rising 2008 (OK), and Thunder CL 2008 (CO). More hard white wheat varieties are in the pipeline in several states, including varieties resistant to the new stem rust race Ug99. A new value-added market class of wheat for the U.S.	Seven public varieties to date. Sixteen publicly-available near-isogenic wheat lines (8 +/- sets). Over 50 scientific publications. Multiple graduate theses or dissertations. Multiple extension and outreach publications. Increased farm income: est. $20 million/yr value-added for CO wheat growers from improved wheat quality.	New knowledge of the genetics of grain protein content, sprouting resistance, and grain color in cereal grains. Knowledge of a new type of whole wheat bread.	Hard white wheat is planted in more areas. Improved pre-harvest sprouting tolerance as in OK Rising variety will expand hard white wheat growth into higher-rainfall areas. Thunder CL variety provides the first yield-competitive, herbicide-resistant hard white wheat variety that is adapted to dry land plains conditions.	New domestic and export markets for U.S. agricultural products. Higher farm income and diversification. Impetus from on-farm and export success of the new hard white wheat varieties is speeding up incorporation of DNA marker applications in breeding programs, for faster addition of needed traits, in particular, improved resistances to biotic and environmental stresses.

Assumptions: Research success combining productivity, stability, and quality in hard white wheat will continue. Demand for hard white wheat will continue.	**External Factors:** Funding availability and federal/state collaborations are important for development of new varieties of hard white wheat varieties to meet the challenges of abiotic and biotic stressors. Asian market purchasing power and overall demand is important for the economic value of hard white wheat. Wheat growers must have access to adequate marketing channels, and the response of the nutrition and food science community to white wheat will influence success of use of hard white wheat bread as a healthier alternative to refined flour white bread will influence demand.

Modifiers of Endosperm in Sugary1 Maize
NRI Integrated Competitive Grant to University of Wisconsin CRIS accession no 0210753

This project studies how starches and sugars are metabolized in corn grain to develop innovative new genetic resources for breeding. Because the nation is facing a shortage of plant breeders, the project is designed to integrate student education with this research to inspire passion and commitment among students most likely to enter the discipline. The project also aims to raise awareness of plant breeding among the general public.

Key Outputs

- DNA markers have been developed in the region of the sugary enhancer gene (se1) gene.
- Three summer interns and five students (2 undergraduate, 3 graduate) travelled for a week to CIMMYT, the international maize and wheat breeding center in Mexico in 2008.
- Videos on plant breeding covering a wide range of plants with more in progress are posted at www.wisconsinplantbreeding.com and are available by Podcast. Videos are of two types:
  - "Fields of Study" focus on background and contributions of individual breeders, human aspects, and what breeders find most satisfying about improving plants for human use. This type is aimed at general audience, for people who would like to learn about the efforts that are behind the foods that they eat.
  - Technical videos instruct how to make controlled crosses with a range of plants and are for viewers with some biology background, plant breeding students and other hybridizers (backyard and commercial).

Outcomes

- New varieties of corn for farmers to grow and market, thus providing economic opportunity.
- Increased public awareness of plant breeding in the general public.
- Strengthened science work force for the future, specifically in plant breeding.

KA 202: Modifiers of Endosperm in Sugary1 Maize Logic Model

Participants: Univ. of Wisconsin **Dollars Invested:** $500,000

Situation	Activities	Outputs		Outcomes		
		Product	Metric	Change in Knowledge	Change in Actions	Change in Conditions
This project studies how starches and sugars are metabolized in corn grain to develop innovative new genetic resources for breeding. Because the nation is facing a shortage of plant breeders, integrated activities are designed to raise awareness of plant breeding among scientists and non-scientists, and inspire students to enter the discipline.	Develop experimental maize population and complete map-based cloning. Conduct summer intern program. Develop videos and written teaching materials. Targeted community education activities.	A unique genetic stock for study of the sugary enhancer gene. DNA markers in the region of the sugary enhancer gene (se1). Summer internships. Under-graduate and graduate student week-long visit to CIMMYT, the international maize and wheat breeding center in Mexico. Videos on plant breeding, posted at www.wisconsinplantbreeding.com and can be downloaded by Podcast.	Three summer interns were trained. Five under-graduate and three graduate students traveled to CIMMYT. Six videos were completed and available for download.	Students exposed to plant breeding in field and lab. Students acquired international experience. Three videos show potential students about contribution of breeders and their professional satisfaction. Three technical videos demonstrate controlled crosses of corn, switch grass, pepper; and videos in progress on peas, alfalfa, lilies, fruit trees, carrots, beets, orchids, roses, cucumber, squash, potato, tomato, wheat, barley, oats.	New varieties of corn for farmers to grow and market will be developed through the research portion of this project. Increase in students to the discipline of plant breeding. Increased public awareness about plant breeding among the general public.	Economic growth likely to result from increases in corn varieties. Strengthened science work force for the future, specifically in plant breeding.

Assumptions:	External Factors:
High-resolution genetic mapping will identify the putative se1 gene. Sequence and identity of the gene can be confirmed using transgenic and genetic approaches. Gene function can be characterized using appropriate biochemical and molecular approaches. Podcast videos will increase understanding of plant breeding.	Opportunities for targeted community education activities may have external factors that influence availability and success. The response of prospective students and the public to an agriculture-related topic may negatively impact the number of students trained and the public's interest in the videos.

Plant Genetic Resource Conservation and Utilization (W-6)
Hatch funds to Washington State University CRIS accession no 0014583 in collaboration with ARS

Genetic resource acquisition, preservation and evaluation is important to the long-term success of U.S. agriculture, to provide genes to improve crops. W-6 is responsible for resources of cool-season food and forage legumes, turf and forage grass, vegetables, ornamentals and medicinal plants (80,074 accessions including 797 genera, 3,642 species and 3,970 taxa).

Key Outputs

- Receipt of 1,136 new accessions from Russia, Germany and Australia.
- Updated the internationally-used Genetic Resources Information Network (GRIN) database with new characterization data (30,194 data points) for 21 crop species.
- Distributed a record high number of seed packets to 730 requestors, including 17,433 (61%) packets within the U.S. and 11,159 (39%) packets internationally.
- Identified and released germplasm lines with special traits for research and breeding:
  - Three new pea lines with improved agronomic traits and high levels of resistance to Fusarium root rot for new cultivar development, and
  - Three winter-hardy safflower lines for developing an alternative broadleaf crop to rotate with wheat in dry areas.
- 18 publications.

Outcomes

- Information in GRIN has been used to identify germplasm used in breeding and other research.
- Breeders and other researchers have access to and are able to use: (1) new accessions from collaborating countries, and (2) characterized and selected germplasm lines in peas and safflower.
  Farmers are able to grow crops that have lower production costs, more reliable productivity, and improve soil and plant health in rotations.

KA 202: Plant Genetic Resource Management, Preservation, Characterization and Utilization (W-6) Logic Model

Participants: Washington State U., with U. Arizona, UC Davis, U Idaho, Montana State U., New Mexico State U., North Carolina S. U.

Dollars Invested: Not available

Situation	Activities	Outputs		Outcomes		
		Product	Metric	Change in Knowledge	Change in Actions	Change in Conditions
Genetic resource acquisition, preservation and evaluation are important to the long-term success of US agriculture, to provide genes to improve crops and respond to future challenges and opportunities. In addition to Western States, the project fills needs nationwide, such as for lentil farmers in North Dakota, beans in Michigan, and forage and turf grasses throughout the Midwest and Atlantic states.	Acquisition, exchange, preservation and evaluation of cool-season food and forage legumes, turf and forage grass, vegetables, ornamentals and medicinal plants. Maintain crop data in the internationally-used Genetic Resources Information Network (GRIN) database. Distribute seed packets to requestors, including within the U.S. and packets internationally. Identify and release germplasm lines.	Accessions acquired, conserved and curated. New data in GRIN. Seed packets sent to requestors. Characterized and selected germplasm lines with special traits for research and breeding.	80,074 accessions including 797 genera, 3,642 species and 3,970 taxa. 1,136 new accessions from Russia, Germany and Australia. 30,194 new GRIN data points characterizing 21 crop species. Record high number of seed packets distributed: 17,433 (61%) packets within the U.S. and 11,159 (39%) packets to other countries. Three germplasm lines of pea (agronomic traits and *Fusarium* resistance). Three germplasm lines of safflower (alternative rotation crop for dry land wheat).	Information in GRIN used to identify germplasm for use in breeding and other research.	Breeders and other researchers have access to and are able to use: (1) new accessions from collaborating countries, and (2) characterized and selected germplasm lines in peas and safflower.	Farmers are able to grow crops that have lower production costs, more reliable productivity, and improve soil and plant health in rotations.

Assumptions:	External Factors:
Accessions in the collection have traits of value to human uses of plants. Methods and tools are available to make crosses with the accessions and to identify desirable parents and progeny.	Plant breeding programs exist to use the germplasm resources to serve agriculture in western and other states and internationally, and without them, this work would not be as productive. Demand for crop variety development and distribution are other external factors important to this project.

Knowledge Area 203: Plant Biological Efficiency and Abiotic Stresses Affecting Plants

KA 203 Introduction

The **short term goal** of this KA is to identify and/or characterize genes, proteins, processes, and/or networks that contribute to abiotic stress tolerance for water stress, carbon dioxide/ozone stress, temperature stress, and nutrient stress. The **long term goal** is to develop, through biotechnology and/or breeding, new plant lines or populations for improved stress resistance or tolerance in agricultural plants. The **priorities** of this KA are to transfer knowledge gained about abiotic environmental stress from model plant species such as Arabidopsis to agricultural plants, and to create crop models for stress biology research. **Public benefits** of this KA include providing the basic knowledge to devise new or improved strategies for decreasing the impact of environmental stress and climate change on agricultural and forest productivity and sustainability. Research supported by this KA will also make possible economically and environmentally sustainable plant production for affordable, high quality food, feed, and fiber and to meet increasing demands for bioenergy and biobased products. This **KA contributes to the agency** Strategic Goal of enhancing international competitiveness of American agriculture, and specifically the objective of providing research, education, and extension to increase the efficiency of agricultural production and marketing systems.

We believe that the KA is **moving in the right direction** in that more and more plant biologists are using crop and forest species in their research on plant responses to abiotic environmental stress, and agricultural research has benefitted from the infusion of knowledge gained from model species where a lot of progress has been made recently. This KA could benefit from additional resources as funding rates have been lower than 20% in recent years.

This Knowledge Area **contributes to mission and goals of the portfolio in the following ways:** The mission of the Plant Systems Portfolio is to support high quality, innovative, and relevant research, extension and educational programs in partnership with universities, the private sector and other Federal agencies to promote sustainable and globally competitive plant agriculture that produces superior and safe products. KA 203 contributes to this mission by supporting high quality, innovative, and relevant research. Areas of work supported through this knowledge area include but are not limited to: the identification and/or characterization of genes, proteins, processes, and/or networks that contribute to abiotic stress tolerance for water stress (including drought stress, salt stress and flooding stress), carbon dioxide/ozone stress, temperature stress, and nutrient stress.

KA 203 Key Activities

1. Generate fundamental knowledge through laboratory and/or field studies regarding the mechanisms of plant cell abiotic stress response, including identification and/or characterization of genes, proteins, processes, and/or networks involved in tolerance of water stress (including drought, salt and flooding stresses), carbon dioxide/ozone stress, temperature stress and nutrient stress.
2. Use fundamental knowledge from cell to field level to develop approaches and tools to aid agricultural plant productivity in response to reduced inputs or increased environmental stresses.
3. Develop, through biotechnology and/or breeding, new plant lines or populations for improved stress resistance or tolerance in agricultural plants.

KA 203 Outputs and Outcomes

Drought Tolerance Resulting From Exploitation of Hydraulic Variability of Slow-Wilting Genotypes

NRI Competitive Grant CRIS accession no.0207464

This research looks at ways to minimize the impact of drought on soybeans by selecting varieties that are more water conserving. The mechanism found in slow wilting varieties was due to leaf stomatal closing in response to special leaf hydraulic properties when air humidity is low. Identification of basic mechanism of this process will give an understanding of when and where the slow witling trait would contribute to drought tolerance and yield increase.

Key Outputs

- 1 publication.
- Training for 2 postdoctoral scientists.
- Industry interest in water stress resistant cultivars.

Outcomes

- Development of soybean cultivars that have greater productivity under water limited conditions.
- Understanding of mechanism resulting in the slow wilting characteristic.
- Development of techniques in soybean breeding to incorporate the slow witling trait into commercial cultivars.

KA 203: Drought Tolerance Resulting From Exploitation of Hydraulic Variability of Slow-Wilting Genotypes Logic Model

Participants: Academic researchers at the University of Florida

Dollars Invested: $399,316 from NRI Competitive Programs

Situation	Activities	Outputs		Outcomes		
		Product	Metric	Change in Knowledge	Change in Actions	Change in Conditions
Drought is by far the major limitation of crop yield. If plants lose less water while there is still moisture in the soil, water will be conserved when drought develops. Some of these slow-wilting lines of soybean have been developed from a breeding program, and can be used to gain insights into how the trait can contribute to drought tolerance and yield increase	Investigate various leaf characteristics that might account for conservative stomatal behavior exhibited by a slow-wilting variety. Discover the physiological basis for the conservative stomatal behavior. Characterize hydraulic properties of the slow-wilting phenotype in different soybean lines.	Field work showed that substantial temperature variation exists across the surface of single leaves. Greenhouse work has determined variation within near isogenic lines for the response of transpiration rate to vapor pressure deficit. Laboratory studies have been initiated to develop techniques to measure the possible contribution of leaf anatomical characteristics and leaf aquaporin to differences in leaf hydraulic conductance.	One paper has been published in Physiologia Plantarum. Two postdoctoral scientists have been trained.	Better understanding of the mechanism resulting in the slow-wilting characteristics.	Development of soybean cultivars that have greater productivity under water limited conditions and use of plant breeding techniques to incorporate the slow-wilting trait into commercial cultivars.	The ability to improve plant drought tolerance can be used to increase crop yield on marginal lands, thus enhancing economic opportunities for agricultural producers.

Assumptions:	External Factors:
Basic understanding in plant leaf characteristics and hydraulic properties can be used to improve the plant's ability to tolerate drought conditions.	Research funding fluctuates in a zero-sum game with competing national priorities. Changing program priorities. Climate changes due to global warming.

Characterizing Function of Multiple Phospholipase DS in Plant Production and Quality
NRI Competitive Grant CRIS accession no. 0211226

Water and nutrient status are the two most critical factors that limit crop productivity. Recent studies in model plant Arabidopsis indicate that membrane lipid hydrolysis by phospholipase D (PLD) is involved in plant water loss, nutrition status, and seed quality and production. Little is known about the role of the membrane hydrolysis process in crop plants. The goal of this project is to characterize specific PLDs that may impact soybean productivity. Emphasis is on specific functions of soybean nitrogen response, water usage efficiency, and seed quality.

Results from this research have determined the effect of knockout and over expression of PLDs in plant response to hyperosmotic stress and nitrogen availability and cloned the full length cDNAs of GmPLDa1 and GmPLDe from soybean and expressed GmPLDe protein in E. coli. Several transgene constructs have been developed and proceeding to transform the constructs into soybean cultivars.

Key Outputs

- Filing for patent for the technology used to manipulate specific PLD to enhance plant growth and nitrogen response.
- Training of 1 high school student, 2 graduate students, and 3 postdoctoral researchers.
- 3 publications and multiple conference presentations.

Outcomes

- Improvement of plant production will enhance economic opportunities for agricultural producers.
- Development cultivars will reduce water and nitrogen fertilizer usage.
- Creations of multi-institutional research collaborative between three institutions.

KA 203: Characterizing Function of Multiple Phospholipase DS in Plant Production and Quality Logic Model

Participants: Academic researchers at the University of Missouri, St. Louis **Dollars Invested:** $400,000 from NRI Competitive Programs

Situation	Activities	Outputs		Outcomes		
		Product	Metric	Change in Knowledge	Change in Actions	Change in Conditions
Water and nutrient status are the two most critical factors that limit crop productivity. Recent studies in model plant Arabidopsis indicate that membrane lipid hydrolysis by phospholipase D (PLD) is involved in plant water loss and nutrition status. Little is known about the role of the membrane hydrolysis process in crop plants. The goal of this project is to characterize specific PLDs that may impact soybean productivity, with emphasis is on specific functions of soybean nitrogen response, water usage efficiency, and seed quality.	Analyze enzymatic properties and regulation of the soybean phospholipase D by expressing the soybean enzyme in E. coli, Determine the role of the soybean enzyme in response to nitrogen availability. Determine the role of the enzyme in seed oil content, stability and seed quality. Investigate the enzymes' function in guard cells to determine its effect on water use.	Determined the effect of knockout and over-expression of PLDs in plant responses to osmotic stress and N availability Cloned the full length cDNAs for two soybean PLDs and expressed one of them in E. coli. Made several transgene constructs under the control of different promoters and obtained transgenic soybean lines for some of the constructs.	A patent has been filed that detailed the technology of manipulating specific PLD to enhance plant growth and N response. Two graduate students and 3 postdocs have been trained. One high school student gained training in plant biology and biochemistry. Three papers were published in Plant Cell, Molecular Plant, and J Biol. Chem.	Better understanding of how PLDs mediate plant responses to osmotic stress, and how increased PLD expression and associated changes promote root growth, flowering and stress avoidance.	Development of cultivars that will reduce water and nitrogen fertilizer usage.	The ability to improve plant stress tolerance and nitrogen use efficiency has the potential to increase crop yield and enhance economic opportunities for agricultural producers. The reduction of water and fertilizer usage will protect and enhance the nation's natural resources and environment.

Assumptions: Basic understanding in plant leaf characteristics and hydraulic properties can be used to improve the plant's ability to tolerate drought conditions.	**External Factors:** Research funding fluctuates in a zero-sum game with competing national priorities. Changing program priorities. Climate changes due to global warming.

Cellular Mechanisms for Rapid Adjustment of ABA Levels and Its Application to Develop Drought-Tolerant Crops

NRI Competitive Grant CRIS accession no. 0210658

Agricultural plants are irrigated in order to avoid water stress and maintain agricultural productivity under drought. This results in significant use of freshwater which is becoming scarce worldwide. This project seeks to develop agricultural plants with increased productivity and drought and salt stress tolerance using a molecular biological approach. Specifically, the project will identify molecular components involved in the homeostasis and signaling of abscisic acid (ABA), a plant hormone known to be involved in drought and salt stress.

Key Outputs

- Created knockout mutant Arabidopsis plants and generated 100,000 M2 seeds.
- Isolated rice and soybean orthologous to the Arabidopsis AtBG1 gene.
- Trained 1 postdoc, 1 undergraduate student and 1 high school intern student.
- Published one paper.

Outcomes

- Providing insights into the mechanism by which plants respond to drought conditions via the plant hormone ABA.
- Development of new approaches to produce agricultural plants with increased productivity and water stress tolerance.
- Reduction of global consumption of fresh water used in agricultural irrigation.

KA 203: Cellular Mechanisms for Rapid Adjustment of ABA Levels and Its Application to Develop Drought-Tolerant Crops Logic Model

Participants: Academic researchers at the University of Maryland **Dollars Invested:** $350,000 from NRI Competitive Programs

Situation	Activities	Outputs		Outcomes		
		Product	Metric	Change in Knowledge	Change in Actions	Change in Conditions
Water stress (drought and salt stress) is one of the major environmental problems causing severe loss in agriculture, with an average loss of $6 to 8 billion annually in the U.S. In order to avoid water stress and maintain agricultural plant productivity under drought, plants are irrigated, which accounts for significant water use. In fact, 65% of global fresh water is used in agriculture. This project seeks to develop agricultural plants with increased productivity and drought and salt stress tolerance using a molecular biological approach. Specifically, the project will identify molecular components involved in the homeostasis and signaling of abscisic acid (ABA), a plant hormone known to be involved in drought and salt stress.	Identify novel molecular components in the stress signaling network involving the AtBG1 gene. Generate rice and soybean lines expressing AtBG1 driven by three different promoters. Isolate and characterize rice and soybean AtBG1 orthologs.	Created knockout mutant Arabidopsis plants and generated 100,000 M2 seeds. Isolated rice and soybean orthologous to the Arabidopsis AtBG1 gene.	One undergraduate student, 1 postdoc, and 1 high school student have been trained. Published one article in The Arabidopsis Book.	Better insights into the mechanism by which plants respond to drought conditions via the plant hormone ABA.	Development of new approaches to produce agricultural plants with increased productivity and water stress tolerance.	Potential to reduce global consumption of fresh water used in agricultural irrigation.

Assumptions: Orthologs of the Arabidopsis atBG1 gene function the same way in rice and soybean as in Arabidopsis. Basic understanding of plant responses to stress will lead to the development of new plant varieties with improved water stress tolerance.	**External Factors:** Research funding fluctuates with competing national priorities. Changing program priorities. Global climate change. Availability of improved molecular technologies.

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 process 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. **The long term goal** for this KA is to 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.

Some of the **short and medium goals** of KA 204 include genetically improving cultivars to increase their biomass and bioactive ingredients for medicinal purposes.

Key priorities in this KA include the understanding of the relationships between chemical composition, molecular and physical structure, and end use quality and functions of bioproducts.

Public benefits from this work include the development of medicinal plants and forest products to position the U.S. in global markets and to increase producers and ranchers' income from sustainable management of goods and services from working lands.

This KA contributes to the overarching goals of the agency by supporting the development and maintenance of technologies to help producers engage in sustainable agricultural production systems.

KA 204 Outputs and Outcomes

Developing Medicinally Used Echinacea Cultivars by Intra- and Interspecific Hybridization

SBIR funds to Gaia Herbs, Inc (NC) CRIS accession no. 0204092

Cultivation of Echinacea has gained worldwide interest in recent years due to its non-specific immunomodulatory activity in humans. However, Echinacea species have not been genetically improved for medicinal use. This project is to develop genetically improved Echinacea cultivars for medicinal use. The new cultivars will produce higher yield of biomass and bioactive phytochemicals than the types currently cultivated.

Key Outputs

- The results indicate that interspecific hybridization can significantly increase (more than 200%) the biomarker alkamides in Echinacea.
- Two peer-reviewed publications were generated.

Outcomes

- Improved phytochemical yield in Echninacea.
- Commercialization of the research results could make significant contribution to Echinacea final products by providing the industry with high quality raw plant materials.

Wood and Fiber Quality of Juvenile Pine: Characterization and Utilization
Other grant funds to NCSU CRIS accession no. 0190841

There is a great need for rapidly growing short rotation juvenile loblolly pine with greatly improved wood properties. This project targeted this goal by integrating research on wood properties, tree breeding, propagation and genomics. The Southern U.S. is losing its position as the world's major supplier of industrial wood. To meet future demands and remain competitive, more wood will have to be produced on less land. The use of intensive plantation forestry on less land creates greater opportunities for habitat conservation and recreational use of natural forests. The specific research objectives were to: determine the genetic variation in juvenile wood properties across an entire breeding population of loblolly pine, understand the molecular and biochemical basis for variation in wood properties using microarray analysis and metabolic profiling, and develop efficient methods for assaying and predicting variation in wood properties, and learn how to deploy variation for wood properties in pine plantations.

Key Outputs

- Studies on loblolly pines from across the planted range showed good potential for selecting parents whose offspring have improved wood density and microfibril angle.
- Eleven papers were published.
- Five graduate students have completed their degrees on this project and numerous undergraduate students have been employed, enriching their educational experience.

Outcomes

- A fundamental understanding of the complex pathways controlling wood characteristics using microarray analysis of gene expression and metabolic profiling has been gained.
- These and other techniques were utilized to understand the formation of compression wood, a major defect-type in juvenile wood.
- The research results from this project have been transmitted to numerous industry and state agency partners in a number of technology transfer meetings and conferences.
- The information gained has been or is being published to allow forest practitioners to grow better wood on their forest plantations.
- New methods for rapid, non-destructive assessment of small wood samples were developed to facilitate the large-scale screening necessary for genetic improvement programs.
- Field tests using clones and families demonstrated how trees selected specifically for their wood properties could be deployed in plantations to increase the quality of wood produced.
- These advances will facilitate the genetic improvement in wood properties of future plantations.

Quantitating and Manipulating Seed Metabolic Networks
NRI Competitive Grant funds to Michigan State University CRIS accession no. 0194544

The biosynthesis of oil in plant seeds is an economically important but imperfectly understood process. The purpose of this study was to answer key questions about how oil is made in canola seeds. These questions concern the flow of energy and carbon into oil during seed development.

Key Outputs

- The findings are described in four published peer reviewed research articles and two peer-reviewed review articles.
- Insights shared with the wider community through two review articles and presentations at national and international talks.

Outcomes

- A better understanding of the oil synthesis in canola has been gained.
- Findings expanded the understanding of plant metabolic flux analysis.
- This has large potential impacts on value added agricultural production.
- A new collaboration has formed with a major ag-biotech company that wants to use these methods for improved oil yield in U.S. crops.
- New expertise in analyzing and understanding metabolic fluxes through the network of central metabolism in plants developed.
- Two of the researchers working on this project have gone on to leadership research positions in industry and a DOE national laboratory where they conduct research using the tools developed in this work.

Knowledge Area 205: Plant Production Management Systems

KA 205 Introduction

Knowledge Area 205 relates to research, education, 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.

NIFA-sponsored programs in this Knowledge Area **benefits the public** by providing science-based information, knowledge, and learning to enhance the competitiveness and sustainability of rural and farm economies and to protect and enhance the Nation's natural resource base and environment.

Whereas KA 205 has traditionally focused on agronomic and horticultural crops and systems, bioenergy crops and production systems are now included. It is anticipated that this new focus will add new energy-driven crops to the Nation's agricultural portfolio, for which research and extension knowledge is limited, and will create challenges for how we managed traditional crops where cellulosic waste streams now have value in the marketplace. While plant production systems are only a small piece of this new agriculture-based bioenergy enterprise, their success is very dependent on downstream infrastructure and technologies and is limited by economic realities.

In combination with capabilities in other Knowledge Areas that are integral to crop production (e.g., biotic and abiotic stressors, genetic resources, breeding programs, engineered systems, economic analyses, and technological change) the **key priority** for Knowledge Area 205 is to create a sustainable system of production where biological efficiency and capacity are synchronized with the physical environment and its resources that remain compatible with social and economic needs. Where agency activities thoughtfully consider the full spectrum of crop production (beyond KA 205), NIFA is making significant strides toward this goal, and **heading in the right direction**. Where programmatic activities are segmented, diluted, and disjoint, progress is necessarily less noticeable. KA 205, Plant Production Management Systems **contributes to the agency** by providing the nexus where knowledge and outreach from many different NIFA activities are brought to bear in the generation of food, fiber, feed, and fuel.

Across human history, agriculture has generated one of the largest ecological and environmental footprints on the planet. Through the implementation of **short-term goals** of improving plant and cropping efficiency, reducing energy use, applying chemicals smarter, using water resources more wisely, and culturing new plant materials, KA 205 can achieve its **long-term goal** of helping to reduce the depth and extent of agriculture's footprint in the long term. More immediately, it can produce demonstrable improvements in soil and water quality, agricultural productivity, and economic viability for rural enterprises.

KA 205 Plant Management Systems Logic Model

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 - NIFA 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 for 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 NIFA Research findings disseminated Publications Citations Disclosures Patents Best management practices Curricula designed Undergraduate and graduate students graduate Training provided to producers	Increased knowledge about precision application of chemicals, fertilizers, and water. Increased knowledge about alternative cropping systems for agronomic and horticultural crops. Increased knowledge about concepts of sustainability and sustainable production practices. Increased knowledge about organic production practices.	Growers are adopting precision agriculture and variable-rate application technologies. The horticultural industry has invested heavily in high-tunnel production systems to extend growing seasons and improve product quality. Numerous industries and regions are exploring the development of certification programs for sustainable production systems.	Over-spray is reduced, fertilizer applications are precisely delivered in time and space for maximum effect, and agricultural water use is reduced. Smaller producers and rural enterprises are increasing revenues, and consumers have access to locally grown horticultural crops. More local and regional food production is expanding our food system diversity. The availability of organic products in supermarkets has increased dramatically.

Assumptions - This KA integrates knowledge from KAs 203, 204, & 206; 101-104 (Soil); 111-112 (Water); & the 400 series (Engineering & Support Systems). NIFA accomplishes work on plant biological efficiency by collaborating with partner organizations & agencies. NIFA 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 NIFA; level & flexibility of funding; interest & ability of private sector in partnering; success of partners' management of research, education, & extension programs.

KA 205 Outputs and Outcomes

Small Fruit Production Systems
Hatch project CRIS accession no. 0193369

There is a need to increase the production efficiency and fruit quality of small fruit crops through development of improved cultural practices, particularly strawberries and brambles. Target audiences are strawberry, blackberry, and raspberry growers in the Mid-Atlantic region.

Key Outputs

- Blackberry Certification Standards were developed for North Carolina.
- No effect on marketable strawberry yield was found among three different composts. However, the composition of the composts was significantly different and their ability to alter soil properties (nutrient levels, pH, CEC and organic matter) was demonstrated.
- Two budgets were developed to aid new growers in determining costs of establishing and running a blackberry operation.

Outcomes

- A new blackberry industry has been created in North Carolina, with a four-fold increase in acreage under production.
- An increasing number of strawberry growers are using alternative fumigation chemicals, rather than methyl bromide.
- Many of the organic growers are using or trialing biologically based alternatives, e.g., cover crops or composts.

Establishing a Viable Organic Goldenseal Production System for Small Family Farms
Small Business Project CRIS accession no. 0196961

Many small, limited resource farms are only marginally profitable and their owners are seeking ways of increasing farm income and financial stability through diversification. Goldenseal (Hydrastis canadensis) is a popular shade loving medicinal herb that is primarily wild-collected and has become endangered or threatened in many areas. By developing a viable organic production system for cultivated goldenseal, this project addresses both these problems.

Key Outputs

- Established a reliable seed handling protocol for goldenseal that yields a 35% rate of germination over a maximum of two growing seasons.
- Optimal harvest times and soil pH were determined for maximum alkaloid content.
- Several workshops were held (>500 total attendance) to present goldenseal culturing methods and business practices to potential growers.

Outcomes

- The network of growers developed and trained through this project planted a total of 10 acres of goldenseal over four years, the last seven acres planted after the grant period ended.
- The new goldenseal plantings effectively doubled the amount of certified organic goldenseal in the U.S. with total current plantings through 2008 amounting to approximately 20% of all currently cultivated goldenseal.
- Cultivated goldenseal plantations established on small farms have increased farm income and relieved over-collection pressure on wild populations.
- Led to formation of goldenseal growers cooperative, which now includes a processing component, wherein member growers receive 83 cents on each dollar marketed and sold.

High Tunnels for the Central Great Plains: Profitable, Season-Extending, Horticultural Production Systems

IFAFS project CRIS accession no. 0190078

Responding to growing interest by horticultural producers in the central Great Plains, this project critically assessed the potential for high tunnels (unheated plastic greenhouse structures) to reliably provide a protected environment for the profitable production of a range of high value fruit, vegetable and flower crops. High tunnels provide growers improved farm income and reduce production. Consumers benefit through having access to an extended season of high quality, locally-grown produce.

Key Outputs

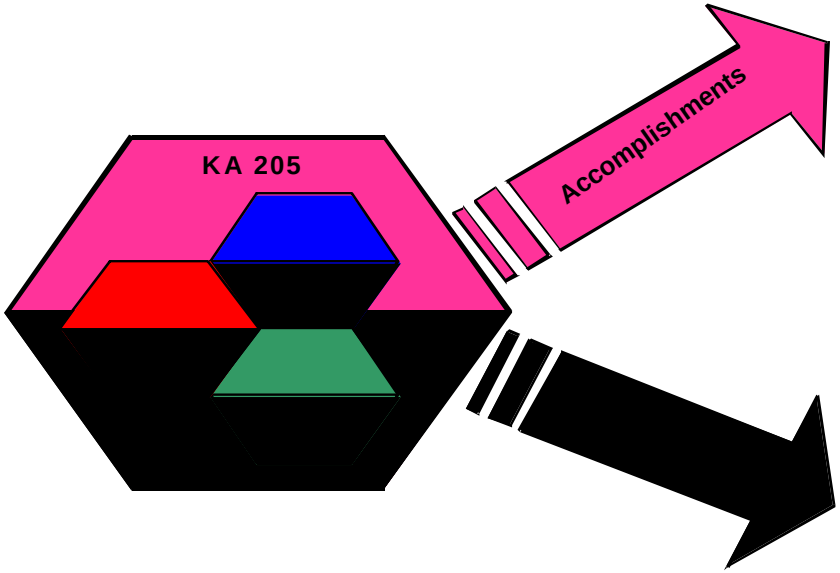
- Production in tunnels produced superior yields and quality in most trials.
- Information on high tunnels was extended to hundreds of growers and prospective growers through multiple efforts over the course of the project. Annual high tunnels workshops have become a regular feature of the program at the Great Plains Vegetable Conference in St Joseph, MO, and attracted about 100 participants each year from 2003 through 2006. Multiple field days and construction workshops held on-station and on-farm in Missouri, Kansas and Nebraska were attended by several hundred participants over the course of the project.
- An educational/extension website (www.hightunnels.org) was developed under the project, and serves as a valuable resource. Associated with the website a listserv (hightunnels@mailserv.ksu.edu) serves an expanding national and global audience of growers and industry experts. Multiple extension bulletins and reports, particularly from work conducted at the University of Missouri, are now posted on the site.

Outcomes

- While prior to 2002, there were approx. 25 high tunnels in the U.S., there are now several thousand such structures.
- The KSU listserver membership includes many hundreds of growers, allied industry partners, and academics that regularly share information.
- In most states, high tunnels are being used by relatively small-scale producers to serve local markets, primarily providing tomatoes, leafy greens, and cut flowers.
- High tunnel research and extension is now conducted in nearly every state.

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 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

The **short term goal** of this KA is to produce fundamental knowledge of the biological processes of agricultural plants (including forest species) from the molecular to the systems level. The **long term goal** is to allow scientists to make use of such fundamental understanding of plant biology, coupled with the increasing wealth of genomics data and tools, to develop new varieties of agricultural plants through biotechnology and plant breeding approaches.

The **priorities** of this KA are to transfer knowledge gained from model plant species such as Arabidopsis to agricultural plants, and to create crop models for biological research.

The **public benefits** contributed by this KA include science-based knowledge that 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 and producers in the ever more competitive global market.

This KA **contributes to the agency by** addressing CSREES Strategic Goal of enhancing international competitiveness of American agriculture, and specifically the objective of providing research, education, and extension to increase the efficiency of agricultural production and marketing systems.

We believe that the KA is **moving in the right direction** in that more and more plant biologists are using crop and forest species in their research of basic plant processes, and agricultural research has benefitted from the infusion of knowledge gained from model species where a lot of progress has been made recently.

NIFA as a whole is a mission-oriented agency and most of its programs can be categorized as applied. The Basic Plant Biology Knowledge Area represents a relatively small portfolio within the agency and therefore does not have a lot of resources. Success rates of the NRI basic plant biology programs have been below 15% in recent years. Some of these resources have recently been reallocated from a research program to an integrated program under another KA. KA 206 **could benefit from additional resources.**

The mission of the Plant Systems Portfolio is to support high quality, innovative, and relevant research, extension and educational programs in partnership with universities, the private sector and other Federal agencies to promote sustainable and globally competitive plant agriculture that produces superior and safe products. KA 206 **contributes to this mission** by supporting high quality, innovative, and relevant basic plant biology research. 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 Basic Plant Biology Logic Model

Situation	Inputs	Activities	Outputs	Outcomes		
				Knowledge	Actions	Conditions
Future advances in agriculture will require advanced understanding of the processes and mechanisms underlying plant growth, adaptation, and quality. A great deal of information has been generated through genomic studies. A lot of new knowledge has also been gained from studies of model organisms. This wealth of information could potentially be used effectively to improve agricultural plants.	**Funding Sources:** - Federal - State - Commodity groups - Industry - Other sources **Human Capital**: - NIFA NPLs - Administrative support - Researchers - Graduate students - Postdocs - Stakeholders	Elucidation of plant genetic, developmental and biochemical pathways. Analysis of plant growth regulation. Study of the regulation of plant gene expression. Study of metabolism, cell wall structure, photosynthesis and nitrogen fixation. Development of methods for identifying function of agriculturally important genes and gene products.	Research findings disseminated through publications, presentations, posters, citations, and patents, and used by scientists and educators. Findings used to develop best management practices. Curricula developed. Undergraduate and graduate students trained. Postdoctoral researchers trained. Training provided to producers.	Better understanding of gene regulation mechanisms. Increased knowledge of genes and biochemical pathways conferring resistance to plant diseases and pests. Increased understanding of the modes of action of plant hormones and signal transduction mechanisms. Better understanding of biochemical pathways important for nitrogen fixation, photosynthesis and respiration. Increased understanding of cellular structures and processes.	Crop models (e.g., tomato, rice, alfalfa) are being developed for the study of basic plant biology and knowledge gained from model organisms is being transferred to agricultural species. Knowledge on disease resistance has been used in breeding programs and can be used to develop anti-pathogen compounds. Knowledge on plant physiology has helped Master Gardener programs design proper growing techniques. Knowledge on metabolism has helped farmers reduce the use of fertilizers and therefore the contamination of ground water.	Detailed understanding of basic biological processes of agricultural plants can result in better use of agriculturally important genes to improve crop performance, production, quality and add value to the products which can enhance the economic opportunities for agricultural producers via increased marketability of high end products.

Assumptions – Increased knowledge on basic plant biological processes can be used to manipulate genetic and biochemical pathways of plants and used in breeding programs to produce plants with improved traits.	**External Factors** - Decrease in funding, changing program priorities, natural disasters, and economic conditions. Funding will determine the availability of capable scientists and graduate students.

KA 206 Key Activities

1. Functional analyses of agricultural important genes such as those involved in primary and secondary metabolism, development, and disease resistance.
2. Studies on the mechanisms of gene regulation.
3. Elucidation of the modes of action of plant hormones and how they interact with each other.
4. Studies on signal transduction mechanisms, and “cross talk” between different signaling pathways.
5. Characterization of cellular structures and processes that are crucial for plant growth and development.
6. Studies on photosynthesis, respiration, and nitrogen fixation.

KA 206 Outputs and Outcomes

Quinone Dependent Electron and Proton Transfers in Bacterial Reaction Centers
NRI Competitive Grant to City College of CUNY CRIS accession no. 0191681

Photosynthesis occurs in plants, algae, and many species of bacteria. It is a series of chemical reactions that converts carbon dioxide and water into organic compounds and oxygen using the energy from sunlight. Some of the energy in photosynthesis is used to remove electrons from water which are then used to turn carbon dioxide into organic compounds. The terminal electron acceptors in these reactions are a family of chemicals called quinones.

The researchers characterized conformational intermediate states in photosynthetic bacteria by freezing photosynthetic reaction center (RC) proteins in the presence and absence of light. RCs frozen in the dark do not allow electron transfer between reduced primary and secondary quinones. RCs frozen under illumination are trapped in a conformation that allows electron transfer and reduced product formation. The authors show that, depending on the freezing procedure, RCs can be trapped in active or inactive conformations that can significantly affect electron transfer between primary and secondary quinone electron acceptors. The authors discuss implications for protein dynamics and charge separation in biological electron transfer pathways.

Key Outputs

- Researchers successfully trapped photon-induced photosynthetic reaction intermediates.
- Researchers measured the electron transfer rates between quinones and bacteriochlorophylls at cryogenic temperatures.
- Researchers demonstrated that small structural changes can transform photosynthetic reactions centers from active to inactive conformations.

Outcomes

- Scientists better understand the protein dynamics of charge separation/recombination and electron transfer in photosynthesis.
- A scientific publication describing the results of this project was cited by other publications 45 times between 2002 and 2009.

KA 206: Photosynthetic Quinone Dependent Electron/Proton Transfer Logic Model

Participants: Academic researchers at City College of New York

Dollars Invested: $110,000

Situation	Activities	Outputs		Outcomes		
		Product	Metric	Change in Knowledge	Change in Actions	Change in Conditions
Photosynthesis is a key process for life on earth in which plants, algae, and bacteria use the energy of sunlight to convert water and carbon dioxide to organic compounds and oxygen. In photosynthesis, electrons are removed from water and then used to convert carbon dioxide to organic compounds through terminal electron acceptors called quinones.	Custom quinone synthesis and site-directed mutation were used to enhance electron transfer between quinones. Photosynthetic reaction intermediates were frozen under dark and light conditions. Optical transients associated with electron transfer reactions were measured.	Researchers successfully trapped photon-induced photosynthetic reaction intermediates. Researchers measured electron transfer rates between quinones and bacteriochlorophylls at cryogenic temperatures. Researchers demonstrated that small structural changes can transform reaction intermediates from active to inactive conformations.	A scientific publication describing the results of this project was cited by other publications 45 times between 2002 and 2009.	Scientists better understand protein dynamics of charge separation/recombination and electron transfer in photosynthesis.	Increased knowledge of photosynthesis makes possible the manipulation of protein structure-related bottlenecks and rate limiting steps in photosynthesis.	Increased knowledge of photosynthesis could lead to improvements in agricultural and energy production.

Assumptions: Photosynthesis is a key process for life on earth. Advances in understanding photosynthesis may facilitate improvements in agricultural and bioenergy production.	**External Factors:** Research funding fluctuates in a zero-sum game with competing national priorities.

Developmental Regulation of Gibberellin Biosynthetic Genes in Arabidopsis
NRI Competitive Grant to Duke University CRIS accession no. 0195706

The plant hormone gibberellin (GA) has long been known to modulate development throughout the plant life cycle. The final step in the biosynthesis of gibberellin is catalyzed by an enzyme called gibberellin 3-oxidase (GA3ox). In Arabidopsis, this enzyme is encoded by four homologous genes. This project is directed toward study of the expression pattern of these genes over the course of plant development. To determine the physiological role of each *GA3ox* gene, the project analyzes the effect of mutations in one or multiple *GA3ox* genes on plant growth.

Key Outputs

- Researchers identified the upstream regulators of GA biosynthesis.
- Project elucidated the function of GA cell signaling components.
- Researchers isolated downstream targets of transcriptional regulation.
- Project elucidated initial regulatory interactions between GA and other plant hormones at the molecular level.

Outcomes

- Scientists better understand where and when GA is synthesized during plant development and this knowledge will facilitate crop improvement by manipulating GA levels in specific plant tissues.
- A scientific publication describing the results of this project was cited by other publications 78 times between 2005 and 2009.

KA 206: Regulation of Gibberellin Logic Model

Participants: Academic researchers at Duke University **Dollars Invested:** $225,000

Situation	Activities	Outputs		Outcomes		
		Product	Metric	Change in Knowledge	Change in Actions	Change in Conditions
The plant hormone gibberellin has long been known to modulate development throughout the plant life cycle. This project is directed toward study of the spatial and temporal expression pattern of four homologous genes that encode for gibberellin in Arabidopsis.	Generation of transgenic Arabidopsis plants expressing promoter and reporter genes. In-situ hybridization using gene-specific antisense RNA probes. Immunostaining using anti-gibberellin oxidase antibodies.	Identification of the upstream regulators of gibberellin biosynthesis. Isolation of down-stream targets of transcriptional regulation.	A scientific publication describing the results of this project was cited by other publications 78 times between 2005 and 2009.	Elucidation of the function of gibberellin cell signaling components. Elucidation of initial regulatory interactions between gibberellin and other plant hormones at the molecular level. Scientists better understand where and when gibberellin is synthesized during plant development.	Facilitation of crop improvement by manipulating gibberellin levels in specific plant tissues.	The ability to manipulate plant hormones such as GA will be useful in enhancing economic opportunities for agricultural producers via increased marketability of more productive crops.

Assumptions: Gibberellin is a key component of plant growth and development. Increased knowledge of the biological regulation of gibberellin in plants can help to improve agricultural crops.	**External Factors:** Research funding fluctuates in a zero-sum game with competing national priorities.

Regulation of Tip Growth in Pollen by Phospholipase C
NRI Competitive Grant to Penn State University CRIS accession no. 0195958

The control of pollination is an important aspect of both natural plant reproductive success and common practices in agricultural production. One approach to controlling pollination is to manipulate the molecular mechanisms that allow pollen grains to fertilize the target plant. This approach is limited by the currently rudimentary state of knowledge of the molecular mechanisms underlying pollen tube growth. The goal of this project was to characterize the molecular events in the control of pollen tube tip growth. Results included elucidation of two counteracting molecular pathways involved in dynamic control of growth related actin dynamics and pollen tube tip growth through a check and balance mechanism between the two pathways.

Key Outputs

- Researchers demonstrated the molecular basis of two coordinately counteracting pathways that affect pollen tube tip growth.
- One pathway promotes the assembly of apical F-actin and the other its disassembly.
- These two pathways regulate each other to control actin dynamics and tip growth in pollen tubes.

Outcomes

- This project accomplished the first demonstration of an enzymatic signaling network with two antagonistic pathways acting coordinately to control actin dynamics and pollen tube tip growth.
- This provides important new insights into the mechanisms underlying these fundamental processes in higher eukaryotic organisms.
- This knowledge may have agricultural applications in hybrid seed production or restricting the spread of genetically modified transgenes in the environment through manipulation of pollen tube growth thereby altering the fertilization efficiency of the plant.
- A scientific paper communicating these results was cited by other publications 53 times between 2005 and 2009.

KA 206: Regulation of Pollen Tube Tip Growth Logic Model

Participants: Academic researchers at Penn State University **Dollars Invested:** $220,000

Situation	Activities	Outputs		Outcomes		
		Product	Metric	Change in Knowledge	Change in Actions	Change in Conditions
The control of pollination is an important aspect of both natural plant reproductive success and common agricultural practice. One approach to controlling pollination is to manipulate the molecular mechanisms that allow pollen grains to fertilize a target plant.	Collection of Arabidopsis pollen and screening for expression of selected enzymes. Biolistic transformation of pollen for over-expression of selected enzyme. Agrobacterium-mediated transformation of Arabidopsis with selected phenotypes. Two-hybrid library screening of petunia and Arabidopsis pollen for selected interacting proteins.	Researchers demonstrated the molecular basis of two coordinately counteracting pathways that affect pollen tube tip growth. Identified 1 pathway that promotes the assembly of apical F-actin Identified the pathway of disassembly of F-actin	A scientific publication describing the results of this project was cited by other publications 53 times between 2005 and 2009.	This project accomplished the first demonstration of an enzymatic signaling network with two antagonistic pathways acting coordinately to control actin dynamics and pollen tube tip growth. This provides important new insights into the mechanisms underlying these fundamental processes in higher eukaryotic organisms.	This knowledge may have agricultural applications in: -hybrid seed production, and -restricting the spread of GM transgenes in the environment through manipulation of pollen tube growth thereby altering the fertilization efficiency of the plant.	Hybrid seed production and the ability to control the spread of GM transgenes in the environment will have a great potential in enhanced economic opportunities for agricultural producers via increased marketability of high-end products.

Assumptions: Control of pollination is an important aspect of plant development in both nature and in agricultural production. Increased knowledge of the biological regulation of pollen tube tip growth in plants can help to both improve agricultural crops and contain the spread of transgenes from GM crops into the environment.	**External Factors:** Research funding fluctuates in a zero-sum game with competing national priorities.

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).

Research, education and extension topics supported within KA 211 include **long term goals** encompassing fundamental research on biosystematics/taxonomy, population dynamics, ecology, and behavior (including the impact of climate and other abiotic factors on arthropod biology and management of pests), 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 is a component of the plant production component of the Plant Systems Portfolio (KA 202).

Mission-oriented **short and medium term goals** are addressed through 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. 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.

Key priorities for this KA include work addressing: biology, physiology, genetics, ecology and systematics of arthropods; detection and diagnosis of pest species; prevention of pests; epidemiology; economics and safety; and management of pest and beneficial species. **Public benefit** from the work conducted includes greater knowledge about the group as a whole that will lead to conservation of species, management of both pest and beneficial arthropods to ensure health, safety and well being of the public, protection of a safe, affordable and nutritious food supply and a secure and sustainable environment.

This KA contributes to overarching goals of the agency by addressing national needs to ensure a safe and affordable food system, and to protect our environment for future generations through sustainable solutions to protect the public and ecosystems, locally, regionally and globally. The current portfolio is **moving us in the right direction** to achieve these broad goals and represents an appropriate mix of basic, developmental and applied research, followed by implementation through transfer of discovery research to constituents through education and extension delivery. The **resources for this KA are balanced** through both competitive and non-competitive sources of funding.

KA 211 Plant Insects, Mites, and Other Arthropds Affecting Plants Logic Model

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 widely diverse audiences	**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	Develop and optimize pre- and post-harvest management tools for control of plum curculio in cherries. Enhance national and international plant (natural resources) and crop biosecurity through multidisciplinary and specialized graduate training on the doctoral level in plant health management. Develop and provide tools to minimize/eliminate the negative environmental effects of pesticides. Conduct studies on existing and new insecticide products for thrips and other important insect pests on vegetables. Refine traps and their deployment for apple maggot control. Train students in the multidisciplinary Plant Medicine Program at the University of Florida.	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 NIFA Research findings disseminated Publications Citations Patents Best management practices Curricula Undergraduate and graduate education Training provided to producers	Pre- and post-harvest advancements enabled reduced pesticide sprays and increased growers' confidence for meeting the zero-tolerance in product quality standards. Doctor of Plant Medicine students accumulated 120 graduate credit hours, encompassing all relevant agricultural science disciplines, including agronomy, entomology, nematology, horticulture, plant pathology, soil and water science, and related subjects. Opt-Electronic Infestation Detection provides a basis for developing rapid nondestructive automatic sorting technology for tart cherry.	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. The post-harvest research results have also created grower-level interest for developing a commercial automatic sorting technology for the purpose of eliminating pests and/or insect infested products.	Increased control efficiency for U.S. agriculture. Increased plant pest identification. Improved commodity quality. Potential human health risk from pests and the use of pest management practices are reduced. Unreasonable adverse environmental effects from pests and the use of pest management practices are reduced. The adoption of IPM practices improves economic benefits to users 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.

KA 211 Outputs and Outcomes

Development and Optimization of Pre- and Post Harvest Pest Management Strategies in Cherries: A Multi-tactic Approach
Crops at Risk Competitive Grant to Michigan State University CRIS accession no. 0201138

The Food Quality Protection Act dramatically restricted insecticide options for cherry production. Reduced risk chemistries are becoming available, but little is known about them. Orchard floor management and post-harvest technology are underutilized resources. Without effective controls the cherry industry will not maintain quality standards. This project developed and optimized pre- and post-harvest management tools for control of plum curculio in cherries.

Key Outputs

- Lab results were confirmed in field tests, showing that the sub-lethal activities of the insect growth regulator insecticides can be dependably implemented at a grower level.
- The penetrative action of neonicotinoid insecticides was further tested in the field and lab, showing that live larvae can be eliminated from cherry fruit up to two weeks post-infestation.
- Classification accuracies of 82 and 93 percent were obtained for infested and good fruits respectively by using high intensity broadband light in post-harvest spectroscopy studies.
- Pitting and agitation techniques removed up to 50 and 67 percent of the total larvae inside the cherries.
- The number of pest management tools available to cherry growers for plum curculio control has doubled. Instead of relying solely on organophosphate insecticides, cherry growers can now confidently integrate reduced-risk IGRs, neonicotinoids and oxidiazines into their IPM programs, and save up to 2-3 cover sprays per season.
- Results were disseminated to fruit growers through a series of extension meetings, including field season demonstration events as well as lecture format educational events.
- One Ph.D student and one post-doctorate research associate were first authors on four publications during the final year of the project. A total of eight publications were reported over the during the four year project.

Outcomes

- Opto-Electronic Infestation Detection provides a basis for developing rapid nondestructive automatic sorting technology for tart cherry.
- Post-harvest research results have created grower-level interest for developing a commercial automatic sorting technology for the purpose of eliminating pests and/or insect infested products from the intact products.
- These pre- and post-harvest advancements will have the effect of reducing pesticide sprays and increasing growers' confidence for meeting the prescribed zero-tolerance in product quality standards.

- Together these knowledge-based IPM tools promise to help enable the U.S. cherry industry to remain healthy and sustainable long into the Twenty First Century.

KA 211: Development and Optimization of Pre- and Post Harvest Pest Management Strategies in Cherries: A Multi-tactic Approach Logic Model

Participants: Wise, J.C.; Whalon, M.; Guyer, D.; Dolan, K.; Vander Voort, C. (Michian) **Dollars Invested:** $310,000

Situation	Activities	Outputs		Outcomes		
		Product	Metric	Change in Knowledge	Change in Actions	Change in Conditions
The Food Quality Protection Act dramatically restricted insecticides for cherry production. Reduced risk chemistries are becoming available, but little is known about them. Orchard floor management and post-harvest technology are underutilized resources. Without effective controls the cherry industry will not maintain quality standards.	Develop and optimized pre- and post – harvest management tools for control of plum curculio in cherries.	Developed and doubled the number of pest management tools available to cherry growers for plum curculio control.	Number of pesticide applications reduced; saving up to 2-3 cover sprays per season. Number of low risk pesticides adopted by growers (3 groups of pesticides)	New knowledge on sub-lethal activities of the insect growth regulator insecticides can be dependably implemented at a grower level. Opto-Electronic Infestation Detection provides a basis for developing rapid nondestructive automatic sorting technology	The post-harvest research results have created grower-level interest for developing a commercial automatic sorting technology for the purpose of eliminating pests and/or insect infested products from the intact products. Pre-and post-harvest advancements will reduce pesticide sprays and increase growers' confidence for meeting the zero-tolerance in product quality standards. Instead of relying solely on OP insecticides, cherry growers can now integrate reduced-risk IGRs, neonicotinoids and oxidiazines into IPM programs.	Together these knowledge-based IPM tools promise to help enable the U.S. cherry industry to remain healthy and sustainable long into the twenty first century.

Assumptions: Reduced risk chemistries will be available, but little is known about them. Orchard floor management and post-harvest technology are underutilized resources. Without effective controls the cherry industry will not maintain quality standards.	**External Factors:** This project is a combination of research and extension. A change in conditions depends upon growers actually adopting the options developed during the project. Use of the sorting technology depends on commercial development of the sorting equipment.

Graduate Training for Plant and Crop Biosecurity
SERD National Needs Fellowship Grant to University of Florida CRIS accession no. 0212517

This project addresses the targeted expertise shortage area of the sciences for agricultural biosecurity. Expertise is needed in the prevention, diagnosis and management of plant health problems. This project addresses the national need for practitioners able to protect the U.S. food supply and natural resources. It will provide three additional well trained plant health professionals.

Key Outputs

- Specialized graduate level instruction in plant pest risk assessment and mitigation.
- Broad based doctoral level training of students in prevention, detection, diagnosis, monitoring, and integrated management of plant health problems.
- Opportunities to apply this knowledge by working in a statewide Extension IPM program.

Outcomes

- Three fully trained graduate students will be knowledgeable in abiotic plant problems and the biology, epidemiology and management of indigenous and exotic pests of economic significance to U.S. agriculture.
- Students will be capable of serving virtually any aspect of agriculture, e.g., production, agrichemicals, consulting, etc., and will be ideally suited for careers in USDA, DHS, APHIS, or state departments of agriculture to help protect the food supply of our nation.

KA 211: Graduate Training for Plant and Crop biosecurity Logic Model (potential results)

Participants: Leppla, N. C.; Gillett, J. L.; McGovern, R.J. (Florida) **Dollars Invested:** $229,500

Situation	Activities	Outputs		Outcomes		
		Product	Metric	Change in Knowledge	Change in Actions	Change in Conditions
Currently there is an expertise shortage in the area of the area of the sciences for agricultural biosecurity. Expertise is needed in the prevention, diagnosis and management of plant health problems.	Enhance national and international plant (natural resources) and crop biosecurity through multidisplinary and specialized graduate training on the doctoral level in plant health management. Includes training in the multidisciplinary Plant Medicine Program with a Certificate in Plant Pest Risk Assessment and Management at the University of Florida.	A Certificate in Plant Pest Risk Assessment and Management at the University of Florida is an expected product. Three students will be trained who are needed immediately to fill positions in the APHIS, PPQ; DHS; Cooperative Extension; etc.	Three doctoral students will be educated as highly skilled plant health management professionals during the term of this grant.	DPM Students must accumulate 120 graduate credit hours, encompassing all relevant agricultural science disciplines, including agronomy, entomology, nematology, horticulture, plant pathology, soil and water science, and related subjects.	Students will be recruited for careers in IPM, regulatory ag., extension, education, urban horticulture, international agriculture, and many other kinds of work. NNF students receive a unique, multidisciplinary education across the plant sciences that enables them to work as practical problem solvers in agriculture.	Students will be capable of serving virtually any aspect of agriculture, e.g., production, agrichemicals, consulting, etc., and will be ideally suited for careers in USDA, DHS, or state departments of agriculture to help protect the food supply of our nation.

Assumptions: The project will enhance national and international plant and crop biosecurity through multidisciplinary graduate training on the doctoral level in plant level in plant health management. Practitioners are needed to protect the U.S. food and natural resources.	**External Factors:** This project focuses on graduate education. A change in conditions will depend upon whether the students successfully complete the degree program and successfully find employment in a career in agriculture.

Improved Systems for Management of Economically Important Arthropod Pests Attacking Pecan

Hatch Multistate Project Grant to Texas A&M University CRIS accession no. 0205131

Pecan arthropod pests are a major constraint to pecan production. Management has relied heavily upon at-risk pesticides and alternatives are needed to ensure natural enemies are not disrupted while quality and quantity of production is maintained. This project examined improved detection and monitoring of pests using pheromone-baited traps; improved trap designs; improved models for predicting pest occurrence and implementing control decisions; improved pesticide management strategies to conserve and optimize pesticide efficacy for current and research phase pesticides; and continued integration of reduced-risk pesticides into pecan pest management systems. The work also developed pest management strategies that incorporate host plant resistance, development of Biological Control Systems for Pecan Arthropod Pests through selection of superior strains of insect-pathogenic nematodes and fungi to attack pecan insect pests. Field tests to evaluate efficacy of biological control agents against pecan arthropod pests were included as is enhancement of natural enemies against pecan pests using habitat manipulation, attractants, and conservation.

Key Outputs

- A real-time decision support system for pecan nut casebearer (PNC) using internet technology interfaced with cooperators and the development/delivery of programs to stakeholders that increase adoption of the pecan nut casebearer pheromone for monitoring/decision purposes and further reduce reliance on at-risk insecticides by producers.
- Documentation of the impact of honeydew aphid complex on pecan may improve IPM decision making and may improve varietal evaluations for identification of resistant pecan cultivars in the breeding program.
- 23% reduction in use of at-risk pesticides by Texas pecan producers.
- Overall reduction in pesticide on pecan is estimated to be 192,000 kg/yr less than was used in 1980 with an annual material cost savings to producers of $4.4 million/yr in Texas.

Outcomes

- The real-time prediction of the pecan nut casebearer damage window in 2006 alerted producers to an unprecedented early damage window and conservatively averted an estimated $1 million in crop damage had treatments been delayed.
- Improved conservation of natural enemies, reduced potential for resistance, and improved sustainability of production.
- Website improvements have resulted in increased use by producers and preliminary results indicate this will translate to improved adoption of IPM.
- Further development of an *ipm*PIPE web-based interactive pecan belt-wide pecan IPM program was funded October 2008 based on the foundation work done by this project.

KA 211: Improved Systems for Management of Economically Important Arthropod Pests Attacking Pecan Logic Model

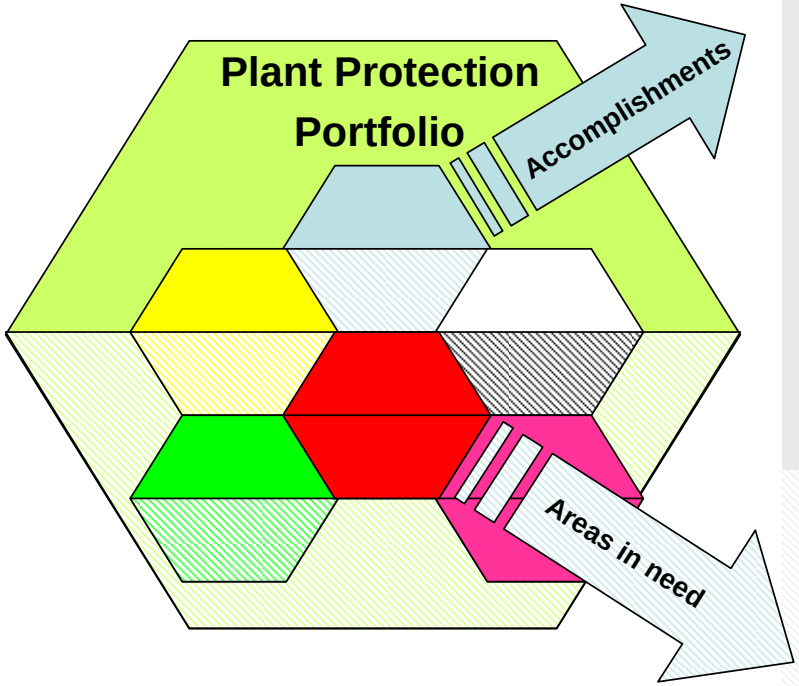
Participants: MUTISTTE PROJ NO: s-1017 (AR, FL, GA, KS, LA, OK, and TX) **Dollars Invested:** Texas Contributing Project M. K. Harris

Situation	Activities	Outputs		Outcomes		
		Product	Metric	Change in Knowledge	Change in Actions	Change in Conditions
Pecan arthropod pests are a major constraint to pecan production. Current management relies heavily upon at-risk pesticides. Alternative methods are needed to ensure natural enemies are not disrupted while quality and quantity of production is maintained.	Develop alternative methods to detect and monitor pests using pheromone-baited traps, improved trap designs, Improve models for predicting pest occurrence Implement control decisions Improve pesticide management strategies; Encourage the continued integration of reduced-risk pesticides into pecan pest management systems Development biological control systems.	A real-time decision support system for pecan nut casebearer. Documented the impact of the honeydew aphid complex on pecan	Twenty-three percent reduction in reliance on at-risk insecticides by producers in Texas. Overall reduction is estimated to be 192,000 kg/yr less than was used in 1980: an annual material cost savings to pecan producers of $4.4 million/year in Texas.	The real-time prediction of the pecan nut casebearer damage window in 2006 alerted producers to an unprecedented early damage window and conservatively averted an estimated $1 million in crop damage had treatments been delayed.	Web-site improvements have resulted in increased use by producers and preliminary results indicated this will translate to improved adoption of IPM.	The projected impact is to improve profitability of pecan production to growers while promoting environmental stewardship and providing a safe, high quality product to consumers. 23% reduction in use of at-risk pesticides by Texas pecan producers. Overall reduction in pesticide on pecan is estimated to be 192,000 kg/yr less than was used in 1980 with an annual material cost savings to producers of $4.4 million/yr in Texas.

Assumptions: Effective control strategies can be developed using new pesticides and the pest prediction model. Without effective management strategies Texas pecan growers will continue to suffer economic losses due to pecan arthropods pests.	**External Factors:** This project is a combination of research and extension. A change in conditions depends upon growers actually adopting the options developed during this project. Use of new pesticides and prediction model for management will need to be accepted by growers.

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 NIFA portfolio as plant diseases are a significant drain on the agricultural and natural resource production and financial productivity in the country. The scope of this knowledge area covers research, education, and extension concerning the health of crop, range and forest lands of the U.S. (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 and nematodes, 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. Projects in the KA 212 portfolio include expenditures primarily concentrated in large acreage and/or high value targets, viz fruits and vegetables, grain crops, tree crops (including forests), oilseed and oil crops, ornamentals and turf, potato, fiber crops, and pasture and forage. Other expenditures are on miscellaneous crops and basic subject matter areas such as microbiology and microbial ecology.

Long-term goals include development of more environmentally sustainable and more cost-effective methods of controlling plant disease and damage caused by nematodes. **Short- and medium-term goals** include development of fundamental knowledge (about mechanisms of pathogenesis and host resistance, knowledge of pathogen biology, spread and response to environmental changes), development of improved pathogen and nematode detection methods, and training the current and future workforce in subject areas relevant to KA212, and extension of knowledge gained to growers, the general public and other relevant stakeholder groups.

Key priorities include elucidation of mechanisms of pathogen and nematode colonization of the host, mechanisms of disease development, improved understanding of pathogen and nematode spread and improved methods of pathogen and nematode detection and disease mitigation.

Public benefit includes 1) improved knowledge about how plant pathogens and nematodes cause disease, 2) improved health, safety and well-being of the public as a result of the development of methods of disease control that are less harmful to the environment, and 3) improved economic prosperity for growers and other producers as a result of improved crop productivity and more cost-effective methods of disease control.

This KA contributes to the overarching goals of the agency by ensuring a safe and affordable food system and by protecting the environment through more sustainable methods of control of diseases and nematodes. The current portfolio **is moving us in the right direction** to achieve the goals of KA 212.

KA 212 Pathogens and Nematodes Affecting Plants Logic Model

Situation	Inputs	Activities	Outputs	Outcomes		
				Knowledge	Actions	Conditions
This knowledge area is a highly relevant section of the NIFA 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	Research investigating mechanisms of plant-pathogen interactions. Research methods that will reduce/eliminate the detrimental effects of pathogens on crops. 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 NIFA 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 by fungal, bacterial and viral plant pathogens. Growers who attended IPM monitoring programs indicated increased awareness and knowledge of how to control plant diseases without pesticides. Increased grower's awareness of late blight disease, proper detection and identification of plant diseases.	Growers implementing improved methods of pathogen detection. Use of the number of preventive spray applications were reduced because of early disease detection practices used.	Decreased spread of disease. Improved control of plant disease epidemics. Increased 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.

KA 212 Outputs and Outcomes

Coordinated Control of Epiphytic Fitness and Virulence of *Pseudomona syringae* by Iron and Quorum Sensing

National Research Initiative Competitive Grant CRIS accession no. 0207727

Researchers at the University of California at Berkeley have been studying the influence of iron availability on microbial communication (quorum sensing) and behavior. They have found that low iron availability on plants suppresses bacterial quorum sensing, enhances motility and prevents formation of bacterial cell aggregates that would contribute to epiphytic fitness. Invasion and infection efficiency of plants by *Pseudomonas syringae* is inversely proportional to the levels of available iron on plant surfaces. The fundamental information of the iron-dependent behavior of *Pseudomonas syringae* gained from the study should lead to practical new strategies of disease control.

Key Outputs

- 1 publication in the Proceedings of the National Academy of Sciences and a book chapter.
- Training of one undergraduate student, three graduate students and a postdoctoral scientist.
- A community resource for scientists investigating quorum sensing in plant pathogenic bacteria. Specifically, this is a dual color fluorescent biosensor for quorum sensing in plant pathogenic bacteria, which was developed and described in a 2008 PNAS paper. The strain is available for general use upon request.

Outcomes

- The work has led to a new paradigm in plant disease management that suggests that, by altering the physical environment of the plant, bacterial plant pathogens can be tricked into not expressing deleterious traits or to expressing traits that can lead to their recognition and hence defeat by the plant.

KA 212: Coordinated Control of Epiphytic Fitness and Virulence of *Pseudomonas syringae* by Iron and Quorum Sensing Logic Model

Participants: Academic researchers at the University of California, Berkeley **Dollars Invested:** $393,924

Situation	Activities	Outputs		Outcomes		
		Product	Metric	Change in Knowledge	Change in Actions	Change in Conditions
The purpose of this study is to better understand how bacteria live and interact on plant leaves in an iron and population density-dependent fashion. The study addresses how 1) bacterial cell-to-cell signaling interference (pathogen confusion) and 2) modifying iron levels on leaves can be novel means of disease and frost control.	Using whole cell biosensors, researchers examined how iron levels and quorum-sensing affects swarming motility and the ability of *Pseudomonas syringae* to invade plants of all types and cause disease in susceptible hosts.	Discovery that iron-dependent quorum sensing controls epiphytic fitness and virulence in the plant pathogenic bacterium, *Pseudomonas syringae*	One undergraduate student trained. Three graduate students trained. One postdoctoral scientist trained. One publication in PNAS and a book chapter.	A new paradigm in plant disease management that suggests that, by altering the physical environment of the plant, bacteria can be "tricked" into not expressing traits that are harmful to the plant or into expressing traits that will lead to their recognition and, hence, their defeat by the plant.	Increased knowledge of how environmental factors influence microbial behavior opens up a whole new range of potential methods of plant disease management.	Increased knowledge of how environmental factors influence microbial behavior could lead to more environmentally sustainable and cost-effective disease control options. This could result in cleaner environments and increased profitability for growers.

Assumptions: Advances in understanding how environmental factors influence microbial behavior will lead to more environmentally sustainable and less expensive methods of controlling plant diseases.	**External Factors:** The state of the national and international economy will affect the ability to bring novel disease management methods into commercial production.

The Ohio State University/Ohio Department of Agriculture Plant Diagnostic Facilities

NPDN CRIS accession no. Unknown

The state of Ohio and the Ohio State University entered into an agreement to collaborate on plant pest diagnostics that coordinates the efforts of the National Plant Diagnostic Network along with State Department of Agriculture and University resources to support the $14 billion agriculture industry of Ohio. Early detection and rapid response are critical when dealing with new pest introductions. The collocation of service and regulatory functions will serve to improve on the ability of the state and university experts to respond to invasive pests in Ohio. This combined lab will serve as the central lab for the Ohio Plant Diagnostic Network that will link plant specialists throughout the state, including digital diagnostic capabilities, and increase the surge capacity for the NPDN.

Key Outputs

- The Ohio State University NPDN lab has processed nearly 8700 samples since 2000 and nearly 2000 since January 1, 2008.
- Several select agents or high consequence pests have been among the top pests tested for or diagnosed in NPDN labs, including plum pox, sudden oak death, soybean rust, and the light brown apple moth.
- Since the inception of the NPDN, the Ohio lab has examined more than 600 samples for soybean rust.
- Pervasive diseases like soybean cyst nematode and Phytophthora stem rot of soybean are widely reported from the lab, with greater than 1/3 of the soybean cyst nematode sample in the country since January 1, 2008 reported form Ohio.

Outcomes

- Clients understand the importance of sample submission.
- Clients understand the pest dynamic.
- New partnerships have been forged.

KA 212: The Ohio State University/Ohio Department of Agriculture Plant Diagnostic Facilities Logic Model

Participants: Academic extension specialists and researchers in Ohio

Dollars Invested: Not available

Situation	Activities	Outputs		Outcomes		
		Product	Metric	Change in Knowledge	Change in Actions	Change in Conditions
Plant diseases are widespread and proper diagnosis is critical for proper management. Several diseases of high consequence warrant closer observation and reporting and other invasive pests require close collaboration with regulatory agencies to respond quickly to avoid establishment of the new organism that would be placed in an ecosystem of unbalanced parasitism and could become serious impediments to plant production.	Develop Extension fact sheets. Encourage sampling and sample submission. Train First Detectors.	Developed extension fact sheets Lab results. 600 samples for soybean rust. Face-to-face training in recognizing new pests.	brochures distributed. Number of samples. 8700 samples since 2000 and nearly 2000 since January 1, 2008. Number of high consequence samples. Lab capacity and throughput.	Clients understand the importance of sample submission. Clients understand the pest dynamic.	Partnerships are forged. Funding is leveraged with the potential of greater outcomes. Pervasive diseases like soybean cyst nematode and Phytophthora stem rot of soybean are widely reported from the lab, with greater than 1/3 of the soybean cyst nematode sample in the country since January 1, 2008 reported form Ohio.	The project is too young to report changes in condition or culture.

Assumptions: Producers want to make good management decisions. They strive for economical decisions. Diagnoses are fast, affordable and accurate. Reporting and submission of samples occurs early in an epidemic.	**External Factors:** Extension funding fluctuates with competing national priorities. Funding for monitoring and base infrastructural costs through the Food and Agriculture Defense Initiative is stable, but is not optimized.

Improvement of BIO-PCR for Routine Detection of the Watermelon Fruit Blotch Pathogen
SBIR Phase I and Phase II CRIS accession no. 0189985

Watermelon fruit blotch accounts for losses of up to 90 percent of marketable yield in some watermelon fields. The U.S. watermelon crop is worth $434 million. Each 1 percent of the crop lost to the disease accounts for an annual loss of $4.34 million. In addition, the average value of watermelon per acre of land is $3,488; if a farmer lost 90 percent of a crop to watermelon fruit blotch, the loss would be $3,139 per acre. Watermelon fruit blotch was first detected in Florida in 1989 and has since been found in eleven eastern seaboard states and westward into Indiana. It is assumed that the disease has spread so rapidly because the pathogen is seed-borne. Fruit blotch, transferred into a field by infected seeds or transplants, is first expressed as the fruit begins to develop. The disease appears as a coffee-colored stain on the rind of the fruit. The stain marks a point of weakness where the rind splits open allowing microorganisms to invade and rot the fruit.

Key Outputs

- Over the past five years, 1,925 seed lots of 10,000 watermelon or cantaloupe seeds were tested for six major melon seed producers and distributors.
- The new technology and protocol provided sufficient sensitivity and specificity to detect less than a 0.2% infection level in lots of thousands of watermelon or cantaloupe seeds and associated viability of the pathogen in the seeds.
- The new test reduces the time required to screen a seed lot by 40% from previous technologies.
- A blind test of 30 seed lots successfully and correctly detected the pathogen-infected seeds.
- The company plans to develop a PCR test kit for 10 of the most important bacterial pathogens to vegetable crops for growers and the vegetable seed industry.

Outcomes

- Easier tests are used that are able to detect the presence of the pathogen even at low levels. It is a real-time polymerase chain reaction (PCR) test that amplifies a few copies of available DNA and replicates it by several orders of magnitude.
- Importantly, the new test has been accredited by the National Seed Health System which means that it will be adopted for widespread use in the seed industry.
- Detection in seed lots can help seed suppliers and producers assess the risk from the disease and reduce the risk to producers.

KA 212: Improvement of BIO-PCR for routine detection of the watermelon fruit blotch pathogen. Logic Model

Participants: A private company in California with USDA-ARS and land grant university collaborators. **Dollars Invested:** $271,000

Situation	Activities	Outputs		Outcomes		
		Product	Metric	Change in Knowledge	Change in Actions	Change in Conditions
Watermelon fruit blotch is among the most damaging and costly diseases of melon production. Since it is caused by a bacterial pathogen it cannot be controlled by pesticides and pathogen-free seed offers the best hope of exclusion of the pathogen from a field. A fast, sensitive and specific test is needed for seed lots to assure a minimal impact form this disease to melon producers.	Adapt primers and probe developed from USDA-ARS research to a real-time PCR. Increase efficiency of extraction of the pathogen from naturally infected seeds. Develop a pathogen enrichment procedure. Validate the new protocol through comparison with standard techniques.	Greater sensitivity and faster turn-around than existing methods while maintaining specificity. Protocol for industry. The new test reduces the time required to screen a seed lot.	Lab results. 1,925 seed lots of 10,000 watermelon or cantaloupe seeds were tested for six major melon seed producers and distributors.	Pathogen enrichment is better understood by scientists.	Industry adopts the new test. Approval and adoption by the National Seed Health System. Implementation of smaller primers reduces the time for the test by 40% from previous technologies. .	It is anticipated that the new test becomes the standard for detecting the pathogen from seed lots.

Assumptions: End users want the best seed possible. Companies want to sell a good product. Diagnostic tests are fast, affordable and accurate.	**External Factors:** Commercialization will require constant improvement to remain as the standard. The first to develop a multiplexed test using this technology or improvements will become the standard.

Knowledge Area 213: Weeds Affecting Plants

KA 213 Introduction

The Knowledge Area (KA) of research in weed science is based on applied and basic science underlying complex issues in vegetation management. **Priorities** for research problems primarily focus on herbicide efficacy and maintenance; and in some instances also expand to include research topics within a complex systems focus such as invasive biology, ecosystem restoration, ecological weed management, and the genetics, molecular biology and physiology of weedy traits.
This KA contributes to overarching goals of the agency by advancing discovery and education opportunities to address the challenges of increasing population, decreasing agricultural land area, global food security. The **current portfolio is moving in the right direction** to accelerate plant production and protection by expanding our fundamental knowledge about weed science in a coordinated manner, facilitating new applications of knowledge and innovative approaches to weed management.

The resources for this KA include competitive and non-competitive sources of funding. Work through the KA is achieved by cooperation and coordination; thus, it highly leverages scientific expertise and resources from multi-federal agencies including the USDA-ARS, USDA-FS, NSF, DOE USAID, and NIH.

KA 213 Outputs and Outcomes

Aegilops cylindrical (Jointed Goatgrass)
Special Grants CRIS accession no. 0208014

Aegilops cylindrica, jointed goatgrass, infests nearly five million acres of winter wheat lands in the west and Midwest and costs wheat producers an estimated $145 million annually in lost yield, reduced quality, production of less profitable crops, increased management costs, and reduced land values. A thirteen year, coordinated study on the control of one of jointed goatgrass conducted by approximately 30 scientists in 10 western and Midwestern states has significantly reduced the rate of spread of this weed in the past six years. The project demonstrates an integrated system for managing jointed goatgrass and shows how to determine the most effective and efficient way to introduce herbicide-resistant wheat into the integrated system.

Key Outputs

- Extension bulletins provide a lasting and readily-accessible record of the accomplishments of this program and new information to help wheat producers manage jointed goatgrass.
- A website (www.jointedgoatgrass.org) has been established and will be updated annually to further enhance information transfer. Information on the website include summaries of annual progress reports a video, poster, and slide set produced to assist extension personnel in transferring information on jointed goatgrass biology and management to producers.
- Nine publications were produced: (1) Introduction to Jointed Goatgrass; (2) Ecology of Jointed Goatgrass; (3) Jointed Goatgrass Control Tactics; (4) Jointed Goatgrass Genetics; (5) Jointed Goatgrass Herbicide Resistance: (6) Jointed Goatgrass, Best Management Practices, Intermountain Region; (7) Jointed Goatgrass, Best Management Practices, Southern Great Plains; (8) Jointed Goatgrass, Best Management Practices, Central Great Plains; and (9) Jointed Goatgrass, Best Management Practices, Pacific Northwest.

Outcomes

- Significant understanding of gene flow between wheat and jointed goatgrass - information valuable in managing the introduction of herbicide-resistant wheat for the control of jointed goatgrass.
- Six long-term Best Management Practices studies across the western U.S. to determine how to best integrate a herbicide-resistant wheat, developed by traditional breeding, into jointed goatgrass management systems.
- An integrated weed management system to reduce the devastating effect of jointed goatgrass on winter wheat production and quality.
- Prevention of the spread of this weed into new non-infested areas.

Knowledge Area 214: Vertebrates, Mollusks, and Other Pests

KA 214 Introduction

This Knowledge Area (KA) focuses on plant yield and plant quality affected by indigenous and exotic vertebrate pests (including birds and mammals), mollusks (including slugs and snails), and other plant pests not included in other KAs. 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.

The **long-term goal** for this KA is to have methods in use that improve national plant production and protection and solve problems caused by vertebrates, mollusks, and other related pests. The **short-term goal** for this KA is to support research, education, and extension to develop and improve methods to prevent and mitigate damage to plants caused by vertebrates, mollusks, and other pests.

Key priorities for this KA include development of improved prevention methods; understanding ecological impacts of management and conservation practices; knowledge of factors that influence pest population changes; use of remote sensing tools; development of real time detection methods; improvement in non-lethal control methods; establishment of improved damage estimates and thresholds for food/crop safety; and development of cost-effective wildlife control.

The results of research, education, and extension activities for this KA **benefit the public** by improving agricultural products, the environment, human health, and the well being of communities. This KA **contributes to overarching goals of the agency** by improving protection and safety of the Nation's agriculture and food supply against threats from vertebrate, mollusk, and other pests.

Research, education, and extension activities are appropriate and addressing priority areas; however, the **resources available** for this KA have been inconsistent and low. Increased funding to this area may provide advanced methods to prevent and mitigate damage beyond the current methods of: 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.

This KA **contributes to the mission and goals of the portfolio** by addressing and reducing the significant adverse impacts and reductions in plant yield and quality caused by vertebrate pests, mollusks, and other related plant pests.

KA 214 Outputs and Outcomes

eXtension Wildlife Damage Management Community of Practice
Smith-Lever 3(d) to University of Nebraska-Lincoln Extension CRIS accession no. 0207967

eXtension is an educational partnership of more than 70 universities, found in every state and territory throughout the U.S., providing 24/7/365 access to dynamic and evolving objective, research-based information and educational opportunities. 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, event calendar, a training/ education resource, and access to the Wildlife Damage Management Community of Practice members. The Nuisance Control Training Manual, providing a training manual for "best management practices" for nuisance wildlife control, is an example of one of the publically available resources on this site.

Key Outputs

- eXtension Wildlife Damage Management Community of Practice and website developed and launched for public.
- 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 identify wildlife damage, select appropriate mitigation techniques, and identify 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.

KA 214: eXtension Wildlife Damage Management Community of Practice (CoP) Logic Model

Participants: University of Nebraska-Lincoln Extension **Dollars Invested:** $1,425,600 (for all eXtension CoPs)

Situation	Activities	Outputs		Outcomes		
		Product	Metric	Change in Knowledge	Change in Actions	Change in Conditions
eXtension is an Internet-based collaborative environment where Land Grant University content provides objective, research-based knowledge to solve real challenges in real time. eXtension transforms the way the Cooperative Extension system delivers its mission and message through technology (eXtension). Wildlife Damage Management resources are available at: http://www.extension.org/wildlife+damage+management 24/7/365 to the public.	Develop collaborative new Community of Practice for Wildlife Damage Management linking scientists with each other and the public. Develop content for the eXtension website for the management of rodents, carnivores, other mammals, birds, and reptiles.	The Wildlife Damage Management CoP developed resources on a wide variety of wildlife species, news stories, frequently asked questions, an event calendar, ask the expert area, and training materials.	The number of times the public accesses the eXtension Wildlife Damage Management Community of Practice website, uses the resources on the website and asks questions through the Ask the Expert feature of the site.	eXtension Wildlife Damage Management Community of Practice and website developed and launched for the public provides detailed resources on a wide variety of wildlife species, news stories, frequently asked questions, an event calendar, access to the CoP members, and Nuisance Control Training Manual for nuisance wildlife control.	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 of 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.

Assumptions: eXtension is based on a community of practice (CoP) providing content to a community of interest (CoI), providing credible expertise, reliable answers based upon sound research, connections to the best minds in American universities, creative solutions to today's complex challenges, customized answers to users' specific needs, trustworthy, field-tested data, and dynamic, relevant and timely answers.	**External Factors:** Support for eXtension will be available for the Cooperative Extension Service to develop a national Internet-based educational network to provide customers 24/7/365 access to objective, science-based information from land-grant universities and partners nationwide. Duplication across the system. Interest and use of website will maintain or expand.

Berryman Institute
Competitive grants, Hatch Funds, Smith-Lever, and others CRIS accession no. 198860

The Berryman Institute (http://www.berrymaninstitute.org) 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 continues to provide research funding, technical assistance, and outreach education through its funding of multiple projects throughout the U.S. that address the critical issue of human-wildlife conflicts.

Key Outputs

- The Berryman Institute continues to provide research funding, technical assistance, and outreach education through its funding of multiple projects throughout the U.S. 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 28 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.
- The Berryman Institute funded educational and research programs for 20 undergraduate and graduate students from 9 institutions in 9 states, including 6 graduate fellowships, 2 mini-grants, and 5 NWRC undergraduate internships, as well as multiple professional development and travel opportunities.
- Cooperative efforts with 24 WS professionals were undertaken, including 6 directed cooperative research efforts with NWRC personnel.
- Berryman Institute personnel taught 13 undergraduate/graduate courses related to WS needs at MSU and USU and offered 5 online/distance learning courses were offered.
- Berryman produced 15 workshops/short courses for USDA/WS employees and 5 workshops for other professionals, gave 10 presentations at USDA/WS State/Regional meetings, produced 22 media contacts (TV, newspapers, magazines, radio, etc.), and gave 20 presentations at other professional meetings.
- 24 WS personnel from 15 states were assisted in becoming 486-qualified.

Outcomes

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

KA 214: Berryman Institute Logic Model

Participants: Leopold, B. D., Department of Wildland Resources at Utah State University and Department of Wildlife & Fisheries at Mississippi State University

Dollars Invested: [State funded]

Situation	Activities	Outputs		Outcomes		
		Product	Metric	Change in Knowledge	Change in Actions	Change in Conditions
There is a need to improve 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	Develop a program to financially support research and education programs conducted by institutions in the U.S. that address these issues. Conduct national workshops for professionals Support graduate education	28 states now received research funding. National workshops attended by over 200 professionals. Number of students supported and number of states supported for competitive research programs.	Participant ratings – actual overall rating of 4.7 out of 5.0 Supported 20 doctoral students, 42 M.S. students, and internships for 69 undergraduate students.	Teaching, research, and extension programs supported by the Berryman Institute will increase knowledge of student, interns, professionals, and the public to help improve human-wildlife relationships and resolve human-wildlife conflicts.	Research, teaching, and extension programs supported by the Berryman Institute will change actions as wildlife and non-wildlife professionals adopt knowledge learned and best management practices (BMPs).	Research, teaching, and extension programs supported by the Berryman Institute will effect changes in conditions as professionals put BMPs in place and the public adopts these BMPs to in improving human-wildlife relationships and resolving human-wildlife conflicts. Actual overall participant rating of 4.7 out of 5.0

Assumptions: The activities of the Institute will enhance human-wildlife relationships and resolve human-wildlife conflicts through research, education and extension programs. These types of programs are needed in the U.S. to address management and control of pest vertebrates.	**External Factors:** Funding may impact the size and impact of these programs. This is a research, education, and extension program. Changes in Actions and Conditions will depend on many factors including research developing new best management practices (BMPs), adoption of BMPs by wildlife and non-wildlife professionals, and acceptance of methods by the public

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

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 underrepresented minorities, expand field training opportunities and increased use of decision cases in the curriculum.

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.
- 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.

KA 214: Experiential Learning in Agriculture and Wildlife as an Aid to Recruitment Logic Model

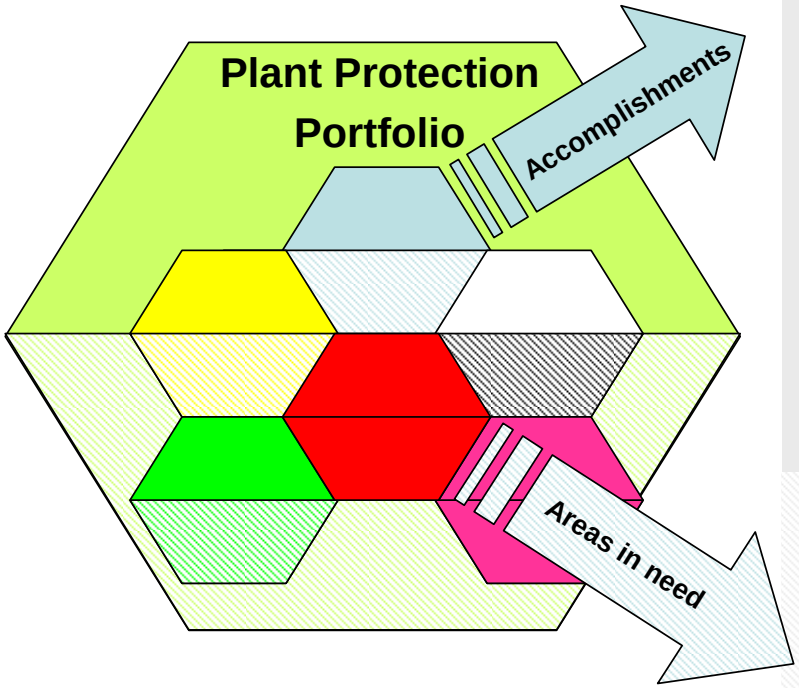
Participants: Lincoln University, Dept. of Ag and Natural Sciences **Dollars Invested:** $199,290

Situation	Activities	Outputs		Outcomes		
		Product	Metric	Change in Knowledge	Change in Actions	Change in Conditions
Through a NIFA, Science and Education Resources Development Grant, Lincoln University instituted an experiential learning in agriculture and wildlife program as an aid to increase recruitment. The primary objectives in this project were to improve success in recruiting under-represented minority students, expand field training opportunities and increase use of decision cases in the curriculum.	Recruit underrepresented minority students Expand field training opportunities Increase use of decision case in the curriculum	Developed a course called Field and Experiential-based Wildlife Techniques. 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.	Success in recruiting additional under-represented minority students into the major. Successful in recruiting underrepresented minority students into our project activities.	Increased skills of students using typical wildlife equipment.	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.	Possible change in conditions may occur as students in these courses choose careers in the wildlife field.

Assumptions: Course content and experiential learning activities are important factors in attracting students, and especially under-represented minority students, to courses and fields of study.	**External Factors:** Students and potential students make independent decisions concerning their course selection and curriculum.

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

Knowledge Area (KA) 215 is the biological control of pests affecting plants. 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 insects, mites, weeds, pathogens, nematodes, and vertebrates.

Long term goals are to improve human and environmental health by emphasizing biological control and bio-based pest management strategies. The implementation of these strategies will increase grower awareness and the adoption of biological control methods to reduce the population densities of key arthropod, weed, and pathogen pests. Long range plans also include the development of sustainable and environmentally friendly pest management systems that utilize bio-based management strategies for the management of key arthropod, weed, and pathogen pests.

Key priorities for this KA are to: 1) develop better strategies for predicting biological control agent efficacy; 2) develop strategies for increasing longevity and UV resistance of microbial agents; 3) improve predictions and assessment of non-target impacts and potential host shifts of biocontrol agents; 4) improve environmental safety of biological control agents; 5) develop better risk assessment strategies for evaluating safety of biocontrol organisms; 6) achieve better continuity in funding for bio-based pest management; 7) increase funding for large-scale efficacy trials for pathogens and area-wide pest management projects; 8) improve the regulatory process for natural enemies of arthropods, weeds, and pathogens; 9) improve pheromone delivery systems; 10) achieve greater transparency in development of genetically modified crops and other biological organisms; 11); improve our understanding of necessary size and distance of refugia for genetically modified crops; and 12) improve assessment of non-target effects of plant immunization (e.g., use of endophytic fungi to confer resistance).

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 **public 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.

The agency is not moving in the right direction because it has too little funding going towards biological control projects, especially for biocontrol of plant pathogens. Stakeholder feedback demands that funding levels need to be increased in our integrated 406 pest management programs. A new program needs to be developed in AFRI that focuses exclusively on the biocontrol of arthropods, weeds, and pathogens.

Projects aligned with KA 215 will **help support the Plant Systems Portfolio mission** by providing 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.

KA 215 Outputs and Outcomes

Understanding and Managing Arthropod Pests and Natural Enemies through Various Approaches on Deciduous Tree Fruits in Pennsylvania

Hatch funds CRIS accession no. 0202302

Outbreaks of the Oriental fruit moth (OFM), *Grapholita molesta*, and the codling moth (CD), *Cydia pomonella*, have caused severe financial losses to both growers and processors in Pennsylvania. These outbreaks have occurred because of resistance development to various insecticides, current grower management practices, and a lack of highly cost effective products for their control. This project will examine why these two pests have become problems and what approaches (i.e., new insecticides - timing, concentration and application method; new technologies for pheromone mating disruption; host effects on biology and behavior) can be taken to again achieve economic control. In addition, it is critically important to devise new management options for these two pests, as well as other pests, that minimize the likelihood of resistance to any chemical option and to determine their toxicity to the natural enemy complexes.

Key Outputs

- Bio-based pesticides identified that are safe for natural enemies and effective against oriental fruit moth and codling moth.
- Pheromone application rates determined for OFM and CM.
- Models developed for OFM dispersal and movement within and between orchards.
- Eighteen publications produced.
- Graduate students trained.
- New methods and technologies developed.

Outcomes

- Growers and integrated pest management (IPM) practitioners will be able to choose bio-based strategies that are effective against OFM and CM and safe for natural enemies.
- Growers and IPM practitioners will be able to determine optimal levels of pheromone to disperse to better manage OFM and CM.
- Armed with more refined information, growers and IPM practitioners will be able to better utilize bio-based IPM strategies against OFM and CM.
- Growers will be more comfortable in adopting bio-based strategies to manage OFM and CM, rather than relying on conventional chemical control.
- Number of apple and peach fruit injured by OFM and CM reduced.
- Broad-spectrum insecticide use reduced for most growers.
- Some form of mating disruption used in over 3000 ha of apples and peaches.

KA 215: Understanding And Managing Arthropod Pests And Natural Enemies Through Various Approaches On Deciduous Tree Fruits In Pennsylvania Logic Model

Participants: Penn State University **Dollars Invested:** Hatch

Situation	Activities	Outputs		Outcomes		
		Product	Metric	Change in Knowledge	Change in Actions	Change in Conditions
Outbreaks of the Oriental fruit moth (OFM), *Grapholita molesta*, and the codling moth (CM), *Cydia pomonella*, have caused severe financial losses to both growers and processors in Pennsylvania. These outbreaks have occurred because of resistance development to various insecticides, current grower management practices, and a lack of highly cost effective products for their control. The decision-maker must have available sampling/monitoring techniques that are economical, relatively easy to use, and provide a reasonably precise estimate of the density of the critical/sensitive stages of both pests/natural enemies.	Both experimental and registered insecticides and acaricides will be evaluated in replicated laboratory bioassays and/or orchard experiments for their potential or continued use as valuable tools for both IPM and organic programs Studies involving various application technologies to dispense sex pheromone for mating disruption will be conducted in a number of large orchard blocks for a variety of species, but in particular the codling moth and Oriental fruit moth. Mark-release-recapture studies will be implemented to study Oriental fruit moth dispersal and movement within and between orchards	Bio-based pesticides identified that are safe for natural enemies and effective against oriental fruit moth and codling moth Pheromone application rates determined for OFM and CM. Models developed for OFM dispersal and movement within and between orchards New methods and technologies developed Graduate students trained	18 Publications produced Number of Graduate students trained Number of new methods and technologies developed	Growers and IPM practitioners will be able to choose bio-based strategies that are effective against OFM and CM and safe for natural enemies Growers and IPM practitioners will be able to determine optimal levels of pheromone to disperse to better manage OFM and CM	Armed with more refined information, growers and IPM practitioners will be able to better utilize bio-based IPM strategies against OFM and CM	Number of apple and peach fruit injured by OFM and CM reduced Broad-spectrum insecticide use reduced for most growers Some form of mating disruption used in over 3000 ha of apples and peaches Growers will be more comfortable in adopting bio-based strategies to manage OFM and CM rather than relying on conventional chemical control Improvements in organic pest control products has helped Pennsylvania's expanding organic industry achieve better control of arthropod pests

Assumptions: Bio-based pest management strategies will be successfully identified, developed, and adopted by apple and peach growers in Pennsylvania	**External Factors:** Bio-based strategies tend to be more expensive and labor/knowledge intensive. Hence, researchers and extension specialists will have to have convincing evidence of efficacy and a strong outreach program to encourage growers to adopt bio-based pest management strategies against OFM and CM in Pennsylvania apples and peaches.

Integrated Management of Arthropod Pests of Washington Pome Fruits
Hatch funds CRIS accession no. 0210666

Washington tree fruit growers need to transition from a primarily organophosphate insecticide-based pest management program to one that is based on non-insecticidal tactics or reduced-risk pesticides. Mating disruption, using pheromone-based products, is a non-insecticidal tactic useful against the codling moth (CM), the key pest of Washington pome fruits. New, easier-to-use pheromone products will be tested and implemented where appropriate. These materials are species-specific and environmentally safe. Supplementing this core tactic will be reduced risk insecticides, including insect growth regulators and neonicotinyls. Other studies will provide new biological knowledge on the primary and secondary pests of apple and pear. This basic knowledge provides the basis for developing management strategies. For example, knowing more about the mating behavior of female codling moth will help in refining mating disruption techniques; predicting the occurrence of the stages of pear psylla will help use new pesticides more effectively. These products and tactics work differently than past products, and research, education and implementation are necessary for growers to use them successfully.

Key Outputs

- Pre- and post-treatment counts of arthropod and natural enemy densities will determine relative efficacy of the various products, rates and timings.
- Bio-based pesticides identified that are safe for natural enemies and effective against codling moth.
- Pheromone application rates determined for CM.
- Three publications produced.
- New methods and technologies developed.

Outcomes

- Growers and IPM practitioners will be able to choose bio-based strategies that are effective against CM and safe for natural enemies.
- Growers and IPM practitioners will be able to determine optimal levels of pheromone to disperse to better manage CM.
- Armed with more refined information, growers and IPM practitioners will be able to better utilize bio-based IPM strategies against OFM and CM.
- Sound resistance management strategies developed for organophosphate alternative/ reduced-risk insecticides.
- Growers will be more comfortable in adopting bio-based reduced-risk strategies to manage CM rather than relying on conventional organophosphate control.
- Number of apple fruit injured by CM reduced.
- Cost of pheromone technology reduced.

KA 215: Integrated Management Of Arthropod Pests Of Washington Pome Fruits Logic Model

Participants: Washington State University **Dollars Invested:** Hatch

Situation	Activities	Outputs		Outcomes		
		Product	Metric	Change in Knowledge	Change in Actions	Change in Conditions
Washington tree fruit growers need to transition from a primarily organophosphate insecticide-based pest management program to one that is based on non-insecticidal tactics or reduced-risk pesticides.	Test new pheromone-based technologies (flakes and fibers) for control of codling moth (CM). Assess female CM calling behavior. Study woolly apple aphid life history at three locations. Study the effect of lepidopteran pesticides on mite populations (with and without the addition of sulfur products and carbaryl). Develop a temperature-based pear psylla model. Test new insecticides for codling moth, leafrollers, mites, aphids, psylla and mealybug.	Pre- and post-treatment counts of arthropod and natural enemy densities will determine relative efficacy of the various products, rates and timings. Bio-based pesticides identified that are safe for natural enemies and effective against codling moth. Pheromone application rates determined for CM. New methods and technologies developed.	3 Publications produced. Number of new methods and technologies developed.	New knowledge on bio-based strategies that are effective against codling moth and safe for natural enemies. New knowledge on the optimal levels of pheromone to disperse to better manage codling moth.	Armed with more refined information, growers and IPM practitioners will be able to better utilize bio-based IPM strategies against CM in Washington apple orchards. Sound resistance management strategies developed for organophosphate alternative/reduced-risk insecticides.	Number of apple fruit injured by CM reduced. Cost of pheromone technology reduced. Growers will be more comfortable in adopting bio-based strategies to manage OFM and CM rather than relying on conventional chemical control.

Assumptions: Bio-based pest management strategies will be successfully identified, developed and adopted by apple growers in the state of Washington. The research on new organophosphate alternative/reduced risk insecticides demonstrates the inherent vulnerability of these products to a relatively rapid resistance development. It is imperative that sound resistance management practices be implemented as a way to preserve the value of these new pest control technologies.	**External Factors:** Bio-based strategies tend to be more expensive and labor/knowledge intensive. Hence, researchers and extension specialists will have to have convincing evidence of efficacy and a strong outreach program to encourage growers to adopt bio-based pest management strategies against CM in Washington apples.

The Influence of Native Plants on Arthropod Population Dynamics: Can Natives Enhance Conservation Biological Control?

National Research Initiative Program CRIS accession no.02004194

Pesticide use in ornamental plants is highly intensive and certain compounds are very harmful to humans and the environment. Also, insects develop resistance to these chemicals rapidly due to heavy use in these systems. Biological control of insect pests is desired because it tends to have fewer impacts on the environment and does not adversely affect humans. Increased usage of native plants could reduce the threat of ornamental plants becoming invasive, which is a serious problem in the U.S. Increased basic understanding about how predators and parasitic wasps develop in native vs. alien plant systems could lead to a method of controlling pests biologically. The goal of this project is to determine if predators and parasitic insects are better supported when native ornamental plants are grown. Increased diversity of insects, both beneficial and pest insects, occurs in native plant systems. Thus, the challenge is to determine whether wide spread use of native plants favors beneficial species and reduces insect pests below the aesthetic injury level.

Key Outputs

- Preliminary data from first year show that damage levels were significantly below the aesthetic injury level of 10% (the level that triggers homeowner application of pesticides).
- Two publications in Journal of Conservation Biology (peer reviewed).
- One Master's student graduated and completed thesis on this topic.
- Seven undergrads trained; one wrote a senior thesis on this topic.
- PD gave 35 public presentations to master gardeners, native plant societies, landscape designers and architects, arboreta, and academics.
- Project achieved national exposure (e.g., PD was interviewed by National Public Radio 5 times and he appeared on "Science Friday").

Outcomes

- Potentially increased usage of native species as ornamental plants in suburban environments by landscape designers, architects, and homeowners.
- Potentially widespread adoption of biologically-based methods to control pests (in this case predators and parasitic wasps of pests on ornamental plants).
- Potentially reduced load of pesticides in the environment.
- Potentially decreased establishment and spread of invasive pest species through successful use of these beneficial insects.

KA 215: The Influence of Native Plants on Arthropod Population Dynamics Logic Model

Participants: U. Delaware, U. Maryland **Dollars Invested:** $390,000, NRI

Situation	Activities	Outputs		Outcomes		
		Product	Metric	Change in Knowledge	Change in Actions	Change in Conditions
Pesticide use in ornamental plants is very intensive and certain pesticides are harmful to humans and the environment. In addition, pesticide resistance is rampant in these plant systems. There is an urgent need to increase basic knowledge and to implement environmentally sound practices to control ornamental plant pests. Biological control has great promise as an alternative. The opportunity is to determine if predators and parasites are enhanced and if native ornamental plants are better protected in suburban environments. The long term goal is to encourage homeowners and landscape managers growing these plants to use these alternative control measures.	Develop gardens in Delaware and Maryland to compare levels of pest and beneficial insects. Establish plots comprised of an equal number of native and alien ornamental plants. Measure the time duration in which plants had $\leq$ 10% foliar damage over a 3 years period.	Two years of insect samples collected. Identifications to species level are underway. Potentially will yield accurate information about efficacy of beneficial insects.	Publications (2). One Master's student graduated and completed a successful thesis. Seven undergrads trained, one of which wrote a senior thesis. 35 talks given to master gardeners, native plant societies, landscape designers and architects, arboreta, and academics.	The public and researchers better appreciate the potential of native plants in enhancing biological control of pest insects. Students have applied this knowledge to careers in conservation biology	Potentially increased usage of native species in suburban environments by landscape designers, architects, and homeowners. Potentially widespread adoption of biologically-based methods to control pests (in this case predators and parasitic wasps of pests on ornamental plants).	Potentially reduced load of pesticides in the environment. Potentially decreased establishment and spread of invasive pest species through successful use of these beneficial insects.

Assumptions: Beneficial species such as insect predators and parasitic insects will suppress plant pests more successfully when other insect species are present. Native plants will support a higher diversity of these prey species. Plants will be protected and biological control will be used more widely.	**External Factors:** The project is limited to the time it takes to establish plots and to hire and train students to conduct studies and help evaluate results.

Knowledge Area 216: Integrated Pest Management Systems

KA 216 Introduction

The IPM Knowledge Area, KA 216, 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 **priorities** 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 plant production, in fact, there is great application of IPM principles in managing livestock pests, structural integrity, schools, homes, and other urban settings. These improvements have direct **public benefit.**

KA 216 contributes to the agency by supporting the strategic goal "Enhance Protection and Safety of the Nation's Agriculture and Food Supply." The research, extension, and education activities help **support the Plant Systems Portfolio mission** by providing safe plant products for the American consumer and international markets.

KA 216 Outputs and Outcomes

The Cucurbit Downy Mildew PIPE (CDM-PIPE)
ipmPIPE grant CRIS accession no.0207055

Downy mildew is a serious disease affecting all cucurbit crops (cucumber, cantaloupe, squash, pumpkin and watermelon). In 2004 this disease caused a massive epidemic on cucumber. The Cucurbit Downy Mildew PIPE (CDM-PIPE) is a component of the ipmPIPE (integrated pest management Pest Information Platform for Extension/Education). The CDM-PIPE tracks the CDM pathogen, *Pseudoperonospora cubensi*, on a complement of cucurbit hosts planted in sentinel plots across the monitoring area which began in North Carolina has expanded to essentially every state east of the Great Plains, including Texas and California. CDM-PIPE also hosts educational materials and are developing a public-use risk map system.

Key Outputs:

- Over 6,600 CDM-PIPE brochures have been distributed by CDM-PIPE staff and cooperators among cucurbit producers and consultants across the U.S.
- Up to 700 brochures have been distributed to clientele and cooperators in Canada, an important partner in early detection the past two years.
- Online educational materials and diagnostic resources have been produced and are instrumental in expanding the ability of agricultural professionals and producers to recognize and report the disease.

Outcomes:

- The CDM-PIPE working group has established a common fungicide recommendation for cucurbit production regions, north to south, in the contiguous production areas in the eastern U.S. that eliminates some of the state-to-state variation that is confusing to producers and managers that operate production systems in multiple states.
- Cucurbit growers received early warning of cucurbit downy mildew (CDM) development in 2008, a severe year for CDM development, informing producer and farm manager decisions on timing of treatment to optimize fungicide applications, potentially saving unnecessary inputs and improving the influence of applications made.
- Improved recognition of the spread of downy mildew allows producers to focus their disease scouting and target their control dollars, optimizing profitability.
- Georgia, North Carolina and Michigan specialists report that growers saved 2-3 fungicide applications in 2009, due to information posted about the threat from cucurbit downy mildew. With about 122,000 acres of cucurbits in three states, that translates into more than $6 M in savings to the cucurbit producers of the states..

KA 216: The Cucurbit Downy Mildew PIPE (CDM-PIPE) Logic Model

Participants: Academic researchers and extension specialists in Florida, Georgia, South Carolina, North Carolina, Virginia, Maryland, Delaware, New Jersey, New York, Ohio, Iowa, Illinois, Kansas, Indiana, Louisiana, Massachusetts, Kentucky, Alabama, Mississippi, Texas, Michigan, Missouri, Oklahoma, Pennsylvania, Wisconsin, Tennessee, Ontario

Dollars Invested: $900,000

	Activities	Outputs		Outcomes		
		Product	Metric	Change in Knowledge	Change in Actions	Change in Conditions
Cucurbit downy mildew, caused by *Pseudoperonospora cubensis*, is the most damaging disease among all cucurbit crops which include cucumbers, squash, pumpkins, and melons.	Improve communication among cucurbit pathologists. Enhance coordination of efforts on identifying CDM. Develop grower education materials. Enhance forecasting with NOAA HYSPLIT model and migrate to particulate model. Research to develop new web-based visualization and communication tools	Launched website. Information posted on continuous basis year-round. Poster and brochure printed for training purposes.	Number of hits or unique visits to website. Number of observations posted. Number of brochures distributed.	Understanding of the disease cycle was improved. Relationship better understood between proximity to existing disease and local fields.	Producers and decisions makers turned to the CDM-PIPE tool in the decision-making process. Fungicide was applied only as needed, based on disease maps and forecasts.	Producers can focus their disease scouting and target their control dollars to optimize profits.

Assumptions: Producers want to make economical decisions. Mapping and forecasting information is accurate. Significant sources of inoculum are all accounted for on the maps. Early outbreaks are identified and reported.	**External Factors:** Research funding fluctuates with competing national priorities. Funding for monitoring and base infrastructural costs is not stable.

Agronomic Crops in Mississippi

Hatch and Smith-Lever CRIS accession no. 0214124

Cotton production in the Gulf South states has historically required significantly higher inputs than other field crops. Increasing costs of production paired with a flat income potential contributed to a 50% decline in acres of cotton production in Mississippi from 2007 to 2008. The Demonstration and Education of Management Options (D.E.M.O.) program was initiated in 2008 to help producers learn how to produce the crop more economically and in a more environmentally responsible manner. As a result of the program, evidence was generated to reduce pesticide use through the use of IPM tactics and strategies and two insecticide sprays were eliminated for control of the pest, tarnished plant bug, in cotton.

Key Outputs:

- Extension-based field demonstration showed no need for fungicide application in 2007 or 2008 since conditions were not favorable for disease development, a classic example of IPM principles.
- Efficiency in cotton production through enhanced extension-based producer training resulted in an average reduction of two insecticide applications.
- At a cost of $13.80/A for each application and 665,000 A of cotton in 2007 and 365,000 A of cotton in 2008, the cost saving alone was potentially greater than $10 million.
- At least five peer-review publications have resulted from this work.

Outcomes:

- The reduction in insecticide applications also resulted in reduced human and environmental exposure of substantial amounts of pesticide.
- Fewer insecticide applications also result in reduced selection pressure for resistant biotypes of the tarnished plant bug.

KA 216: Agronomic Crops in Mississippi Logic Model

Participants: Academic researchers and extension specialists at Mississippi State University.

Dollars Invested: Not available

Situation	Activities	Outputs		Outcomes		
		Product	Metric	Change in Knowledge	Change in Actions	Change in Conditions
Cotton pests, especially tarnished plant bug, can cause significant losses in yield. The standard practice in Mississippi has been to spray insecticides on a calendar basis. As cotton production has become more competitive and efficiencies have been needed to continue with the crop, producers have been open to new management approaches.	Developed Extension fact sheets. Held producer meetings. Hosted demonstration plots/tours. Tutored producers in new farm management strategies.	Face-to-face training in grower meetings and one-on-one tutoring.	Number of brochures distributed. Number attending meetings. Number attending field tours. Amount of dollars saved by eliminating unneeded pesticide applications.	Understanding of the pest dynamic was improved. Understanding of farm management and crop budgeting was improved. Crop monitoring and treatment options were better understood.	Fewer insecticide applications were made to cotton. Cotton insect control was more targeted.	The reduction in insecticide applications will reduce human and environmental exposure of substantial amounts of pesticide.

Assumptions: Producers want to make economical decisions. Crops are being monitored to trigger decisions. Early pest outbreaks are identified.	**External Factors:** Research funding fluctuates with competing national priorities. Funding for monitoring and base infrastructural costs is not stable.

Development of Ecologically and Economically Sustainable Pest Management Programs for Soybean Production

Hatch CRIS accession no. 0202724

A major new invasive pest of soybean, soybean aphid (*Aphis glycines*), infested over 42 million acres of soybean in the North Central U.S. in 2003, and 7 million acres were treated with insecticides. Yield reductions have been documented to exceed 50% if crops are left untreated, and in the North Central region alone, an average 13.9% yield loss equates to an annual loss of $1.7 billion/year. This project found that improved timing of insecticide applications and the development of soybean aphid resistant cultivars could save Iowa soybean producers millions of dollars through improved efficiencies and alternative pest control methods, while reducing environmental exposure to nearly as much as 34,000 pounds of insecticide.

Key Outputs:

- Studies provided training of a postdoctoral scientist, four graduate students (3 M.S. and 2 Ph.D. candidates), and 20 undergraduate students in insect ecology and integrated pest management.
- At least two peer-review publications and two extension bulletins have resulted from this work.
- Extension newsletters to growers and an insecticide evaluation report available online at www.soybeanaphid.info. This website also has several podcasts.
- Several stakeholder meetings have been conducted through this project, which included commodity groups, agribusiness and conservation organizations.

Outcomes:

- Appropriately selected and effectively timed insecticides can reduce yield loss due to soybean aphid at a per acre cost of up to $18 per acre. The cost of that treatment in a peak aphid year could be as high as $129 million in Iowa alone.
- Iowa soybean producers will save millions of dollars through improved efficiencies and alternative pest control methods, while reducing environmental exposure to nearly as much as 34,000 pounds of insecticide. Soybean aphid resistant cultivars are now available that reduce the cost of control and yield losses to the pest. Aphid-resistant soybeans have a 40% greater yield than those susceptible when these varieties were left untreated within insecticide.
- If only 30% of the lost yield potential is protected, the financial savings of these new tools for managing soybean aphids could amount to as much as $62 million in Iowa alone.

KA 216/KA211: Development of Ecologically and Economically Sustainable Pest Management Programs for Soybean Production Logic Model

Participants: Academic researchers at Iowa State University

Dollars Invested: Not available

Situation	Activities	Outputs		Outcomes		
		Product	Metric	Change in Knowledge	Change in Actions	Change in Conditions
In 2003, over 42 million acres of soybean in the North Central US were infested soybean aphid, *Aphis glycines*, a major new invasive pest of soybean. Yield reductions have been documented to exceed 50% and in the North Central region alone, an average 13.9% yield loss equates to an annual loss of $1.7 billion/year. The overall goal of the project is to develop an economic and ecologically sustainable IPM for soybean aphid that is integrated within a multi-pest management program.	Research on insecticide use relative to: 1) Timing 2) Product used 3) Economic threshold Develop publications and a public website. Communicate with growers.	Research trials determined which stages of plant development result in the greatest yield loss, insecticide efficacy and cost of control, and the levels of infestation needed to offset the cost of control application and warrant treatment - 250 aphids per plant action threshold. Website with podcasts.	Appropriately selected and effectively timed insecticides can reduce yield loss at a per acre cost of up to $18 per acre. Aphid-resistant soybeans have a 40% greater yield than those susceptible. Training of one postdoctoral scientist, four graduate students (3 M.S. and 2 Ph.D. candidates), and 20 undergraduate students. At least two peer-review publications and two extension bulletins	Soybean producers better understand effective strategies for controlling aphid damage.	Producers support, accept, and implement the 250 aphid per plant action threshold. Producers utilize new aphid-resistant soybean varieties.	Alternative pest control methods will reduce environmental exposure to insecticides.

Assumptions:	External Factors:
Assumptions: Soybean aphid populations reduce yield. Properly timed control of the aphid will protect yield. Host resistance genes can be deployed without significant yield drag. Producers will adopt practices that are shown to be cost effective solutions to the pest problem.	**External Factors:** Research funding fluctuates with competing national priorities.

Section III: Secondary Knowledge Areas

Secondary knowledge areas were not addressed in the Plant Systems Internal Portfolio Review document.

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

Given that the plant protection and plant production combined in 2007 into one plant systems portfolio, the responses have been combined to reflect the new portfolio. We have attempted to synthesize and combine the separate external panels' recommendations from 2003 into one statement throughout the 14 dimensions. This serves the basis upon which the plant systems' portfolio team provides its 2009 responses. External recommendations and portfolio responses for both Plant Protection and Plant Production may be found in Appendix I.

Relevance

Overall, the Review Panel believes that the relevance of the portfolio is very good. The chief weakness relates to integration of education and extension with research. This is partly, though not entirely, due to the current reporting systems. Improvement in the collection of appropriate outcomes and impacts for extension and education will greatly improve the overall issue of integration. Likewise, a more active role in multistate projects and more discretion to support conferences would facilitate improved two-way communication with regional, state, and local stakeholders.

Scope

The Review Panel did not find the extension and education links to be clear and they believe that better education, outreach, and public relations could be conducted to inform the consumer/customer about activities and outcomes. In addition, the portfolio's scope is wide, but perhaps not balanced. Materials presented did not showcase major issues.

2009 Response: Concerning the lack of integration pointed out by the panel, there are more integrated research/education/extension programs in the portfolio now, and more money is being spent on integrated projects. The AFRI is required by the 2008 Farm Bill to spend no less than 30% of its budget on integrated projects. The current document covers major issues and the contexts of those issues are better explained. There is a need to highlight the non-food aspects of the portfolio and partners that are not traditional land grant institutions.

Focus

Overall the portfolio's focus is good. The Panel found the lack of a NIFA strategic plan to be a systemic weakness. It also found the portfolio's ability to remain focused on time sensitive needs is outstanding. However, information presented is not sufficient to make an evaluation on all issues possible. Funding is spread too thinly across too many areas, affecting the portfolio's ability to remain focused.

2009 Response: NIFA strategic plan is in place, and is referred to in the document where relevant. There has been considerable effort in NRI/AFRI to focus program priorities, with no more than three priorities per program in a year. Some priorities are rotated so programs can stay focused in any given year. The SCRI and OREI programs have also become more focused. Concerning the comment that funding is spread too thin, there is significant financial support for each KA in the portfolio. It was noted that addition of new programs to the portfolio did not reflect a greater focus.

Contemporary and/or Emerging Issues
The Panel believes that sustainability, green industry, organic farming, and agro-forestry are emerging issues that are not adequately covered by this portfolio. Homeland Security issues such as security of genetic and other plant-related resources are emerging issues and should be considered by the portfolio. The link between nutritional plants and human health is an issue not adequately addressed.

2009 Response: All these areas are better covered now by the portfolio, with FADI, SCRI and OREI. The AFRI also has a new program on critical and emerging issues that can receive proposals any time of the year. This is a mechanism to deal with issues that cannot be covered by any other program in the RFA in a timely manner. The link between nutritional plants and human health is addressed in SCRI, as well as in the Food/nutrition portfolio.

Integration
The Panel did not find strong collaboration between Higher Education Programs and the portfolio. At the exception of the Master Gardener program, the Panel found extension missing from the portfolio. The need for a good reporting system for extension and education is urgently needed.

2009 Response: The collaboration between Higher Education Program and the portfolio is improving through the RFA planning process. Each RFA working group has a representative from the Higher Education Programs, and vice versa. Many AFRI programs are now integrated, combining research with education and/or extension. There are also new single function extension-only priorities in several AFRI programs. Other NIFA programs (e.g., SCRI) are also highly integrated. The 406 integrated programs are specifically described in this portfolio review. The portfolio is also more engaged in eXtension activities. The need for a better reporting system is being addressed by the agency's efforts to move to a system called One Solution.

Multi-disciplinary Balance
The Panel had difficulty judging this aspect of the portfolio because complete evidence was not available. Although there was some evidence of multidisciplinary research projects, not much was shown regarding multidisciplinary and inter-functional education, extension, and research projects.

2009 Response: The SCRI requires multi-disciplinary approaches to address issues as does the Risk Avoidance and Mitigation Program. In addition, the AFRI is required to spend not less that 30% of its budget on multidisciplinary projects.

Quality
The metrics were limited and not presented for all areas. NIFA needs to develop an effective reporting system to capture quality outcomes from its various partners.

Significance of Findings
The Panel believes that better communication between Federal-state partners would enhance this aspect of the portfolio. A summary of known outputs and impacts also would have been useful.

2009 Response: We believe that One Solution will address the need to develop an effective reporting system. Communication between Federal-state partners is being addressed by PIPE and the NIFA state liaison program which assigns two NPLs as liaisons to each state. Significance of findings is sometimes not publicized in a timely manner due to limitations of the agency's communication staff. There is a need to articulate cost savings as a result of the portfolio's activities.

Stakeholder/Constituent Inputs

The portfolio has done a good job of soliciting and gathering stakeholder input from a variety of sources. However, a systematic method needs to be put into place that reliably gets information to the end users. The portfolio has conducted workshops for the end-users but additional ones need to be provided. NPLs need to make sure they receive and use information from state partners.

2009 Response: The current document contains a list of stakeholder input activities, some of which occur on a regular basis. NPLs also obtain stakeholder input through a variety of avenues such as panel meeting, project director meeting, and regular interactions with professional societies.

Alignment with Current State of Science

The Panel believes that NIFA has effective control of portfolio alignment. The NRI Competitive Grants Program has shifted its areas of emphasis over the years and is in alignment with the current state of Plant Science. There is good alignment in some areas such as plant pathology, but alignment should be evident in other sciences, such as weeds and entomology.

2009 Response: The agency has programs in both weeds (Biology of Weedy and Invasive Species) and entomology (e.g., honey bee colony collapse CAP) which have good alignment with the current state of science. The Specialty Crop Research Initiative is another good example of the alignment of many science-based goals and objectives with USDA and NIFA strategic plans.

Appropriate and/or Cutting Edge Methodology

The portfolio's 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. The portfolio has shown good improvement over the years. However, evidence is lacking in terms of showing that all KAs were necessarily using the cutting edge technology.

2009 Response: The team agrees with the comment on the lack of good evidence for extension and education methods. However, we believe that as integrated programs become more common, applicants will learn how to describe methods and metrics for education and extension. Cutting edge technologies are described in the RFAs. Many KAs support research using cutting edge technologies; therefore, we must become more adept at presenting technology as part of an outcome, rather than consider it as methodology. There is usually a lag between funding and reporting of accomplishments. Although the proposed research may have been cutting edge at the time of funding, it may not be considered as such when the results are reported.

Performance
The Panel needed additional documentation and evidence in order to judge the performance of this portfolio. A Review Panel must be able to better understand the indicators about which it is asked to comment. The portfolio needs to address the issue of documentation and evidence and implement a better reporting system before the next review.

Portfolio Productivity
Productivity was high and might increase pending increased funding. The panel knows that productivity is better than what was presented by the NPLs. The Panel is aware of additional examples that could have been presented. The Review Panel would have liked to have seen more evidence of productivity, such as lists of publications, patents, and other social or physical measures. There needs to be a better system for reporting and tracking metrics.

2009 Response: The Office of Planning and Accountability keeps track of patents and inventions. The re-designed project-level logic models in the current document allow better tracking and reporting of output metrics.

Portfolio Comprehensiveness
The Review Panel's comments for this area are similar to those expressed in Portfolio Productivity. The portfolio showed gaps in its comprehensiveness evidenced in the imbalance across the various KAs. Reporting of outputs should be more comprehensive.

2009 Response: Some gaps still exist in the portfolio's comprehensiveness, although the lack of comprehensiveness previously noted by the panel may have been an artifact of reporting. Many of the NRI/AFRI programs have reduced the number of priorities to create more focus and increase the chances of success, but this makes the programs less comprehensive. Some programs are underfunded and have no concentrated program for funding (e.g., biobased pest management) and limited funding opportunities are scattered across a number of programs. With a flat budget, it is a challenge to achieve comprehensiveness in the portfolio's performance. However, the current document puts the portfolio in context, and better describes its strategic and comprehensive nature.

Portfolio Timeliness:
The Panel believed that most portfolio projects were completed within the allocated time frame. Evidence lacks to demonstrate the need to get adequate information on the number of projects that were completed on time.

2009 Response: The data on no-cost extensions should provide this information. A significant number of funded projects are under no-cost extension due to various factors such as inability of the project director to identify suitable students or postdocs to work on the project.

Agency Guidance
There is some evidence of good portfolio leadership. However, the Review Panel was unclear as to how to evaluate this aspect of Performance. The Panel had insufficient information concerning the portfolio's management. The panel would have benefited from a complete description of NPLs' role (including CVs), and a detailed organizational chart.

2009 Response: The agency's organization chart and NPL's CVs are readily available on the agency website. Further, the role of NPLs is described in this document. Under current NIFA structure, the portfolio is managed by two Deputy Administrators plus a section head in the case of the Plant and Animal Systems Unit, and a research director and an integrated program director in the case of the Competitive Programs Unit. Better guidance can be achieved by developing a strategic plan for the portfolio, which will be developed in the future. It is noted that the portfolio is becoming more sophisticated every year.

Portfolio Accountability:
There is a lack of sufficient data necessary to evaluate the accountability of the portfolio.

2009 Response: NIFA has made progress in getting awardees to understand the need for clear reporting through NRI/AFRI Project Director workshops, as well as through the development of the Leadership Management Dashboard so that NPLs can improve post-award tracking for all kinds of grants. The new standard report (REEPort) which will be used for all agency-funded programs and projects (research, K-12 and higher education, and extension) will facilitate far greater accountability for the programs and projects comprising the portfolio. This reporting will include both competitive and non-competitive program components within the portfolio.

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	2009 Score
	Plant Production	**Plant Protection**	**Plant Production**	**Plant Protection**	**Plant Systems**	**Plant Protection**	**Plant Systems**	**Plant Systems**
Relevance								
1. Scope	3	3	3	3	2.5	3	3	2.5
2. Focus	2	2	2	2.5	2	2.5	2.5	2.5
3. Contemporary and/or Emerging Issues	2	3	3	3	3	3	3	3
4. Integration	1	2	2	2.2	2	2.2	2.5	2.5
5. Multi-disciplinary Balance	2	2	3	3	2.5	2.5	2.5	2.5
Quality								
1. Significance of Findings	2	2	3	2.5	3	2.5	2.75	2.75
2. Stakeholder/ Constituent Inputs	3	2	3	2.5	3	3	3	3
3. Alignment with Current State of Science	3	3	3	3	3	3	3	3
4. Appropriate and/or Cutting-Edge Methodology	3	2	3	2.7	3	3	3	3
Performance								
1. Portfolio Productivity	2	3	2	3	2	3	2	2.5
2. Portfolio Comprehensiveness	2	2	3	2	2	2	2	2.5
3. Portfolio Timeliness	2	2	3	2	3	2	2.5	2.5
4. Agency guidance	3	2	3	2.7	3	2.5	2.75	2.75
5. Portfolio Accountability	2	2	3	2.2	2.5	2.5	2.5	2.5
Overall Score	81	80	93	89	87	90	90	89

2009 Portfolio Score Change Discussion

Only the following scores have been changed.

Relevance

Scope:
Score is lowered from 3 to 2.5.

Justification: The portfolio is not able to respond to many of stakeholders' needs (for example, areas in horticulture and biocontrol of plant pathogens). There is concern that the portfolio does not cover enough non-food aspects of plant science or include partners that are not traditional land grant institutions. There are areas where programs are overlapping, leaving room for more coordination. It is also noted that many programs have an overly narrow scope.

Performance

Portfolio productivity:
Score is raised from 2 to 2.5.

Justification: The portfolio has major outcomes, for example through the support of the honey bee colony collapse CAP program. Reporting of productivity has improved due to the project-level logic models introduced this year.

Portfolio comprehensiveness:
Score is raised from 2 to 2.5.

Justification: The current document puts the portfolio in context, and better describes the strategic and comprehensive nature of the portfolio. The lack of comprehensiveness previously noted by the panel may have been an artifact of reporting.

Appendix A – External Panel Recommendations to the Agency

In response to directives from the Office of Management and Budget (OMB) of the President, NIFA implemented the Portfolio Review Expert Panel (PREP) process to systematically review its progress in achieving its mission. Since this process began in 2003, 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 NIFA is addressing the expert panel's recommendations. These internal reports are crafted to specifically address the issues raised for a particular portfolio; however, despite the fact that 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 NIFA 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 NIFA often do not highlight the contributions made by NIFA.

Multiple panel reports suggested NIFA better monitor reports of its funding and ensure that the agency is properly credited. Many panelists were unaware of the breadth of NIFA activities and believe their lack of knowledge is partly a result of NIFA not receiving credit in publications and other material made possible by NIFA funding.

Issue 1: Agency Response:

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

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

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 NIFA material on the web. In addition, the new AREERA Plan of Work (POW) and Annual Report (AR) are fully functional. The agency requires a POW and AR on the four major research and extension formula funds; Hatch, Evans-Allen, Smith-Lever 3b&c, and 1890 Extension Programs. The reporting format and means of submission were substantially revised, they were restructured using an outcome-based, logic model design. They are collecting reports electronically via the internet using a database system. The purpose of this revision was not only to reduce the burden imposed on collecting the Plan of Work (POW) and Annual Report of Accomplishments (AR), but to make the information collected usable for NIFA program leadership and portfolio evaluation. Additional benefits were realized; the information collected can be easily analyzed and assembled into a national report on the POW and AR for these formula funded programs.

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. Questions revolving around long-term planning between the entities were common as were ones that asked how the NIFA mission and goals were being supported through its partnership with universities and vice versa.

Issue 2: Agency Response:

NIFA has taken several steps to strengthen its relationship with university partners. First, to the extent possible, implementing partners will be attending the NIFA strategic development exercise which is intended to help partners and NIFA fully align what is done at the local level. Second, NIFA has realigned the state assignments for its National Program Leaders (NPLs). Each state is now assigned to one specific NPL. By reducing the number of states on which any individual NPL is asked to concentrate and assigning and training NPLs for this duty, better communication between state and NPLs should occur.

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

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. Understanding the specific job functions of NPLs was something that helped panelists in the review process. 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:

NIFA 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, it 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 NIFA requires of its NPLs, quick hires are not always possible. Often, NIFA is unable to meet the salary demands of those it wishes to hire. It is essential that position gaps be 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. NIFA has recognized the need for these approaches and has undertaken steps to remedy this situation. NIFA has recently mandated that up to twenty 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. Finally, 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:
Outcomes that come about as a result of extension are, by the very nature of the work, more difficult to document than the outcomes of a research project. NIFA has recently shuffled its strategy of assigning NPLs to serve as liaisons for states. In the past, one NPL might serve as a liaison to several states or a region comprised of states. Each state will be assigned a specific NPL and no NPL will serve as the lead representative to more than one state. This will ensure more attention is paid to extension activities.

In addition NIFA also has been in discussion with partners and they have pledged to do their best to address this issue. The new POW will make extension-based results and reporting a priority. Placing heavy emphasis on logic models by NIFA will have the effect of necessitating the inclusion of extension activities into the state's POWs. This, in turn, will require more reporting on extension activities and allow for improved documentation of extension impact.

Issue 6: Program Evaluation
Panelists were complimentary in that they saw the creation of the Office of Planning and Accountability 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 NIFA 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 NIFA and program evaluation is an essential component of effective management. In 2003 the PREP process and subsequent internal reviews were implemented. Over the past three years fourteen portfolios have been reviewed by expert panel members and each year this process improves. NPLs are now familiar with the process and the staff of the Planning and Accountability unit 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 NIFA 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 Office of Planning and Accountability 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 Office of Planning and Accountability will be working with NPLs to deliver training to those in the field.

The Office of Planning and Accountability is working more closely with individual programs to ensure successful evaluations are developed, implemented and the data analyzed. Senior leadership at NIFA has begun to embrace program evaluation and over the coming years NIFA 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.

In addition to process developed within the Office of Planning and Accountability, NPLs have discussed methods for improved post award management and reporting. Many agency Requests for Applications (RFAs) are now encouraging program evaluation and post award reporting of outcomes and impacts of funded activities. Steps are being taken to providing an electronic database that will make it easier to report outcomes and impacts of NIFA funded activities anytime after agency funding for the project has ended.

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 NIFA 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 NIFA and the agency has been proactive in promoting the use of logic models to its state partners. Recent agency-wide 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

The system is now operational and states were required to begin using it by June of 2006. By requiring the inclusion of the data components listed above states are in essence, creating a logic model that NIFA believes will help improve both program management and outcome reporting.

OPA conducted a recent training seminar regarding logic model concerns. In October and November of 2005 four separate training sessions were held in Monterrey, California, Lincoln, Nebraska, Washington D.C. and Charleston, South Carolina. More than 200 people representing land-grant universities attended these sessions where they were given training in logic model creation, program planning, and evaluation. In addition, two training sessions were provided to NPLs in December 2005 and January 2006 to further familiarize them with the logic model process. Ultimately it is hoped these representatives will pass on to others in the Land-Grant system what they learned about logic models thus creating a network of individuals utilizing the same general approach to strategic planning. These materials also have been made available to the public on the NIFA website.

As a result of OPAs efforts to inform and educate agency staff about the logic model, NPLs have started implementing logic model use in RFAs, particularly in AFRI. These logic models are used as a planning tool for Agency-funded projects. RFA applicants, reviewers and awarders are able to grasp the progression of a proposed activity and define expected outputs, outcomes and impacts.

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

NIFA Only Funding tables provide details of agency specific funding for a five fiscal year span for primary KA activities. The funding sources are agency ONLY funding sources. The grand total of these funding sources equals NIFA ADMIN funding that is included in the Overall Funding tables. Below are definitions for NIFA funding sources identified in the following funding tables.

- Hatch (HATCH) formula funds are allocated to the States, for the purpose of conducting agricultural research by the State Agricultural Experiment Stations. Hatch dollars are reported as expenditures in the following funding tables.

- McIntire-Stennis (MC-STN) are funds allocated to the States, for the purpose of conducting forestry research by schools of forestry, land-grant colleges, and State Agricultural Experiment Stations. McIntire-Stennis dollars are reported as expenditures in the following funding tables.

- Evans-Allen funds are allocated to the eligible institutions for support of agricultural research by the 1890 Colleges and Tuskegee University. These dollars are reported as expenditures to the Current Research Information System.

- Animal Health and Disease Program formula funds are allocated to eligible institutions for support of livestock and poultry disease research. These dollars are reported as expenditures to the Current Research Information System.

- Special Research Grants funds are awarded to eligible institutions for the purpose of conducting research to facilitate or expand food and agricultural research programs. These dollars are obligated funds reported in the Current Research Information System.

- National Research Initiative (NRI) Competitive Grants awarded to the eligible institutions for the purpose of conducting research emphasizing natural resources and the environment; nutrition, food quality, and health; plant systems; animal system; rural development, markets, and trade; and processing for value-added products. Note that in FY 2009, NRI was replaced by the Agriculture and Food Research Initiative (AFRI). These dollars are obligated funds reported in the Current Research Information System.

- Small Business Innovation Research (SBIR) Program grants awarded to eligible institutions for the purpose of supporting high quality research proposals containing advanced concepts related to research on forests and related resources; plant production and protection; animal production and protection; air, water and soils; food science and nutrition; rural and community development; aquaculture; and industrial applications. These dollars are obligated funds reported in the Current Research Information System.

- OTHER NIFA funds are NIFA Administered funding programs not included in Hatch, McIntire-Stennis, Evans-Allen, Animal Health and Disease, Special Research Grants, National Research Initiative, or Small Business Innovation Research funding programs. These include cooperative agreements, and all other agency administered research grants awarded either competitively or non-competitively. These dollars are obligated funds

reported in the Current Research Information System.

- Smith Lever 3(d) provides, among other Extension programs, the opportunity for 1862 and 1890 Land-Grant Institutions, including Tuskegee University and West Virginia State University, and the University of the District of Columbia to compete for and receive extension funds for plant protection programs. Smith Lever 3(d) funds became competitive in 2008, prior to that, Smith Lever 3(d) was a non-competitive extension funding source. Eligibility was expanded by direction included in the Food, Conservation and Energy Act of 2008. These dollars are obligated funds reported in the Current Research Information System.

- Smith Lever 3(b) and (c) funds provide funding for agricultural extension programs at 1862 Land-grant universities. These dollars are reported as expenditures in the Plan of Work Annual Report.

- 1890 funds provide funding for agricultural extension programs at 1890 Land-grant universities. These dollars are reported as expenditures in the Plan of Work Annual Report.

KA 201: Plant Genome, Genetics, and Genetic Mechanisms NIFA Funding						
Combined Research and Extension Dollars						
$ in the thousands						
Funding Source	**FY 2004**	**FY 2005**	**FY 2006**	**FY 2007**	**FY 2008**	**Total**
Hatch	6,217	6,211	5,919	8,023	9,663	36,033
McIntire-Stennis	192	284	375	721	650	2,222
Evans Allen	1,206	1,246	1,172	931	1,009	5,564
Animal Health	0	0	0	0	0	0
Special Grants	5,145	4,595	6,185	0	4,910	20,835
NRI Grants	9,625	11,160	15,042	13,547	15,883	65,257
SBIR Grants	248	470	56	710	765	2,249
Other NIFA	2,708	2,236	1,644	1,753	5,627	13,968
Smith-Lever 3(d)	NA	NA	NA	0	0	0
Total Reported in CRIS	25,341	26,202	30,393	25,685	38,507	146,128
Smith-Lever 3(b) and (c)	NA	NA	NA	1,347	1,870	3,217
1890 Extension	NA	NA	NA	153	201	3,570
Total Extension Reported in POW	NA	NA	NA	1,500	2,071	3,570
Total (NIFA Admin)	25,341	26,202	30,393	27,185	40,577	149,698

KA 202: Plant Genetic Resources NIFA Funding						
Combined Research and Extension Dollars						
$ in the thousands						
Funding Source	**FY 2004**	**FY 2005**	**FY 2006**	**FY 2007**	**FY 2008**	**Total**
Hatch	5,811	5,889	5,760	6,912	8,280	32,652
McIntire-Stennis	189	175	186	179	105	834
Evans Allen	817	870	969	730	819	4,205
Animal Health	0	0	0	0	0	0
Special Grants	3,048	3,129	4,443	30	3,270	13,920
NRI Grants	1,033	783	1,523	1,845	3,700	8,884
SBIR Grants	289	0	16	0	80	385
Other NIFA	746	826	170	800	2,254	4,796
Smith-Lever 3(d)	NA	NA	NA	0	0	0
Total Reported in CRIS	11,933	11,672	13,067	10,496	18,508	65,676
Smith-Lever 3(b) and (c)	NA	NA	NA	1,051	1,345	2,396
1890 Extension	NA	NA	NA	68	75	143
Total Extension Reported in POW	NA	NA	NA	1,119	1,421	2,540
Total (NIFA Admin)	11,933	11,672	13,067	11,615	19,929	68,216

KA 203: Plant Biological Efficiency and Abiotic Stresses Affecting Plants NIFA Funding						
Combined Research and Extension Dollars						
$ in the thousands						
Funding Source	**FY 2004**	**FY 2005**	**FY 2006**	**FY 2007**	**FY 2008**	**Total**
Hatch	5,364	6,248	5,563	7,275	6,938	31,388
McIntire-Stennis	329	380	358	491	288	1,846
Evans Allen	943	536	331	335	313	2,458
Animal Health	0	0	0	0	0	0
Special Grants	2,154	2,822	2,859	0	2,812	10,647
NRI Grants	3,890	3,999	4,271	4,170	4,394	20,724
SBIR Grants	376	0	0	80	0	456
Other NIFA	621	1,091	1,344	271	348	3,675
Smith-Lever 3(d)	NA	NA	NA	0	0	0
Total Reported in CRIS	13,677	15,076	14,727	12,622	15,093	71,195
Smith-Lever 3(b) and (c)	NA	NA	NA	1,059	1,160	2,219
1890 Extension	NA	NA	NA	233	271	504
Total Extension Reported in POW	NA	NA	NA	1,292	1,431	2,723
Total (NIFA Admin)	13,677	15,076	14,727	13,914	16,524	73,918

KA 204: Plant Product Quality and Utility (Preharvest) NIFA Funding						
Combined Research and Extension Dollars						
$ in the thousands						
Funding Source	**FY 2004**	**FY 2005**	**FY 2006**	**FY 2007**	**FY 2008**	**Total**
Hatch	2,849	3,003	2,843	3,503	4,604	16,802
McIntire-Stennis	96	69	93	96	111	465
Evans Allen	508	665	472	530	277	2,452
Animal Health	0	0	0	0	0	0
Special Grants	3,848	3,457	1,657	0	1,483	10,445
NRI Grants	553	757	1,362	772	301	3,745
SBIR Grants	378	296	199	104	174	1,151
Other NIFA	1,492	957	338	385	2,238	5,410
Smith-Lever 3(d)	NA	NA	NA	6	6	13
Total Reported in CRIS	9,724	9,203	6,964	5,396	9,194	40,482
Smith-Lever 3(b) and (c)	NA	NA	NA	1,934	2,109	4,043
1890 Extension	NA	NA	NA	166	130	296
Total Extension Reported in CRIS	NA	NA	NA	2,100	2,239	2,100
Total (NIFA Admin)	9,724	9,203	6,964	7,497	11,433	44,821

KA 205: Plant Management Systems NIFA Funding						
Combined Research and Extension Dollars						
$ in the thousands						
Funding Source	**FY 2004**	**FY 2005**	**FY 2006**	**FY 2007**	**FY 2008**	**Total**
Hatch	8,584	8,544	8,222	10,167	11,560	47,077
McIntire-Stennis	76	67	50	113	48	354
Evans Allen	1,430	1,986	2,557	2,201	1,803	9,977
Animal Health	0	0	0	0	0	0
Special Grants	7,385	8,156	9,074	30	4,839	29,484
NRI Grants	116	1,069	1,513	1,670	1,106	5,474
SBIR Grants	709	580	708	65	220	2,282
Other NIFA	2,177	4,196	4,696	4,480	10,614	26,163
Smith-Lever 3(d)	NA	NA	NA	451	113	564
Total Reported in CRIS	20,477	24,597	26,820	19,176	30,303	120,811
Smith-Lever 3(b) and (c)	NA	NA	NA	13,651	13,150	13,651
1890 Extension	NA	NA	NA	1,001	1,026	1,001
Total Extension Reported in POW	NA	NA	NA	14,651	14,176	28,828
Total (NIFA Admin)	20,477	24,597	26,820	33,827	44,479	150,201

KA 206: Basic Plant Biology NIFA Funding						
Combined Research and Extension Dollars						
$ in the thousands						
Funding Source	**FY 2004**	**FY 2005**	**FY 2006**	**FY 2007**	**FY 2008**	**Total**
Hatch	4,253	4,755	5,194	5,376	5,913	25,491
McIntire-Stennis	225	195	235	284	184	1,123
Evans Allen	388	480	245	235	381	1,729
Animal Health	0	0	0	0	0	0
Special Grants	745	531	651	0	376	2,303
NRI Grants	9,138	11,969	8,381	10,685	11,395	51,568
SBIR Grants	200	40	0	80	175	495
Other NIFA	561	638	1,288	444	1,043	3,973
Smith-Lever 3(d)	NA	NA	NA	23	14	38
Total Reported in CRIS	15,510	18,609	15,995	17,126	19,481	86,721
Smith-Lever 3(b) and (c)	NA	NA	NA	1,063	1,304	2,367
1890 Extension	NA	NA	NA	54	43	97
Total Extension Reported in POW	NA	NA	NA	1,117	1,346	2,463
Total (NIFA Admin)	15,510	18,609	15,995	18,243	20,827	89,184

KA 211: Insects, Mites, and Other Arthropods Affecting Plants NIFA Funding						
Combined Research and Extension Dollars						
$ in the thousands						
Funding Source	**FY 2004**	**FY 2005**	**FY 2006**	**FY 2007**	**FY 2008**	**Total**
Hatch	7,114	6,420	7,320	7,817	8,539	37,210
McIntire-Stennis	410	271	335	396	456	1,868
Evans Allen	531	540	636	429	632	2,768
Animal Health	0	0	0	0	7	7
Special Grants	5,858	6,531	6,274	3,061	2,395	24,119
NRI Grants	4,686	6,764	5,802	6,996	6,254	30,502
SBIR Grants	200	205	144	861	995	2,405
Other NIFA	1,066	1,089	2,526	3,173	7,028	14,882
Smith-Lever 3(d)	NA	NA	NA	16	0	16
Total Reported in CRIS	19,865	21,820	23,036	22,750	26,306	113,777
Smith-Lever 3(b) and (c)	NA	NA	NA	2,896	2,984	5,880
1890 Extension	NA	NA	NA	355	376	731
Total Extension Reported in POW	NA	NA	NA	3,251	3,360	6,611
Total (NIFA Admin)	19,865	21,820	23,036	26,001	29,666	120,388

KA 212: Pathogens and Nematodes Affecting Plants NIFA Funding						
Combined Research and Extension Dollars						
$ in the thousands						
Funding Source	**FY 2004**	**FY 2005**	**FY 2006**	**FY 2007**	**FY 2008**	**Total**
Hatch	9,671	10,118	10,284	12,295	13,931	56,299
McIntire-Stennis	274	270	377	500	335	1,756
Evans Allen	254	297	466	498	514	2,029
Animal Health	0	0	0	0	0	0
Special Grants	7,220	7,895	8,499	987	5,225	29,826
NRI Grants	12,840	11,990	15,168	15,399	16,750	72,147
SBIR Grants	222	191	512	161	682	1,768
Other NIFA	2,741	2,887	1,744	6,508	9,455	23,335
Smith-Lever 3(d)	NA	NA	NA	6	86	92
Total Reported in CRIS	33,222	33,648	37,050	36,355	46,978	187,253
Smith-Lever 3(b) and (c)	NA	NA	NA	3,610	3,652	7,263
1890 Extension	NA	NA	NA	308	322	631
Total Extension Reported in POW	NA	NA	NA	3,919	3,975	7,894
Total (NIFA Admin)	33,222	33,648	37,050	40,274	50,953	195,146

KA 213: Weeds Affecting Plants NIFA Funding						
Combined Research and Extension Dollars						
$ in the thousands						
Funding Source	**FY 2004**	**FY 2005**	**FY 2006**	**FY 2007**	**FY 2008**	**Total**
Hatch	3,255	3,446	3,121	3,818	4,065	17,705
McIntire-Stennis	70	67	54	74	50	315
Evans Allen	251	268	251	22	60	852
Animal Health	0	0	0	0	0	0
Special Grants	3,449	3,343	3,832	1,211	667	12,502
NRI Grants	0	2,383	2,291	446	1,639	6,759
SBIR Grants	31	80	174	46	251	582
Other NIFA	1,644	1,531	1,651	2,285	3,324	10,435
Smith-Lever 3(d)	NA	NA	NA	48	39	88
Total Reported in CRIS	8,700	11,119	11,374	7,950	10,096	49,239
Smith-Lever 3(b) and (c)	NA	NA	NA	2,499	2,581	5,081
1890 Extension	NA	NA	NA	140	206	346
Total Extension Reported in POW	NA	NA	NA	2,640	2,787	5,427
Total (NIFA Admin)	8,700	11,119	11,374	10,590	12,883	54,666

KA 214: Vertebrates, Mollusks, and Other Pests Affecting Plants NIFA Funding						
Combined Research and Extension Dollars						
$ in the thousands						
Funding Source	**FY 2004**	**FY 2005**	**FY 2006**	**FY 007**	**FY 2008**	**Total**
Hatch	56	88	64	65	69	342
McIntire-Stennis	7	16	8	41	29	101
Evans Allen	0	0	0	0	0	0
Animal Health	0	0	0	0	0	0
Special Grants	927	360	427	0	0	1,714
NRI Grants	0	0	0	0	70	70
SBIR Grants	0	0	0	0	0	0
Other NIFA	0	0	0	125	124	249
Smith-Lever 3(d)	NA	NA	NA	4	0	4
Total Reported in CRIS	990	464	499	234	292	2,479
Smith-Lever 3(b) and (c)	NA	NA	NA	305	336	641
1890 Extension	NA	NA	NA	11	39	50
Total Extension Reported in POW	NA	NA	NA	316	375	691
Total (NIFA Admin)	990	464	499	550	667	3,170

KA 215: Biological Control of Pests Affecting Plants NIFA Funding						
Combined Research and Extension Dollars						
$ in the thousands						
Funding Source	**FY 2004**	**FY 2005**	**FY 2006**	**FY 2007**	**FY 2008**	**Total**
Hatch	4,700	4,113	3,835	3,894	4,096	20,638
McIntire-Stennis	114	122	116	177	148	677
Evans Allen	591	508	691	789	737	3,316
Animal Health	0	0	0	0	0	0
Special Grants	1,223	1,204	1,539	582	701	5,249
NRI Grants	1,453	2,077	2,583	1,906	3,561	11,580
SBIR Grants	376	592	64	32	685	1,749
Other NIFA	1,038	440	1,726	1,364	972	5,540
Smith-Lever 3(d)	NA	NA	NA	0	0	0
Total Reported in CRIS	9,495	9,055	10,554	8,744	10,900	48,748
Smith-Lever 3(b) and (c)	NA	NA		1,131	1,092	2,223
1890 Extension	NA	NA	NA	34	61	96
Total Extension Reported by POW	NA	NA	NA	1,166	1,153	2,319
Total (NIFA Admin)	9,495	9,055	10,554	9,910	12,053	51,067

KA 216: Integrated Pest Management Systems NIFA Funding						
Combined Research and Extension Dollars						
$ in the thousands						
Funding Source	**FY 2004**	**FY 2005**	**FY 2006**	**FY 2007**	**FY 2008**	**Total**
Hatch	3,718	3,256	3,475	4,628	5,591	20,668
McIntire-Stennis	158	117	135	176	87	673
Evans Allen	360	430	525	486	452	2,253
Animal Health	0	0	0	8	21	29
Special Grants	3,924	3,796	3,846	5,314	6,318	23,198
NRI Grants	1,160	947	1,828	988	854	5,777
SBIR Grants	0	48	296	32	79	455
Other NIFA	5,739	5,857	7,835	5,896	9,751	35,078
Smith-Lever 3(d)	NA	NA	NA	736	37	773
Total Reported in CRIS	15,059	14,451	17,940	18,264	23,190	88,904
Smith-Lever 3(b) and (c)	NA	NA	NA	6,590	5,873	12,463
1890 Extension	NA	NA	NA	187	265	452
Total Extension Reported in POW	NA	NA	NA	6,777	6,138	12,916
Total (NIFA Admin)	15,059	14,451	17,940	25,041	29,329	101,820

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

Overall Funding tables provide financial information regarding outside funding sources and their contribution to agency activities, for a five fiscal year span. The grand total of these funding sources amounts to the total funding for agency activities, including internal and external funding.

- NIFA ADMIN funds are expenditures of formula grant and other grant funding administered by NIFA and distributed to the State Agricultural Experiment Stations (SAES) and Other Cooperating Institutions (OCI). The programs included are Hatch, McIntire Stennis, Evans Allen, Animal Health, Special Grants, Competitive Grants, Small Business Innovation Research Grants, Other NIFA grant, Smith-Lever 3(d), Smith-Lever 3(b) and (c), and 1890 Extension programs.

- Other USDA funds are expenditures of funds received by the SAES and other cooperating institutions from contracts, grants, or cooperative agreements, with one of the USDA research agencies other than NIFA.

- Other Federal (FED) funds are expenditures of funds by USDA agencies, the SAES and other cooperating institutions received from federal sources, outside of USDA, through contracts, grants, and cooperative agreements directly with other federal agencies.

- State Appropriations (APPR) funds are expenditures of funds by the SAES and other cooperating institutions received from sources outside of the federal government. Direct appropriations from individual state governments.

- OTHER NON-Federal (FED) funds are expenditures of funds by USDA agencies, the SAES and other cooperating institutions received from sources outside of the federal government. Sources include the sale of products (self generated), industry grants, and miscellaneous non federal sources.

KA 201: Plant Genome, Genetics, and Genetic Mechanisms Overall Funding						
Combined Research and Extension Dollars						
$ in the thousands						
Funding Source	**FY 2004**	**FY 2005**	**FY 2006**	**FY 2007**	**FY 2008**	**Total**
NIFA Admin	25,340	26,202	30,393	27,185	40,577	149,697
Other USDA	4,083	4,409	3,639	5,829	6,180	24,140
Other Federal	38,896	39,758	42,411	42,589	33,387	197,041
State Appr.	44,291	44,682	45,137	47,555	50,588	232,253
Other Non-Fed	20,833	22,097	22,630	25,449	28,808	119,817
Total	133,444	137,148	144,211	147,108	159,540	721,451

KA 202: Plant Genetic Resources Overall Funding						
Combined Research and Extension Dollars						
$ in the thousands						
Funding Source	**FY 2004**	**FY 2005**	**FY 2006**	**FY 2007**	**FY 2008**	**Total**
NIFA Admin	11,932	11,672	13,067	11,615	19,929	68,215
Other USDA	2,254	2,173	2,173	2,526	2,744	11,870
Other Federal	6,418	6,788	6,621	4,558	3,051	27,436
State Appr.	22,231	22,842	24,668	26,482	24,779	121,002
Other Non-Fed	9,953	10,796	10,686	12,072	11,771	55,278
Total	52,788	54,270	57,214	56,133	62,274	282,679

KA 203: Plant Biological Efficiency and Abiotic Stresses Affecting Plants Overall Funding						
Combined Research and Extension Dollars						
$ in the thousands						
Funding Source	**FY 2004**	**FY 2005**	**FY 2006**	**FY 2007**	**FY 2008**	**Total**
NIFA Admin	13,677	15,076	14,727	13,914	16,524	73,918
Other USDA	1,876	1,852	2,018	2,113	2,865	10,724
Other Federal	8,751	8,952	9,495	8,292	9,490	44,980
State Appr.	33,692	34,000	34,105	35,244	37,241	174,282
Other Non-Fed	13,666	15,071	15,398	16,643	16,360	77,138
Total	71,660	74,950	75,743	74,915	82,480	379,748

KA 204: Plant Product Quality and Utility (Preharvest) Overall Funding						
Combined Research and Extension Dollars						
$ in the thousands						
Funding Source	**FY 2004**	**FY 2005**	**FY 2006**	**FY 2007**	**FY 2008**	**Total**
NIFA Admin	9,724	9,203	6,964	7,497	11,433	44,821
Other USDA	2,059	1,990	1,845	1,694	1,992	9,580
Other Federal	1,517	1,614	2,129	1,670	1,747	8,677
State Appr.	20,679	20,832	22,080	19,051	21,669	104,311
Other Non-Fed	9,051	9,092	9,272	9,271	10,203	46,889
Total	43,029	42,732	42,290	37,081	47,044	212,176

KA 205: Plant Management Systems Overall Funding						
Combined Research and Extension Dollars						
$ in the thousands						
Funding Source	**FY 2004**	**FY 2005**	**FY 2006**	**FY 2007**	**FY 2008**	**Total**
NIFA Admin	20,476	24,597	26,820	33,827	44,479	150,199
Other USDA	3,077	2,598	2,860	3,598	4,014	16147
Other Federal	3,700	5,090	5,108	4,791	3,054	21743
State Appr.	41,534	43,687	46,792	47,739	53,445	233197
Other Non-Fed	17,073	19,172	20,025	19,893	20,299	96462
Total	85,861	95,144	101,606	95,197	125,291	503,099

KA 206: Basic Plant Biology Overall Funding						
Combined Research and Extension Dollars						
$ in the thousands						
Funding Source	**FY 2004**	**FY 2005**	**FY 2006**	**FY 2007**	**FY 2008**	**Total**
NIFA Admin	15,508	18,609	15,995	18,243	20,827	89,182
Other USDA	1,122	1,125	1,211	986	1,598	6,042
Other Federal	21,997	23,171	24,074	22,495	22,042	113,779
State Appr.	28,820	30,692	32,554	31,726	33,719	157,511
Other Non-Fed	14,152	14,158	11,394	11,576	10,584	61,864
Total	81,600	87,754	85,227	83,907	88,770	427,258

KA 211: Insects, Mites, and Other Arthropods Affecting Plants Overall Funding						
Combined Research and Extension Dollars						
$ in the thousands						
Funding Source	**FY 2004**	**FY 2005**	**FY 2006**	**FY 2007**	**FY 2008**	**Total**
NIFA Admin	19,866	21,820	23,036	26,001	29,666	120,389
Other USDA	4,378	5,261	6,422	5,832	6,219	28,112
Other Federal	10,111	11,752	10,954	10,224	9,132	52,173
State Appr.	39,011	39,189	38,002	37,950	42,532	196,684
Other Non-Fed	13,828	15,644	17,272	16,533	18,748	82,025
Total	87,193	93,667	95,685	93,289	106,297	476,131

KA 212: Pathogens and Nematodes Affecting Plants Overall Funding						
Combined Research and Extension Dollars						
$ in the thousands						
Funding Source	**FY 2004**	**FY 2005**	**FY 2006**	**FY 2007**	**FY 2008**	**Total**
NIFA Admin	33,222	33,648	37,050	40,274	50,953	195,147
Other USDA	9,267	8,913	9,004	10,880	9,101	47,165
Other Federal	15,561	17,372	19,600	12,909	14,299	79,741
State Appr.	63,033	61,388	63,025	61,874	65,906	315,226
Other Non-Fed	26,956	32,735	32,580	33,146	33,776	159,193
Total	148,039	154,057	161,258	155,164	174,035	792,553

KA 213: Weeds Affecting Plants Overall Funding						
Combined Research and Extension Dollars						
$ in the thousands						
Funding Source	**FY 2004**	**FY 2005**	**FY 2006**	**FY 2007**	**FY 2008**	**Total**
NIFA Admin	8,701	11,119	11,374	10,590	12,883	54,667
Other USDA	1,242	969	1,094	1,767	1,437	6,509
Other Federal	1,965	1,975	2,115	1,746	1,780	9,581
State Appr.	18,113	18,140	17,520	17,922	18,935	90,630
Other Non-Fed	10,157	10,078	11,387	9,511	10,328	51,461
Total	40,178	42,280	43,491	38,894	45,363	210,206

KA 214: Vertebrates, Mollusks, and Other Pests Affecting Plants Overall Funding						
Combined Research and Extension Dollars						
$ in the thousands						
Funding Source	**FY 2004**	**FY 2005**	**FY 2006**	**FY 2007**	**FY 2008**	**Total**
NIFA Admin	990	464	499	550	667	3,170
Other USDA	5	3	5	7	30	50
Other Federal	34	81	42	22	50	229
State Appr.	428	294	138	156	293	1,309
Other Non-Fed	282	250	107	71	65	775
Total	1,739	1,091	791	491	1,105	5,217

KA 215: Biological Control of Pests Affecting Plants Overall Funding						
Combined Research and Extension Dollars						
$ in the thousands						
Funding Source	**FY 2004**	**FY 2005**	**FY 2006**	**FY 2007**	**FY 2008**	**Total**
NIFA Admin	9,495	9,055	10,554	9,910	12,053	51,067
Other USDA	2,264	2,632	2,850	2,048	2,337	12,131
Other Federal	5,103	3,934	3,681	3,569	2,736	19,023
State Appr.	22,828	20,619	17,831	18,819	17,402	97,499
Other Non-Fed	6,060	7,023	6,159	7,116	7,027	33,385
Total	45,749	43,263	41,074	40,296	41,555	211,937

KA 216: Integrated Pest Management Systems Overall Funding						
Combined Research and Extension Dollars						
$ in the thousands						
Funding Source	**FY 2004**	**FY 2005**	**FY 2006**	**FY 2007**	**FY 2008**	**Total**
NIFA Admin	15,060	14,451	17,940	25,041	29,329	101,821
Other USDA	3,966	4,408	4,121	4,231	5,287	22,013
Other Federal	3,873	3,256	1,997	1,629	2,170	12,925
State Appr.	22,594	23,633	24,082	25,706	27,871	123,886
Other Non-Fed	11,385	11,577	12,663	12,489	14,315	62,429
Total	56,878	57,326	60,803	62,319	78,972	316,298

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.
Agriculture and Food Research Initiative	Broad competitive research grants program that provides broad funding, including support for this portfolio. Previously administered as the National Research Initiative (NRI).
Small Business Innovation Research	Broad competitive research grants programs to small businesses that provide 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, NIFA 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 U.S. 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. NIFA 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. **NIFA**	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:

Name of Agency or Organization	
Agricultural Research Service	USDA Agencies
Animal and Plant Health Inspection Service (Plant Protection and Quarantine)	USDA Agencies
Economic Research Service	USDA Agencies
Natural Resources Conservation Service	USDA Agencies
U.S. Forest Service	USDA Agencies
National Agricultural Library	USDA Agencies
National Agricultural Statistical Service	USDA Agencies
Agricultural Marketing Service	USDA Agencies
Farm Service Administration	USDA Agencies
USDA Sustainable Development Council	USDA Agencies
National Park Service	Non-USDA Federal Agencies
U.S. Fish and Wildlife Service	Non-USDA Federal Agencies
Department of Homeland Security	Non-USDA Federal Agencies
Environmental Protection Agency	Non-USDA Federal Agencies
National Science Foundation	Non-USDA Federal Agencies
National Aeronautics and Space Administration	Non-USDA Federal Agencies
USDA Invasive Species Coordinating Committee.	External Organizations
Regional IPM Centers	External Organizations
National Plant Diagnostic Laboratory Networks	External Organizations
Pest Information Platform for Extension and Education (ipmPIPE)	External Organizations
Integrated Pest Management Training Consortium	External Organizations
National Grape and Wine Initiative	External Organizations
National Berry Crop Initiative	External Organizations
National Vegetable Crop Initiative	External Organizations
Specialty Crop Research Team	External Organizations
Specialty Crop Engineering Working Group	External Organizations
Federal Interagency Committee on the Management of Noxious and Exotic Weeds	External Organizations
Management of Invasive Terrestrial Animals and Pathogens	External Organizations
NASA/USDA Focus Area Working Group on Invasive Species	External Organizations
Aquatic Nuisance Species Task Force	External Organizations
Federal IPM Coordinating Committee	External Organizations
Technical Advisory Group for the Biological Control of Weeds	External Organizations
Ad Hoc Working Group for Registration of Pesticides for Aquatic Weeds	External Organizations
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	External Organizations

Appendix F - Program Evaluations:

Program Evaluations		
Date	**Type of Evaluation/Analyses**	**Details of Evaluation/Analyses**
3/3 – 4/2004	Post-Award Peer Review of IFAFS/RAMP Grants	Brief Description: 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. Evaluation Recommendations: • 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. What Was the Effect: • 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	Brief Description: Provide opportunity to critique PMAP while issues are fresh Evaluation Recommendations: Improvements to RFA, Issues such as duplicate applications to other NIFA grant programs, uniformity of relevance reviews by Regional IPM Centers What Was the Effect: Improved understanding of the RFA by applicants, mitigation of duplicate submission issues, enhanced cooperation with Regional IPM Centers, greater accountability

Appendix G – List of Stakeholder Groups Consulted:

Group Consulted	Date of Consultation
International Wheat Genome Sequencing Consortium	January 2008
Workshop on the ARS Overseas Biological Control Laboratories (OBCL)	May 2008
NP 304 Crop Protection and Quarantine National Program Workshop	May 2008
Conservation of Insect Genetic Resources	September 2008
Extension Integrated Pest Management Coordination and Support Program Listening Session	October 2008 & March 2009
Genes to Products Meeting Project Director Meeting	2009
Methyl Bromide Alternatives Organization Conference	2009
NRI Plant Genome Project Directors Meeting	January 2009
Slug and Snail IPM Workgroup Meeting	March 26, 2009

Appendix H - Documentation of Previous Score Changes:

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 from 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: NIFA 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 panels, awardee meetings, 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 NIFA 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 from 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 NIFA 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 taxi; for example, mission-linked systems management of both arthropod and vertebrate pests (e.g., rats, mice, birds, invasive fish.).

- 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: NIFA 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.