National Research Initiative

Competitive Grants Program

Knowledge for Tomorrow's Solutions

Annual Report
Fiscal Year 2005

http://www.csrees.usda.gov/funding/nri/nri.html

Telephone: 202-401-5022

Email: nricgp@csrees.usda.gov

Materials Available on the Internet

This annual report and other NRI materials, such as abstracts of funded active projects and the current Request for Applications, are available on the NRI Funding Opportunities page at http://www.csrees.usda.gov/funding/nri/nri.html.

For more information about the NRI, write or call:

USDA/CSREES/NRICGP
STOP 2241
1400 Independence Avenue, SW
Washington, DC 20250-2241
Telephone: (202) 401-5022
Email: nricgp@csrees.usda.gov

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Message from the CSREES Competitive Programs Extension and Education Advisor

Colleagues,

In an effort to address CSREES's mission to advance knowledge for agriculture, the environment, human health and well being, and communities, the National Research Initiative (NRI) funds a broad and diverse portfolio of fundamental and applied, mission-relevant research. Creation of new knowledge is an essential element of the NRI. Equally important is developing an understanding of how that knowledge can be applied to help resolve some of today's problems. The integrated programs within the NRI do just that – help solve today's problems through education, extension, and research. Faculty incorporate new knowledge gained in laboratory and field studies into the classroom to create a more informed student body. Teachers engage their students to seek new and creative ways to apply this information to their future endeavors. Likewise extension faculty incorporate new knowledge into a multitude of educational venues to help individuals, families, and communities use the information to enhance their economic, social, or environmental well being. In collaboration with clientele, extension faculty also seek new ways to enhance the application of this knowledge to solve issues of local importance. The triad of research, education, and extension in one integrated project ensures the mission of CSREES is achieved and new found knowledge applied.

Projects funded by the NRI creatively weave timely societal issues with CSREES's mission. Knowledge generated by these projects is disseminated to the public in a variety of ways. Research projects commonly contribute their findings to public data bases as well as provide information via scientific journals, patents, and internet web sites. Education and extension components are key features of integrated projects and provide creative and unique methods to bring this information to the public, such as new academic course material, research opportunities for students, and the creation and delivery of extension and education programs. The projects discussed below exemplify the mission-relevant research and integrated projects funded through the NRI and the innovative path the information follows from the research desk to the public realm.

Soybean Rust is a disease caused by a fungus that affects crop plants around the world. An NRI funded project is examining the spatial and temporal dispersion of fungus spores as a means to understand and prevent the spread of this disease. This project presents a classic example of an NRI research project addressing an agricultural need. Maps showing the aerial extent of Soybean Rust will be made available to the public over the internet to better forecast the spread of the disease and inform soybean producers to the potential threat. This research is currently being incorporated by the cooperative extension system to better inform growers to the danger of soybean rust in their region, reduce the use of expensive fungicides, and produce healthier crops in a cleaner environment.

A clean and healthy environment is another aspect of CSREES' mission. The NRI addresses this matter by funding projects that examine environmental issues in a variety of ways. Migrating plant species are aided by humans, both accidentally and intentionally. The arrival of an invasive species to an area is often detrimental to the native plants by negatively affecting biological diversity as well as natural community and ecosystem processes. The Invasive Plant Atlas of New England is an integrated project utilizing a strong volunteer base to develop predictive models of the potential distribution of invasive species in the region. This project may serve as a model for the creation of a national early detection and rapid response network for invasive species.

The NRI promotes human health through a series of projects that address obesity issues in different segments of the population. An integrated project out of New Orleans examines the influence of neighborhood environment on the eating habits of children. The research focuses on the availability of two key food groups - fruits and vegetables versus calorie-dense snack foods - and the consumption of these foods by children after controlling for food prices, household income, and individual socio-demographic characteristics. The project's extension component will develop simple indicators to describe and rank neighborhoods on food access for use in planning and evaluating interventions. In addition, this project will enhance Tulane University's curriculum by creating additional graduate-level course work and field-placement opportunities for nutrition students.

CSREES' mission also extends to rural communities. A study in upstate New York will examine the connections between local producers and consumers in order to improve farm incomes, strengthen rural agricultural economies, reduce the distance food travels, and promote better nutrition. The researchers will map the potential productivity and economic use-value of land for different classes of agriculture using geographic information system (GIS). The distance between food suppliers and population centers will be calculated to determine if local agriculture can meet the food needs of the population. Maps generated during the project will be made available to the public over the internet along with educational materials. The project directors hope the availability of information on local food options will stimulate the local economy and alleviate social and environmental problems prevalent in our modern food system.

I am honored to participate in the 2005 NRI and I hope you enjoy reading and sharing in the vision of these NRI grants.

Elbert Dickey, Ph.D.

Extension and Education Advisor

Competitive Programs

The National Research Initiative: An Overview

The Cooperative State Research, Education, and Extension Service (CSREES) has the unique mission to advance knowledge for agriculture, the environment, human health and well-being, and communities. The mission is achieved by funding projects that support mission-relevant topics benefiting society while advancing agricultural achievements. These projects also promote effective communication between scientific disciplines and bring together stakeholders with similar interests. The National Research Initiative (NRI), the largest competitive program offered through CSREES, was established to further the mission by addressing three key aspects of agriculture.

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

In Fiscal Year 2003, The National Research Initiative (NRI) expanded its interest beyond those set during the program's inception to incorporate education and extension components. The inclusion of education and extension to a traditional research platform allowed the NRI to address agriculturally relevant concerns academically while expanding the reach of this program to better address the needs of the end-user.

In Fiscal Year 2005, the NRI received an increase in the fiscal budget of $15,973,000. The additional funds were allocated to seven programs. Human Nutrition and Obesity Program addressed health problems related to nutrition. The Applied Plant Genomics Coordinated Agricultural Program (APG-CAP) funded projects that explore a plant's response to different environments and conditions. Improving Food Quality Program examined new and enhanced food products. The Nanoscale Science and Engineering for Agriculture and Food Systems Program funded projects which provide new and renewable products for direct consumption thereby reducing adverse global environmental effects. Functional Genomics addressed the preservation of genetic diversity of wild stock while addressing new and reemerging disease and pest threats. Animal and Plant Biosecurity Programs fund projects that improve the productivity, efficiency, and quality of animal production systems. Two new programs were created with the additional Fiscal Year 2005 allocation. The Maize Program and the Porcine Genome Programs sequence the maize and Porcine genomes respectively and expand our knowledge of these agriculturally significant organisms.

Identification of Program Priorities

In Competitive Programs, the Science Advisor, the Extension and Education Advisor, the Deputy Administrator, and the NRI scientific staff are responsible for assimilating the input of diverse stakeholder groups into a program description that will solicit the highest-quality proposals to meet the needs of U.S. agriculture, food, forestry, the environment, and rural communities. Setting program priorities is an important means of facilitating the scientific and technological advances needed to meet the challenges facing U.S. agriculture. The program priorities encompass one and often several of the five strategic goals.

1. Enhance economic opportunities for agricultural producers
2. Support increased economic opportunities and quality of life for rural America
3. Enhance protection and safety of the Nation's agriculture and food supply

4. Improve the Nation's nutrition and health
5. Protect and enhance the Nation's natural resource base and environment

Congress sets the basic budgetary framework for the NRI, which authorizes that grants be consistent with the development of systems of sustainable agriculture. Members of Congress make recommendations for the scientific and programmatic administration of the NRI through appropriation language and through their questions and comments during Congressional budgetary hearings.

Input from coalitions and stakeholders provide broad perspective on current research, extension, and education needs and priorities. Staff also meets with coalition groups and not-for-profit societies to determine current trends in each field. In addition, the NRI receives input on its programs from academia, including administrators, staff members, and scientists, the Experiment Station Committee on Organization and Policy as well as research and extension administrators of the land-grant institutions.

NRI scientific staff members attend scientific and professional meetings to ensure scientific trends are reflected in the Request for Applications. They also coordinate program priorities with other federal agencies. NRI staff participates in meetings with representatives of key commodity groups and other user groups to discuss stakeholders' current research priorities, to solicit comments and suggestions on NRI program priorities, and to determine how the NRI can best meet stakeholders' needs.

Grants Provided

The NRI provides grants that encourage research, education, and extension to address mission relevant goals. **Fundamental Awards** are granted to projects that provide basic knowledge, which advances applied research and conceptual breakthroughs in fields relevant to agriculture. **Enhancement Awards** are provided to strengthen the research capacity of individuals and institutions, such as postdoctoral fellowships, research by new investigators, and Strengthening Awards. **Mission-linked Awards** fund projects that address specific problems, needs, or opportunities in modern society as well as projects that convey information and technology on specific agricultural issues to end-users. **Multi-disciplinary Awards** encourage collaborations between institutions, agencies, and fields of study to solve complex problems, and seek to initiate research in new areas of science and engineering that are relevant to agriculture, food, forestry, the environment, and rural communities. **Integrated Awards** fund projects that bring together two of the three components of the agricultural knowledge system, e.g. research, education, and extension. Integrated projects hold the greatest potential to produce, transfer, and apply knowledge directly to end users, while providing for educational opportunities to assure agricultural expertise in future generations.

In Fiscal Year 2005, the NRI provided integrated opportunities in ten of the 32 programs: (1) Animal and Plant Biosecurity; (2) Managed Ecosystems; (3) Air Quality; (4) Human Nutrition and Obesity; (5) Animal Reproduction; (6) Animal Growth and Nutrient Utilization; (7) Animal Protection: Animal Well-being; (8) Biology of Weedy and Invasive Plants; (9) Enhancing the Prosperity of Small Farms and Rural Communities; (10) Improving Food Quality and Value.

Of the NRI awards funded each fiscal year, Congress designated funds be allocated in a specific manner. Multi-disciplinary funding should be greater than or equal to 30 percent of funds awarded. Mission-linked funding should be greater than or equal to 40 percent of funds awarded. No less than 10 percent is to be used to strengthen the

research capacity of individuals and institutions. Also, since 2003, Congress has permitted funding integrated projects with up to 20 percent of funds across the grant spectrum.

Program Implementation

Proposals are solicited through NRI's standard Request for Applications (RFA). The RFA is distributed widely within the scientific community and among other interested groups. The Fiscal Year 2005 Request for Applications, published in the Federal Register, identified 32 program areas addressing the five strategic goals.

A proven mechanism for stimulating new scientific ideas, the competitive review process favors the funding of important, relevant topics using well-designed and well-organized experimental plans. Each year, panels of scientific peers meet to evaluate and recommend proposals based on scientific merit, investigator qualifications, and relevance of the proposed work to U.S. agriculture. The panel selected includes peers with the appropriate expertise in research, education, and extension.

A total of 2,650 proposals were considered for funding in Fiscal Year 2005. Thirty-nine peer panels reviewed and ranked the proposals. Criteria for the selection of panel members included knowledge of the relevant scientific discipline, educational background, experience, and professional stature within the scientific community. The membership of each panel was balanced carefully to reflect diversity in geographical region, type of institution, type of position as well as gender and minority status as shown in Table 1. Additional expertise was brought to proposal evaluation by a number of scientists and other experts representing a wide variety of fields, who conducted ad hoc reviews. These reviews provided the additional expertise that made it possible to select the highest quality and most meritorious proposals for funding. In total, more than 9,000 scientists contributed their time and expertise to the NRI proposal evaluation process in Fiscal Year 2005.

At the conclusion of the review process, a summary of the peer panel's evaluation and the written reviews were forwarded to the submitting investigators, providing them with critical assessments of their proposed project by recognized leaders in the appropriate fields. The reviewers' comments and suggestions also provided another avenue for refining proposals for future resubmission.

Continuing a practice begun in 1993, non-technical summaries describing each project funded in Fiscal Year 2005 have been published as Abstracts of Funded Projects and posted on the Internet on NRI Funding Opportunities pages (http://www.csrees.usda.gov/funding/nri/nri.html).

Program Outreach

NRI program staff conducted **Grantsmanship Workshops** in Washington D.C. and Tucson, Arizona to increase applicants' and administrators' understanding of the philosophy, directives, and procedures of the NRI competitive review process. These workshops focused on CSREES funding opportunities in competitive research and integrated projects as well as capacity building in the Science and Education Resource Development (SERD) programs, including higher education, international programs, and multi-cultural alliances. Information provided during breakout sessions included guidelines for preparing proposals, individual program descriptions, and recent funding statistics. In addition, the NRI staff conducted individualized workshops or made presentations at national meetings of scientific and/or professional societies, for regional research groups, and other audiences from EPSCoR institutions and 1890 Land Grant Institutions.

In an effort to provide better guidance to our applicants, additional funding information was provided on the CSREES web site. Each program page provides a synopsis of the NRI as well as a quick reference chart listing codes for the 32 NRI programs and submission deadline dates to assist applicants with the grant process. The page also provides additional resources, including a link to an electronic copy of the NRI RFA, information on how to apply for a grant, detailed information on integrated programs and how to develop an integrated project, general grant writing tips, and information on upcoming grant writing workshops. Additional assistance is provided at several links directing the user to recently funded projects and successful project outcomes.

Funded Projects

In Fiscal Year 2005, a total of 2,650 proposals were submitted to the NRI, requesting a total of $1,077,858,825. Awards totaling $161,535,722, were made to the 486 highest-ranked proposals as shown in Table 2. The success rate, calculated in terms of number of proposals funded and excluding conferences, supplements, and continuing increments of the same grant, was approximately 15 percent. In Fiscal Year 2005, 368 standard research projects were funded averaging $357,793 for 2.7 years (excluding Research Career Enhancement Awards, Equipment Grants, Seed Grants, conferences, continuing increments, and supplements). Forty-one standard integrated research, education, and extension projects were funded in Fiscal Year 2005 averaging $592,784 for 2.8 years (excluding Bridge Grants, conferences, continuing increments, and supplements).

The NRI provided funds totaling $378,508 in partial support of 36 conferences in Fiscal Year 2005. These conferences brought scientists together to identify research, education, and extension needs, provide an update on research information, and/or advance an area of science important to U.S. agriculture, food, forestry, the environment, and rural communities. In Fiscal Year 2005, the NRI provided a total of $285,494 in funds to the Agricultural Research Enhancement Awards. This support included Postdoctoral Fellowships, New Investigator Awards, and Strengthening Awards as shown in Table 3.

Crosscutting Areas

A number of topics of major importance to USDA span several program areas. NRI support for these crosscutting program areas in Fiscal Year 2005 is shown in Table 4. The data provided identify the total amount of funding from all program areas for a specified topic. For example, the Water Quality area includes projects from the Watershed Processes and Water Resources Program as well as projects from other programs relevant to water quality such as Soils Processes. The Integrated Pest Management area includes projects funded from the programs on Integrative Biology of Arthropods and Nematodes, Arthropods and Nematodes: Gateway to Genomics, Biology of Plant-Microbe Associations, and Biology of Weedy and Invasive Plants.

Research Dimensions

As noted, research programs can be examined by type of investigation (fundamental or mission-linked) and by organization of research approach (single discipline or multi-disciplinary). These collaborations, where appropriate, may combine the biological, physical, chemical, and social sciences. NRI funding in Fiscal Year 2005 for these categories is shown in Table 5.

Interagency Research

NRI National Program Leaders work closely with their research-funding counterparts in other federal agencies to maximize interagency cooperation and avoid research duplication. Each interagency research program issues a single request for proposals, and representatives of the agencies work together to assemble a panel of scientific

peers to identify the most meritorious proposals. From this group, representatives of each agency select proposals that are the most germane to the mission of that agency. Thus, the NRI is able to attract researchers from a wide applicant pool, to address areas of importance to agriculture, food, forestry and the environment. An example of cooperation is seen in the research that NRI funds jointly with other federal agencies, including:

The Interagency Metabolic Engineering Program was established in 1998 in conjunction with the Department of Energy (DOE), the National Science Foundation (NSF), the Department of Commerce (DOC), the Department of Defense (DOD), the Environmental Protection Agency (EPA), the National Institutes of Health (NIH/NIGMS), the National Aeronautics and Space Administration (NASA) and the USDA/CSREES. Fiscal Year 2005 marks the eighth year of this ongoing program. Information gained from these projects will better society by increasing agricultural production, providing a new insight into the metabolic basis for medical conditions in the development of new cures, and improve our understanding of biological pathways in order to produce cost effective and environmentally sound processes and products.

The Microbial Genome Sequencing Program has been supported jointly by the USDA/CSREES NRI and the National Science Foundation (NSF) since Fiscal Year 2001. Over 75 microbial genomes have been sequenced to date. The USDA/CSREES and NSF Microbial Genome Sequencing Program will lead to improved breeding strategies, increased disease resistance, and enhanced yield and nutritive value.

The Climate Change Science Program is supported with funds from USDA/CSREES National Research Initiative (NRI), National Aeronautics and Space Administration (NASA), National Science Foundation (NSF), the United States Geologic Society (USGS), and the National Oceanic and Atmospheric Administration (NOAA). Knowledge gained from this program addresses the impact of global climate change on land-based systems and the global carbon cycle. In addition, this program identifies agricultural and forestry activities that can help reduce greenhouse gas concentrations by using technologies and practices that reduce carbon in the atmosphere and enacting risk management practices that mitigate natural and human impacts on agricultural ecosystem dynamics.

The Maize Genome Project partners USDA/CSREES with the National Science Foundation (NSF) and the Department of Energy (DOE) in supporting a large-scale sequencing of the corn genome. Previous funding from the USDA/CSREES, NSF and DOE has supported development of maize genome sequence resources, including physical and genetic maps, expressed sequence tags, sequences derived from gene-enriched genomic libraries, and a community genome database. The genetic sequence of maize will open new avenues of research for scientists to increase yields, reduce inputs, and develop more disease-resistant and drought tolerant varieties. This knowledge will also advance our understanding of the biology of important but poorly understood processes such as hybrid vigor and asexual plant production, and the development of renewable fuels.

Table 1. Characteristics of NRI Peer Review Panels, Fiscal Year 2005

Characteristics	Number Peer Review Panelists	Percent
Geographic Region		
North East[1]	114	21
North Central[2]	150	27
South[3]	161	29
West[4]	124	23
Type of Institution		
Land Grant University		
1862 Land Grant University	341	62
1890 Land Grant University	20	4
1994 Land Grant University	1	<1
Hispanic Serving	5	1
Public non-Land Grant	49	9
Private College/University	31	6
Private Research	9	2
Federal	56	10
Industry/Other	37	7
Type of Position		
Professor	193	35
Associate Professor	139	25
Assistant Professor	103	19
Federal	59	11
Industry	29	5
Other (Senior Lecturer)	26	5
Expertise Representation		
Researcher	396	72
Educator	80	15
Extension Educator	37	7
Other	36	6
Gender[5]/Minority Representation		
Non-minority Male	276	50
Non-minority Female	147	27
Minority Male	94	17
Minority Female	32	6

[1]Northeast region includes the following states plus DC: CT, DE, MA, MD, ME, NH, NJ, NY, PA, RI, VT, and WV

[2]North Central region includes the following states: IA, IN, IL, KS, MI, MO, MN, ND, NE, OH, SD, and WI

[3]South region includes the following states: AL, AR, FL, GA, KY, LA, MS, NC, OK, SC, TN, TX, and VA

[4]West region includes the following states: AK, AZ, CA, CO, HI, ID, MT, NM, NV, OR, UT, WA, and WY

[5]Minorities include: Asians, African Americans, Hispanics, Pacific Islanders, and Native Americans

Table 2. National Research Initiative Funding Allocations[1], Fiscal Year 2005

Natural Resources and Environment	**Awards**	**Total Dollars Awarded**
Agricultural Plants and Environmental Adaptation	12	$ 3,500,000
Watershed Processes and Water Resources	14	$ 3,974,884
Soil Processes	21	$ 4,600,000
Managed Ecosystems	11	$ 4,710,000
Air Quality	12	$ 5,293,741
Total:	**70**	**$ 22,078,625**
Nutrition, Food Safety, and Health		
Bioactive Food Components for Optimal Health	13	$ 3,833,750
Food Safety	20	$ 5,010,533
Epidemiological Approaches for Food Safety	4	$ 3,560,000
Human Nutrition and Obesity	14	$ 10,900,000
Food Safety Coordinated Agricultural Project	1	$ 1,000,000
Total:	**52**	**$ 24,304,283**
Animals		
Animal Reproduction	21	$ 4,342,541
Animal Protection	34	$ 9,540,696
Animal Genomics	11	$ 3,220,752
Animal Genome Reagent and Tool Development	4	$ 2,700,000
Animal Growth and Nutrient Utilization	19	$ 4,500,000
Total:	**89**	**$ 24,303,989**
Biology and Management of Pests and Beneficial Organisms		
Arthropod and Nematode Gateways to Genomics	13	$ 3,850,000
Integrative Biology of Arthropods and Nematodes	24	$ 5,976,500
Biology of Plant-Microbe Associations	22	$ 5,699,529
Biology of Weedy and Invasive Plants	15	$ 4,062,605
Total:	**74**	**$ 19,588,634**
Plants		
Plant Genome, Bioinformatics, and Genetic Resources	15	$ 5,500,000
Genetic Processes and Mechanisms of Crop Plants	20	$ 4,200,000
Developmental Processes of Crop Plants	18	$ 4,197,000
Agricultural Plant Biochemistry	21	$ 4,200,000
Application of Plant Genomics Coordinated Agricultural Project	5	$ 2,000,000
Total:	**79**	**$ 20,097,000**
Markets, Trade, and Rural Development		
Agricultural Markets and Trade	11	$ 2,199,794
Rural Development	8	$ 2,400,000
Enhancing the Prosperity of Small Farms and Rural Communities	7	$ 2,500,000
Total:	**26**	**$ 7,099,794**

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Table 2. National Research Initiative Funding Allocations[1], Fiscal Year 2005

Enhancing Value and Use of Agricultural and Forest Products		
Biobased Products and Bioenergy Production Research	16	$ 5,573,234
Improving Food Quality and Value	28	$ 5,988,679
Nanoscale Science and Engineering for Ag. and Food Systems	8	$ 2,615,000
Total:	**52**	**$ 14,176,913**
Emerging Issues		
Animal and Plant Biosecurity	9	$ 6,716,332
Functional Genomics of Agriculturally Important Organisms	23	$ 11,594,533
Total:	**32**	**$ 18,310,865**
Inter-Agency Programs		
Microbial Genome Sequencing	8	$ 5,577,000
Porcine Genome Sequencing	1	$ 5,000,000
Climate Change Science Program	3	$ 998,619
Total:	12	$ 11,575,619
Grand Total:	**486**	**$161,535,722**

[1]The content of this table varies from tables provided in documents supporting the President's budget to Congress each year in that these data represent all awards made with Fiscal Year 2005 appropriated funds regardless of the year awards were made.

Table 3. Agricultural Research Enhancement Awards, Fiscal Year 2005[1]

Type of Award	Number of Grants Awarded	Total Dollars Awarded
Postdoctoral Fellowships	15	$1,746,242
New Investigator Awards	27	$7,105,766
Stregthening Awards		
Research Career Enhancement	4	$285,494
Equipment Grants	16	$383,234
Seed Grants	17	$1,593,192
Standard Strengthening Research Projects	17	$5,647,271
Total	**96**	**$16,761,199**

Table 4. Crosscutting Program Areas, Fiscal Year 2005[1]

Area	Total Awards	Total Dollars Awarded
Plant Genome	39	$11,134,000
Forest Biology	31	$9,290,077
Global Change	21	$4,872,134
Sustainable Ag	42	$10,895,703
Animal Genome[2]	17	$10,920,752
Animal Health	57	$23,934,871
Water Quality	24	$7,903,128
Food Safety	30	$10,663,059
Integrated Pest Management	57	$18,306,933

Table 5. Dimensions of NRI Research, Fiscal Year 2005[1]

Dimension	Amount of Support	Percent
Fundamental	$95,306,076	59
Mission-linked	$66,229,646	41
Multi-disciplinary	$113,075,005	70
Single Discipline	$48,460,717	30
Integrated Research, Education, and Extension Projects	$26,604,455	17
Research Projects	$134,931,267	83

[1]The content of these tables vary from tables provided in documents supporting the President's budget to Congress each year in that these data represent all awards made with Fiscal Year 2005 appropriated funds regardless of the year awards were made.

[2]Includes Porcine Genome Sequencing Program

The National Research Initiative: Supporting the CSREES Mission

In Fiscal Year 2005, the NRI funded 486 grants. This section provides examples of both research and integrated projects reflecting the priorities important to the USDA and CSREES mission. Integrated projects that combine research, education, and extension components into the study are indicated by an asterisk (*) following the project title. All other projects highlighted in the NRI Annual Report are research projects.

Strategic Goal 1: Enhance Economic Opportunities for Agricultural Producers

CSREES promotes sustainable agricultural productivity, data analysis, and management capabilities with improved information and technologies as well as sponsoring the development, teaching, and dissemination of science-based information to promote market efficiency, overcome barriers to trade, and enhance agricultural sales worldwide by funding projects. Objective 1.1 examines the flow of information, knowledge, and education to the community to expand markets and reduce trade barriers. Objective 1.2 focuses on the international economic development and building trade capacity. Objective 1.3 expands on science-based knowledge and technologies to generate new or improved high-quality products and processes to expand markets for the agricultural sector. Objective 1.4 assists farmers and ranchers with risk management by providing science-based information, knowledge, and education. Objective 1.5 promotes efficiency in the agricultural production systems by contributing science-based information, analysis, and education to the community. The following highlights illustrate the success of research projects funded by the NRI for Fiscal Year 2005 under Strategic Goal 1.

Plant Biosecurity Program

Project Title: *Aerial Dispersal of Soybean Rust Spores*

Project Directors: Scott A. Isard, Glen Hartman, Monte Miles, and Joseph Russo

Lead Institution: University of Illinois

Phakopsora pachyrhizi is the more virulent and aggressive species of fungus responsible for soybean rust, a serious disease causing major crop losses world wide. The goal of this project is to develop and operate a Soybean Rust Aerobiology Modeling System to forecast aerial transport of the fungus. A network for reporting soybean rust using high resolution Internet mapping tools will be developed. The tools will be used to record the spatial and temporal dimensions of infestations as well as constructing a state-of-the-art system to generate daily risk-forecasts of aerial dispersal of *P. pachyrhizi* spores to U.S. soybean fields. The USDA Soybean Rust Information System, operated by ZedX in conjunction with Penn State University, is currently providing a platform for collecting field observations from sentinel plots and mobile scouting teams. The groups are entering and managing data on the disease, its hosts, and weather conditions as well as forecasting the spread of the disease throughout North America. Finally, State Specialists will receive information in the form of observation maps, aerobiology model output, and tools for disseminating guidelines to producers throughout the soybean growing regions of the U.S. and southern Ontario. The data produced by this research will aid in forecasting soybean rust fungus spore dispersal, thereby allowing the growers to be better prepared. Disease forecasting will prevent the use of unnecessary and costly fungicide application as risk assessment become part of growers' decision support.

Animal Reproduction Program

Project Title: *An Integrated Approach to Development and Application of Precise Methods of Estrous Cycle Control for Beef Heifers and Cows**

Project Directors: David Patterson and Michael Smith

Lead Institution: University of Missouri

Many of the tools required to improve reproductive management in beef herds in the U.S. are now available. In a competitive global market, it is imperative information is transferred effectively so the U.S. beef cattle sector can maintain competitiveness in the agricultural economy. This integrated project investigates new approaches to facilitate development of more precise methods of estrous cycle control for use in beef heifers as well as transfer of current knowledge of the postpartum beef cow estrous cycle control to facilitate successful adoption and use of fixed time artificial insemination (AI). Research activities address new reproductive management strategies for replacement beef heifers improving procedures to synchronize estrus and facilitate successful use of fixed time AI. The education component will support strategies that will enhance the successful use of estrus synchronization and AI among beef producers, through continuing education, development of course curricula, and internships. Implementation of a comprehensive extension program, which focuses on the transfer of technology currently available, will aid in successfully synchronizing estrus in postpartum beef cows followed by AI performed at predetermined fixed times. The project will expand the use of AI among beef producers in the U.S. without negatively impacting pregnancy rates. This will facilitate more rapid genetic improvement of beef cattle leading to improved quality of beef and greater efficiency of production.

Animal Growth and Nutrient Utilization Program

Project Title: *Mechanism by which IGFBP-3 and IGFBP-5 Mediate the Proliferation-Suppressing Actions of Myostatin and TGF-β on Porcine Myogenic Cells*

Project Directors: William Dayton, Michael White, and Marcia Hathaway

Lead Institution: University of Minnesota

Efficiency and uniformity of animal growth impacts profitability in the U.S. pork industry and is primarily controlled by growth of skeletal muscle. In turn, muscle growth in pigs and other meat-producing animals is controlled at the tissue, cellular, and molecular levels by positive and negative regulators of muscle growth. Myostatin is now known to be an important negative regulator of muscle growth that is predominantly expressed in developing and adult skeletal muscle. In cattle, naturally occurring mutations that cause production of inactive myostatin result in a condition called double muscling in which muscle mass is greatly increased. This condition can be mimicked experimentally in mice by removal of the myostatin gene, resulting in increased muscle mass due to increased number and size of muscle fibers. However, the mechanism by which myostatin exerts its inhibitory action on muscle growth is poorly understood. The goal of this research is to recognize the mechanism by which another important inhibitor of muscle growth, insulin-like growth factor binding protein, interacts with myostatin to limit growth of porcine muscle cells. These studies will increase our understanding of muscle growth and ultimately lead to development of targeted strategies to increase rate, efficiency, and uniformity of muscle growth in meat-producing animals.

Animal Genomics Program

Project Title: *Detection, Identification, and Utilization of QTL for Feed Efficiency and Carcass Traits in a Commercial Beef Cattle Population*

Project Directors: Jerry Taylor and Robert Schnabel

Lead Institution: University of Missouri

Feed efficiency and carcass traits, such as intramuscular fat and muscle mass are extremely important to the beef industry. These traits, referred to as Quantitative Traits (QT), are controlled by multiple genes. Determining the location, or Quantitative Trait Loci (QTL), on genes has proven to be particularly difficult, especially on live animals that

are candidates for selection. The inability to identify the QTL has severely handicapped the application of Marker-Assisted Selection (MAS) in commercial livestock. This project will develop new approaches for the successful implementation of MAS within commercial livestock populations using several methods. First, a cost-effective whole genome scan for growth, carcass, and feed efficiency traits in a 3,840 member Angus pedigree will be completed. Two strategies for the identification of causal mutations and for the development of Single Nucleotide Polymorphism (SNP) haplotypes will be tested. Finally, validating markers developed by other researchers will be utilized for this Angus population. Preliminary work has shown a commercialized test for a SNP mutation is ineffective on marbling Expected Progeny Differences (EPD). This research will significantly enhance the utility of on-going bovine QTL mapping projects. In addition, it will improve the rate of quantitative trait nucleotides discovered and the application of MAS for economically important traits, including feed efficiency, in commercial beef cattle populations.

Biobased Products and Bioenergy Production Research Program
Project Title: *Property Evaluation of Genetically Engineered Wood from Aspen with Down-Regulated Lignin Enzymes*
Project Directors: Perry Peralta, B. Kasal, Laigeng Li, and Ilona Peszlen
Lead Institution: North Carolina State University
This project will evaluate the properties of transgenic trees in order to provide a fundamental understanding of the role of lignin on the strength, shrinkage and swelling, and viscoelasticity of wood. Studies have shown that wood from the transgenic aspen is more easily pulped while providing similar or higher pulp yield than wood from wild-type trees. Considering that 75% of the income to the landowner is for sawtimber while only 12% is from pulpwood, there is an increasing interest in and the need for more research effort on the genetic improvement of wood characteristics for solid wood and structural wood-based composites. In this study, the physical and mechanical properties and anatomical structure of wood from transgenic aspen will be compared to the same properties from wild-type trees. Specifically, the project will propagate one wild type aspen and five lines of transgenic aspen and then evaluate them for three categories of properties. First, the study will examine transgenic tree fibers, specifically fiber and vessel anatomy, fiber length and coarseness on macerated materials, and microfibril angle on radial and tangential sections. The study will also examine the specific gravity, shrinkage anisotropy, and viscoelastic properties of transgenic aspen. Finally, the study will evaluate modulus elasticity and strength both in tension and compression parallel to the grain. The results of the study point to the tremendous potential of controlling the growth and development of trees and of improving wood properties.

Integrative Biology of Arthropods and Nematodes Program
Project Title: *Pheromonal and Genetic Regulation of Honey Bee Foraging Behavior*
Project Directors: Robert E. Page
Lead Institution: Arizona State University
The European honey bee is the world's most important insect pollinator of crops for agriculture. However, there is a serious shortage of honey bee colonies in the U.S. for the pollination of fruit, nut, vegetable, and fiber crops. A viable solution to this problem is to make existing colonies more efficient pollination units. The effects of brood and brood pheromone on foraging behavior of worker bees from high and low-pollen hoarding strains of bees will be examined. Previous work has shown that the presence of brood and brood pheromone resulted in an increase in pollen foraging behavior. A better understanding of foraging differences between high and low strain bees will help develop colony management schemes to increase pollination efficiency of colonies. The research will also address the more fundamental sociobiological question about how complex social behaviors evolved in honey bees. Previously, the researchers discovered major physiological differences between high and low-pollen hoarding strains. The high pollen hoarding strain had measurably higher levels of the protein vitellogenin, which is characteristic in reproductively active females. In addition, these females had larger ovaries. The researchers will test the

hypothesis that high pollen hoarding strains possess the ancestral phenotype of solitary bees, which forage for pollen to maintain egg development. Knowledge gained from this research will advance agriculture's ability to better utilize honey bee colonies to increase honey production as well as be more efficient pollinators.

Suborganismal Biology and Genomics of Arthropods and Nematodes Program
Title: *Functional Genomics of Hessian Fly Avirulence in Wheat*
Project Directors: Jeffrey Stuart, Ming-Shun Chen, and Scott Hulbert
Lead Institution: Purdue University
The Hessian fly represents one of the most economically important insect pests world-wide due to its impact on wheat crops. This pest also provides a valuable comparative model to other plant pests and insect vectors of animal and human diseases. The Hessian fly is a classic example of an organism with the capability to mutate and overcome the immunity conferred by resistance genes in a host plant. This research will identify the DNA sequences of three virulence mutations in the Hessian fly genome which enables this pest to overcome immunity in wheat and cause economic damage. In preliminary work for this project, the first insect avirulence gene was successfully identified and the genomic bacterial artificial chromosome (BAC) clones corresponding to 71 salivary gland protein (SSGP) genes identified. The researchers will determine the physical positions of 41 of these genes in the Hessian fly genome. Fingerprinting will be applied to 5,000 BAC clones representing 6-fold coverage of the Hessian fly genome. The knowledge generated by this research will be useful to plant geneticists engineering resistance to virulent insect genotypes, thereby creating a more sustainable and benign method of pest control.

Nanoscale Science and Engineering for Agriculture and Food Systems Program
Project Title: *Zein Nanofabricated Biomaterials for Tissue Scaffolding*
Project Directors: Graciela Padua, Antony Crofts, and C. Liu
Lead Institution: University Of Illinois
Zein is an abundant, currently low value, storage protein of corn with unique adsorption and self-assembling properties, which may have potential industrial and biomedical applications. Tissue engineering holds a great promise for medical and veterinary treatment of wounded or failing tissues and organs. In general, individual cells do not thrive when implanted in vivo for lack of vital natural infrastructure. Therefore, there is a need to develop critical support infrastructure or scaffolding to guide and encourage individual cells into becoming working tissues. The project proposes harnessing zein's unique hydrophobic/hydrophilic adsorption and self-assembly properties in a nano- and micro-scale construction of tissue scaffolding in the tissue engineering process. The goal of this research is to investigate how to build from the bottom-up a micro-architectural design that will house and connect live cells on their way to become an engineered tissue. The approach is novel and the research findings can lead to the development of a new renewable resource-based platform technology for tissue engineering, drug delivery and controlled release of bioactive compounds, which will add a significant value to agricultural and food processing by products.

Strategic Goal 2: Support Increased Economic Opportunities and Improved Quality of Life in Rural America

CSREES supports research-based information to support new and innovative economic opportunities for communities and to assist community leaders in their decision-making on rural issues by funding projects. Objective 2.1 expands on economic opportunities in rural America by incorporating scientific insights into economic and business decision making. Objective 2.2 facilitates informed decision making in rural America by providing improved science-based technology, products, and information. The following highlights illustrate the success of research projects funded by the NRI for Fiscal Year 2005 under Strategic Goal 2.

Rural Development Program

Project Title: *Rural Household Adjustment Mechanisms and Attitudes Towards Public Investments in the United States*

Project Directors: Scott Loveridge, Janet Bokemeier, and Peter Kakela

Lead Institution: Michigan State University

Rural communities want to bring jobs to their region, but certain job development strategies, though ultimately successful, take several years before their impact is felt. This project examines which factors influence the willingness of people to support longer-term job creation strategies, such as entrepreneurship development, amenity development, and workforce development. A national telephone survey and analysis of secondary data will be used to understand the relationship between time preferences, personal, social, and regional characteristics related to a rural community's willingness to pursue longer-term job creation strategies. Researchers will examine how industrial structure shapes the economic and social climate of communities, with particular emphasis on tradeoffs between current and future benefits, both at the personal and community levels. In addition, the research will explore how attitudes toward the future, embodied in discount rates, vary systematically by characteristics of the regional households, community, labor markets, and industrial economic climate. Results of this research will support community decision-makers as they develop alternate job creation strategies.

Enhancing the Prosperity of Small Farms and Rural Communities Program

Project Title: *Mapping Local Food Systems Potential in New York State: Spatial Modeling of an Emerging Opportunity for Small Farmers and Local Consumers**

Project Directors: Gary W. Fick, Arthur Lembo, and Jennifer L. Wilkins

Lead Institution: Cornell University

Our modern food system has succeeded in providing an abundant, diverse, and affordable food supply. In some circumstances, it created a host of economic, social, and environmental problems. Local food systems have emerged as a possible strategy for addressing such problems in the hopes that closer connections between producers and consumers might, for example, improve farm incomes, strengthen rural agricultural economies, reduce the distance food travels, and promote better nutrition. This project addresses the research needs of expanding local markets and producer-consumer networks. The goal is to model regional food production potential relative to regional food needs within New York State. The researchers will map the potential productivity and economic use-value of land for different classes of agriculture using geographic information system (GIS), and then calculate the distance within which the food needs of upstate New York population centers could be met. The research findings will be made accessible to the public via an internet map server (IMS) for users to view and perform simple queries on the resulting maps as well as through educational materials on the relationship between food choices and local food systems. A more informed public can help expand local food markets and producer-consumer networks in upstate New York and in turn, help solve some of the economic, social, and environmental problems prevalent in our modern food system.

Strategic Goal 3: Enhance Protection and Safety of the Nation's Agriculture and Food Supply

CSREES supports projects that identify and assess organisms, pathogens, and toxins throughout the agricultural environment and supports the development and use practices that manage, reduce, or eliminate food safety risk in the food chain. Objective 3.1 promotes science-based knowledge and education to reduce the incidence of food-borne illnesses and contamination. Objective 3.2 focuses on developing and delivering science-based information and technologies to reduce the number and severity of agricultural pest and disease outbreaks. The following highlights illustrate the success of research projects funded by the NRI for Fiscal Year 2005 under Strategic Goal 3.

Microbial Genome Sequencing Program

Project Title: *Whole Genome Sequence and Assembly of Aspergillus flavus*

Project Directors: Gary A. Payne and Ralph Dean

Lead Institution: North Carolina State University

Aspergillus flavus is a filamentous fungus commonly found in soils and on decaying organic matter. *A. flavus* produces aflotoxin, a potent carcinogen and liver toxin as well as the second leading cause of aspergillus in humans. This fungus is of particular economic interest in U.S agriculture because it infects corn, cotton, tree nuts, and peanuts. There are currently no effective control procedures available for monitoring the presence of *A. flavus* in food products hampering the safety of the food supply. As part of this research project, the genome sequence of *A. flavus* was produced and publicly released in July 2005. Additional work will focus on developing an educational program for end-users based on the information generated during this project. It is expected that characterization of the *A. flavus* genome will increase our understanding of the ecology and evolutionary biology of the fungus, the regulatory networks controlling fungal development as well as primary and secondary metabolism. This new information will reveal vulnerabilities in the fungus that can be exploited to control aflotoxin contamination in agricultural crops.

Food Safety Program

Project Title: *Functional Consequences of Genome Evolution in Listeria monocytogenes and Population Genomics of L. monocytogenes*

Project Directors: Andrew Benson

Lead Institution: University of Nebraska

Listeria monocytogenes is the bacterium responsible for the illness listeriosis. *L. monocytogenes* is particularly insidious in that it can reproduce at refrigerator temperatures, is ubiquitous in the environment, has a high mortality rate when infection occurs, and hits the immuno-suppressed and pregnant women especially hard. This organism is the number one cause of food recalls in the United States. The U.S. food regulatory agencies, e.g. FDA and FSIS, implemented a 'zero tolerance' policy for *L. monocytogenes* in cheese, ready-to-eat meats, and a variety of other minimally processed products causing a point of contention with international trading partners. This research aims to unravel part of the mystery surrounding the virulence of this organism and more importantly indicate which subtypes or lineages are the most likely to be problematic. Not all strains or lineages, i.e. '1/2a', '1/ 2b', '4b', are created equal and there appears to be an inadvertent selection for certain strains within the food production system. A clearer understanding of the lineages of strains and their associated clinical relevance may cause a shift in this regulatory matter to bring the U.S. more in line with some of our European trading partners.

Epidemiologic Approaches for Food Safety Program

Program Title: *From Egg to Carcass: Tracking the Entry of Poultry Food borne Pathogens into the Food Chain*

Program Director: John Maurer, Deborah J. Cole, Charles L. Hofacre, and Michael P. Doyle

Lead Institution: University of Georgia

Food safety remains an important public health issue in the United States. *Salmonella* was responsible for 55% of the bacterial food borne disease and *Campylobacter* was close behind with nearly equal incidences. Consumption of poultry and poultry products is a recognized risk factor for food borne outbreaks of salmonellosis and campylobacteriosis. Most cases of *Salmonella enteritidis* are associated with eggs. This study will develop an epidemiologic database in order to quantify the risk factors that contribute to the transmission of these strains to poultry meat products. This research study will initiate a prospective study and follow cohorts of Salmonella-positive broiler-breeder flocks and their progeny from farm to the poultry processing plant, providing valuable egg to poultry carcass data. A molecular database of *Salmonella* strains will be established to quantify transmission of specific

serotypes and pathotypes through the poultry production pyramid. Finally, this study will develop a stochastic quantitative risk assessment model of food borne pathogens in processor-packaged poultry products. All of these studies aid in finding new avenues to intervention strategies to prevent further incidence of *Salmonella* in poultry.

Animal Protection Program
Project Title: *Bridging Genome Sequence to the Prevention of Marek's Disease in Poultry*
Project Directors: Jerry B. Dodgson, Hans H. Cheng, Robin W. Morgan, and Hongbin B. Zhang
Lead Institution: Michigan State University
Marek's disease is the leading chronic disease of chickens and costs an estimated $1 billion annually. At 41% and growing, poultry is the primary meat consumed in the United States and the third largest agricultural commodity. A reason for the popularity of poultry products is the ability of the poultry breeding industry to economically improve growth, reproduction, and disease resistance traits. To maintain the competitiveness of the U.S. poultry industry, it is imperative that breeding programs continue to be successful in this pursuit. Previous research identified the genes and biological pathways that confer resistance to Marek's disease. In addition using advanced molecular and biotechnology methods, genetic and biochemical tests were developed that accurately predict disease resistance in young chicks from commercial flocks. This research proposes to apply knowledge gained from the human genome sequence and related breakthroughs to better understand the locations and expression patterns of specific chicken genes. The primary goal is improved strategies for the prevention of Marek's Disease in poultry. This information will be made available to poultry breeders and veterinary scientists. Moreover, the information developed during this project will generate tools of value to both industrial and academic poultry scientists. This project will also provide the platform on which a future full genome sequence of the chicken can be based. Enhanced genetic resistance will reduce the need for vaccines and antibiotics in future breeding generations, thereby reducing the potential hazard antibiotics pose to the environment.

Animal Protection Program
Project Title: *U.S. Veterinary Immune Reagent Network*
Project Director: Cynthia Baldwin
Lead Institution: University of Massachusetts
The tools currently available for studying infection and inflammatory disease in a number of animal species are not sufficient. The U.S. Veterinary Immune Reagent Network will address this need specifically for ruminants (cattle), swine, poultry (chickens), horses, and aquaculture species (catfish and trout). This project will generate the most useful tools research scientists need to develop vaccines and new diagnostic tests. The activity coordinates with the larger scientific community and with similar international efforts. Based at the University of Massachusetts Amherst, the Network brings together six co-project directors representing the Agricultural Research Service (ARS) of the USDA, U.S. Geological Service (USGS), academic institutions, including University of Kentucky, University of Mississippi Medical Center, and Cornell University, as well as industry, specifically Pierce Biotechnology, Inc.. Additionally, an international group of consultants and collaborators from throughout the United States, Canada, the United Kingdom., the Netherlands, Australia, and France will contribute to the project. Ultimately, veterinary immunologists, pathologists, microbiologists, and other researchers will be able to rely on the publicly available reagents in their search for medical countermeasures and intervention strategies to control infectious disease in these important animal species.

Functional Genomics of Agriculturally Important Microorganisms Program
Project Title: *Functional Genomics of the Tick Vector-Pathogen Interface*
Project Directors: Kelly A. Brayton, Felix D. Guerrero, and Guy H. Palmer
Lead Institution: Washington State University
Anaplasma marginale, a bacterial pathogen of cattle, is transmitted by ticks, specifically *Rhipicephalus microplus*. The tick vectors are developing resistance to the chemicals previously used to control them. As a consequence, this pathogen is becoming a major threat to animal health in the United States. The purpose of this study is to identify genes affected during infection. These genes will be the targets for blocking development of pathogen infectivity and tick-borne transmission. To accomplish this goal, microarrays will be developed that identify genes from both the bacterial pathogen and the tick vector that are controlled during infection. While this project focuses on a specific and relevant experimental system, successful completion of the research will fill gaps in knowledge broadly applicable to other vector-borne pathogens. In addition, the use of *R. microplus* will provide new information and tools to better understand the development of tick-based infections. This information may lead to new opportunities for development of transmission-blocking methods that could fundamentally alter tick-borne disease control worldwide.

Plant Genome, Bioinformatics, and Genetic Resources Program
Project Title: *Completion of the Peach Genome Database: A Reference Genome for Rosaceae*
Project Directors: Albert G. Abbott, W. Vance Baird, Doreen Main, Jeff Tomkins, Gregory Reighard, Byron Sosinksi, and Pere Arus
Lead Institution: Clemson University
The Rosaceae family comprises over 3000 species of plants. The goal of this project is to develop peach as a model genetic resource for the identification, characterization and cloning of important genes of Rosaceae species. For this purpose, having as complete a genomics database of an integrated genetic and physical map is a high priority. This project has three specific aims. The researchers will complete the construction of the physical/genetic map of peach. The physical map data will be incorporated into the publicly accessible Genome Database for Rosaceae (GDR) to provide a reference genome for identification and cloning of genes important to Rosaceous crop development. Finally, the researchers will complete the development of a high density genetic marker set anchored on the physical map to provide the tools necessary for marker assisted selection, comparative mapping and the eventual sequencing of the peach genome for crop improvement.

Developmental Processes of Crop Plants Program
Project Title: *Intranuclear Targeting and Processing of DNA-Protein Complexes in Plants*
Project Directors: Vitaly Citovsky
Lead Institution: State University of New York, Stony Brook
Agrobacterium tumefaciens is a soil bacterium that causes crown gall disease in plants. It is also the major tool for plant genetic engineering, both in research and agronomical applications, by virtue of its ability to transfer a segment of its DNA to another plant cell. The bacterial DNA molecule, known as the transfer DNA or T-DNA, is 'injected' into the host cell cytoplasm along with a set of bacterial virulence (VIR) proteins. Inside the plant cell, the T-DNA, presumably as a complex with several VIR proteins (the T- complex), enters the host cell nucleus where it integrates into the host genome, modifying it and producing a transgenic plant. These processes of nuclear import and integration are mediated by an intricate interplay between the bacterial and the host cell proteins. This process is not well understood. This project will identify the molecular mechanism by which the A*grobacterium* T-DNA and its associated proteins are targeted to the genome of the host plant. In addition, this project will determine how the T-DNA is "uncoated" of its associated proteins after being targeted to the host cell genome, but before integration.

The results of this study have the potential to lead to new and improved procedures for genetic transformation of crops, and to help protect agronomically important plants through increased resistance to *Agrobacterium* infection.

Improving Food Quality and Value Program

Project Title: *Interaction of Flavors with Macromolecules: Tannins and Proteins*

Project Directors: Susan Ebeler and Hildegard Heyman

Lead Institution: University of California - Davis

Flavor and aroma are important factors influencing consumer food and beverage choices. The physical-chemical interactions between flavor compounds and nonvolatile food component, such as proteins and tannins, can alter volatility and therefore flavor release. Therefore, knowing the concentration of a flavor in a food/beverage alone is not sufficient to determine the sensory aroma intensity. This project will examine the interactions of tannins, proteins, and other larger molecules on the volatility of selected aroma compounds. The interactions between odorants and the tannin/protein aggregates will also be evaluated. Finally, characterization of tannin/protein interactions will be investigated and the effects of these interactions on odorant binding, volatility, and sensory intensity will be explored. By understanding the complex interactions that affect flavor volatility, one could optimize the composition of food ingredients and food processing conditions thereby improving in the flavor as well as nutritional value of food and beverage products.

Strategic Goal 4: Improve the Nation's Nutrition and Health

CSREES strives to improve nutrition and health by promoting healthy diets, reaching children early, ensuring access to healthy food, and improving food and diet decisions. Objective 4.1 focuses on improving human health by better understanding an individual's nutrient requirements and the nutritional value of food. Objective 4.2 promotes research on healthier food choices and lifestyles. The following highlights illustrate the success of research projects funded by the NRI for Fiscal Year 2005 under Strategic Goal 4.

Agricultural Plants and Environmental Adaptation Program

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

Project Directors: Ian M. Ray and Tracy M. Sterling

Lead Institution: New Mexico State University

Drought and diminishing water supply are the most significant environmental stressors limiting U.S. crop production today. Drought tolerance and water use efficiency in plants is a complex process involving many physiological, biochemical, and genetic pathways. Increased understanding of these complex pathways and their components is needed to develop new strategies to maintain or improve crop productivity. This knowledge can also lead to development of crop varieties with increased tolerance to water deficiency while sustaining, or even increasing, yield. This project focuses on the drought tolerance mechanisms in alfalfa, which is the primary forage base for the dairy livestock industry and is an important legume rotation component in sustainable agricultural systems. Specific plant traits and responses, such as growth of leaves, stems, crowns, and roots, will be correlated to drought tolerance and crop productivity. In addition, plant responses that protect the plant from water and drought stress will be investigated. Finally, the genes responsible for the drought resistance traits will be identified and markers developed for improved breeding of drought tolerant alfalfa. The research will use information and genomic technologies developed in model plant systems to improve traits and productivity in crop plants. The results and tools developed in this study can be used to develop alfalfa cultivars that remain productive in conditions of water deficit or drought.

Bioactive Food Components for Optimal Health Program
Project Title: *Influence of Grape (Vitis vinifera) Polyphenols on Dental Biofilm Related Oral Diseases*
Project Directors: Hyun Koo
Lead Institution: University of Rochester
In the United States, dental caries affects 42% of children and adolescents aged 6-19 and approximately 90% of adults. Americans spend close to $40 billion annually on treatment of this ubiquitous disease. Dental caries is the demineralization of the tooth matrix that results from the interaction of specific bacteria, primarily *Streptococcus mutans*, with dietary constituents on the tooth surface. *S. mutans* uses sugar to produce glucans, a plaque-building material, and acids, which lead to the dissolution of the tooth matrix. The purpose of this investigation is to determine whether health promoting compounds in grapes, including anthocyanids, flavonols, phenolic acids, and proanthocyanidins, can block the formation of dental plaque on the tooth surface and prevent acid formation. The investigators will extract and prepare the constituents from grape varieties typically used for wine production, e.g. Cabernet franc and Pinot noir. The investigators will examine the influence of the constituents on dental plaque formation and acid production as well as their effectiveness to prevent dental caries, both in vitro and in vivo, using a rat model. The results of this research will provide critical information for future interventions for promotion of oral health using food components.

Human Nutrition and Obesity Program
Project Title: *New Orleans Food Access and Consumption Study**
Project Directors: Diego Rose
Lead Institution: Tulane University
Neighborhood environments may contribute to the growing problem of obesity by providing easy access to calorie-dense, nutrient-poor snack foods and poor access to low-calorie, nutritious foods, such as fruits and vegetables. This project addresses these issues in New Orleans, Louisiana using an integrated approach. The key research goal of this project tests the relationship between neighborhood availability of two key food groups - fruits and vegetables versus calorie-dense snack foods - and the consumption of these foods after controlling for food prices, household income, and individual socio-demographic characteristics. The data collected before and after hurricane Katrina were included in this project. The extension component will develop simple indicators to describe and rank neighborhoods on food access for use in planning and evaluating interventions. Tulane University's curriculum will be enhanced through this project by creating additional graduate-level course work and field-placement opportunities for nutrition students. The students will learn to integrate the concepts of neighborhood availability, consumer economics, and GIS mapping techniques. Results will aid future obesity prevention interventions as well as policy planning for response to natural disasters. In addition, the project will provide novel training for graduate students on the effects of the local environment on nutritional status of residents.

Agricultural Plant Biochemistry Program
Project Title: *Function of Iqd1 in Glucosinolate Regulation and Defense Response*
Project Directors: Steffen Abel and Carlos F. Quiros
Lead Institution: University of California – Davis
Glucosinolates are a diverse class of products synthesized mainly by the Brassica crops, such as broccoli, cauliflower, cabbage, and brussel sprouts. Although the function of glucosinolates in plants is not precisely understood, the breakdown products of glucosinolates promote a variety of positive results in plants, animals, and humans. In plants, the glucosinolate products function in defending the plant against pathogens and in regulating growth and development. In humans, these products may aid in reducing the onset of certain types of cancer. This research investigates the biosynthesis of glucosinolates using the model Brassica plant *Arabidopsis* and identifies plants with altered glucosinolate metabolism as well as the mutated genes responsible. Both the plants and genes serve as

tools to probe the biological function of glucosinolates in plants. The investigation focuses on enhancing economic opportunities for producers by decreasing production loss and costs due to plant pathogens and by increasing value of the plant through increased bioactive food components. Results from the study will improve the nation's health by increasing the cancer-fighting properties of plant foods and protecting the nation's environment and natural resources through potential reduced use of synthetic pesticides.

Strategic Goal 5: Protect and Enhance the Nation's Natural Resource Base and Environment

CSREES collaborates with its partners in the community on ecosystem management strategies that generate long-term benefits for natural resources and mitigates adverse global change. Objective 5.1 focuses on improving the management of forest and rangelands. Objective 5.2 focuses on the improved management of soil, air, and water resources to support the production and enhancement of the environment. The following highlights illustrate the success of research projects funded by the NRI for Fiscal Year 2005 under Strategic Goal 5.

Managed Ecosystems Program

Project Title: *The Role of Natural Habitats in Agroecosystems: Evaluating Benefits and Establishing Standards for Restored Non-Crop Lands*

Project Directors: Paul Zedler, Deanna Sexson, Claudio Gratton, and Nancy Mathews

Lead Institution: University of Wisconsin

Modern intensive agriculture has been spectacularly successful in producing food and fiber. However, non-crop lands have been drastically reduced and the native communities in agricultural landscapes disturbed or altered. A new approach involves farm management practices that consider the farm as an entire ecosystem. This requires a better understanding of how non-crop habitats within farms function to support biodiversity and influence pest management. This project will assess the biodiversity function in non-crop lands as well as determine the role non-crop lands play in supporting beneficial arthropod populations and minimizing the build up of pests. This project will also develop ecological standards that will be incorporated into the existing eco-label and support, through outreach, the on-going collaboration among growers, the certifying groups, interested conservation organizations, and the research community that is essential to adaptive and sustainable management. Specifically, there has been a call for the development of a quantitative system that addresses the increased data collection requirements of traditional "indicator" approaches used for the certification of conservation efforts. In the past evaluating ecosystems have been cost prohibitive and hampered because of an unfocused approach. This project is focused on refining the evaluation of biodiversity in ecosystems to improve farm management practices.

Soil Processes Program

Project Title: *Molecular Mechanisms of Phosphate Retention and Dissolution in Organic Matter and Clay-Organic Systems*

Project Director: Dean Hesterberg and Wei Shi

Lead Institution: North Carolina State University

This project explores the interactive effects of soil water saturation, mineralogy, organic matter, and microbial activity on phosphorus mobility. Phosphorus is a key limiting nutrient in many crop and forest production systems, but excess phosphorus concentrations in lakes, rivers, estuaries, and coastal waters lead to degradation of water quality. Wet soils including wetlands and low-lying agricultural soils often contain greater amounts of organic matter and feed into streams, rivers, and marine estuaries. These soils, which serve as a buffer minimizing the mobility of phosphorus between agricultural lands and surface waters, are crucial for balancing agricultural sustainability and environmental concerns. This project focuses on involvement of organic matter in phosphate retention and dissolution as soils become depleted of oxygen under wet conditions. Soil variability includes soil type, organic

matter content, and conditions with and without microbial activity. Cutting edge spectroscopic techniques, including x-ray absorption, infrared spectroscopy, and nuclear magnetic resonance, will be applied. The results from model system studies will give insight for understanding phosphate bonding mechanisms and lead to improved ability to manage and predict phosphorus mobility in soils and landscapes.

Watershed Processes and Water Resources Program

Project Title: *Impact of Forest Treatments and Climate Change on Hydrologic Regimes*

Project Directors: Timothy Link

Lead Institution: University of Idaho

A sound scientific basis for forest management decisions is needed to foster and maintain healthy rural economies and sustainable forest environments in the western United States. Forest harvest and road construction patterns along with climate change impact water resources by altering the timing and flow of water from forested watersheds. In the Pacific Northwest, the management of snowpack melt by improved harvest methods can sustain water flow over longer periods of time. This project will develop a model to maximize forest productivity while minimizing impacts on natural resources, such as water supplies and aquatic ecosystem health. A computer model simulates flow changes resulting from different harvest practices and is verified in intensively instrumented experimental water shed. The model can be used to predict how flows change under future harvest and climate scenarios. Recent results indicate that annual flow from a 50% clear-cut watershed can increase by approximately 30%. A thinned or partial cut watershed can increase annual flows by 20%. Increased flows are attributed to a combination of increased snow accumulation as well as decreased evaporation and transpiration in harvested areas. The combination of thinned and cleared areas provides sustained stream flows during the dry summer season for downstream users and aquatic ecosystems. Results from this project are being used as a case study in live and online watershed science and forest hydrology courses as well as adult education programs for natural resource professionals and industry groups.

Air Quality Program

Project Title: *Ammonia Losses from a Commercial Cattle Feedlot: Towards a Realistic NH_3 Emissions Inventory for the Great Plains*

Project Director: Jay M. Ham, Ronaldo Maghirang, Joel DeRouchey, and William Hargrove

Lead Institution: Kansas State University

The impact of cattle feedlot on atmospheric ammonia concentrations is not well understood. In this study, ammonia losses from a commercial cattle feedlot in Central Kansas are being measured continuously over a two year period. A specialized measurement system composed of a meteorological tower, flux monitoring instruments, and a host of ancillary sensors have been established at a large commercial feedlot. This technology will allow measurement of seasonal patterns and annual total losses of ammonia. In addition to aerial measurements, soil cores were collected in cattle pens that had been used for 20 to 45 years. Although high nitrogen concentrations were found in the first meter of the soil profile, the total quantity of nitrogen in the subsoil was negligible compared with the total amount of nitrogen deposited on the pen surface over its lifetime. A detailed study is now underway to determine the rates of nutrient loading on the pen surface by analysis of feeding records, cattle weight gains, and rates of manure removal during pen cleaning. The results from this study will help to quantify agriculture's impact on air quality by improving estimates of ammonia emissions from cattle production in the Great Plains region and improve strategies for reducing ammonia losses from cattle feedlots.

Biology of Weedy and Invasive Plants Program

Project Title: *Integrating Predictive Modeling and Volunteer Networks to Enhance Early Detection and Rapid Response to Invasive Species**

Project Directors: John Silander, Leslie Mehrhoff, Christopher Matrick, Cynthia Boettner, William Brumback, and Beth Goettel

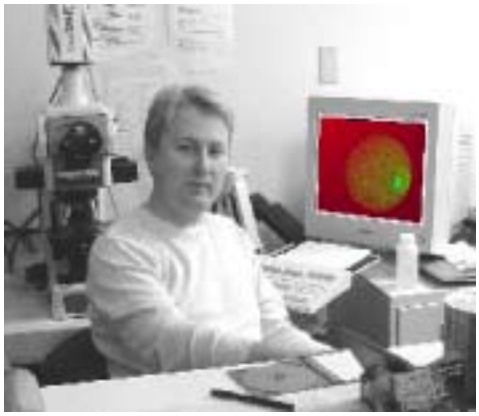
Lead Institution: University of Connecticut

Species of plants, animals, and microbes have migrated to all areas of the globe. A growing number of migrations are facilitated by humans, either intentionally or accidentally. In many cases these migrating species, referred to as alien or invasive species, arrive, establish, and aggressively cause problems for native biota, by negatively affecting biological diversity as well as natural community and ecosystem processes. There have been few successes in predicting the likelihood of invasive species becoming established and spreading across the landscape or in their early detection. The purpose of this study is to investigate the invasive and potentially invasive plant species in New England, focusing on strategies for their early detection and developing modeling protocols for predicting their occurrences and spread across the region. One of the Invasive Plant Atlas of New England (IPANE) goals is to increase the number of project-trained volunteers from 450 to more than 600, increase the coverage to 111 species, and develop predictive models of invasive species potential distribution in the region. This information can, in turn, be used to direct "informed" searches to develop a national early detection and rapid response network. IPANE, with its science-driven programs and use of volunteers is being looked at as a model for early detection networks in this country.

President's Early Career Award for Scientists and Engineers (PECASE)

Dr. Joseph M. Jez, of the **Donald Danforth Plant Science Center**, St. Louis Missouri, was the recipient of the Presidential Early Career Award for Scientists and Engineers (PECASE) for Fiscal Year 2005. The PECASE award is the highest honor bestowed by the U.S. government on outstanding scientists and engineers beginning their independent careers. CSREES selects its awardees from among the most meritorious investigators funded through the National Research Initiative (NRI) Competitive Grants Program New Investigator Award Program. Dr. Jez was nominated by the NRI for his current and potential future excellence in research. He received funding for his proposal entitled "Structure/Function Analysis of the Cysteine Synthase Complex" in the Agricultural Plant Biochemistry Program. This research addresses the structure and function of the plant cysteine synthase (CS) complex. The complex is thought to act as a regulatory component for sulfur metabolism in plants. The results from this study may lead to new approaches for producing crop plants with improved mineral assimilation and nutritional amino acid content. Such plants would reduce the need for fertilizer application and be productive even when grown in marginal soil. As a food and feed source, these plants would provide increased amounts of essential sulfur-containing amino acids and reduce the need for specific supplements particularly in animal feed. Dr. Jez's research addresses the national priorities related to enhanced economic opportunities for producers, improvement of the nation's nutrition, and protection of the environment.

The National Research Initiative (NRI) Discovery Award



Dr. Peter Sutovsky, of the **University of Missouri,** was awarded the National Research Initiative Discovery Award for Fiscal Year 2005. This award recognizes outstanding researchers in agriculture who have supported the Cooperative State Research, Education, and Extension Service's mission to advance knowledge for agriculture, the environment, human health and well-being, and communities. The Discovery Award is presented during a site visit to the project director's institution by a CSREES Administrator. The honor includes a $10,000 supplement to the investigator's research project.

Dr. Sutovsky was nominated for his excellence in research and contributions to his field. He received an NRI New Investigator award in Fiscal year 1999 for his proposal titled *Paternal Contributions to the Functional Zygotic Structure in Bovine.* Dr. Sutovsky received renewal funding in Fiscal year 2002 for his proposal titled *Ubiquitin-dependent proteolysis in farm animal spermatogenesis and fertilization*. The information generated by these two projects advanced current knowledge of sperm function and may lead to improved fertility in livestock. Dr. Sutovsky's work has broad implications for the basic understanding of cell function beyond the field of reproductive biology. His discoveries include two new pathways of ubiquitin-mediated protein degradation in reproductive tissues, thereby markedly increasing what was known previously about this vital cellular process. Dr. Sutovsky received a U.S. patent for the functional assay he developed for rapidly and inexpensively assessing male fertility. In addition, he is awaiting word on four patents pending in the United States and one in Canada. Dr. Sutovsky published a total of 26 journal articles, nine with the new investigator award and 17 with the renewal award. Six of the published articles appeared on the covers of scientific journals, including *Reproduction, Developmental Biology, Molecular Reproduction, Biology of Reproduction, Human Reproduction,* and *Cell Science*.

Directory of NRI Competitive Grants Program Staff and Office of Extramural Programs Contacts

Deputy Administrator – Dr. Anna Palmisano, Phone: (202) 401-1761, Fax: (202) 401-1782, E-mail: apalmisano@csrees.usda.gov

Science Advisor - Dr. Louis Pitelka, Phone (202) 720-1765, Fax: (202) 401-1782, Email: lpitelka@csrees.usda.gov

Extension and Education Advisor – Dr. Elbert Dickey, Phone (202) 205-5700, Fax: (202) 401-1782, Email: edickey@csrees.usda.gov

Integrated Programs Director - Dr. Deborah Sheely, Phone: (202) 401-1924, Fax: (202) 401-1782, E-mail: dsheely@csrees.usda.gov

Research Director- Dr. Mark Poth, Phone: (202) 401-5244, Fax: (202) 401-6071, E-mail: mpoth@csrees.usda.gov

Office of Extramural Programs - Awards Management Branch - Administrative issues regarding award processing and post-award management. Phone: (202) 401-4342 or (202) 401-5050 Fax: (202) 401-6271 or (202) 401-3237

Animal Biosecurity Coordinated Agricultural Projects (CAP) – Dr. Peter Johnson, National Program Leader, Phone: (202) 401-1896, Fax: (202) 205-3641, E-mail: pjohnson@csrees.usda.gov

Plant Biosecurity – National Program Leaders: Dr. Liang-Shiou Lin, Phone: (202) 401-5042, Fax: (202) 401-6488, E-mail: llin@csrees.usda.gov; Dr. John L. Sherwood, National Program Leader, Phone: (202)690-1659, Fax: (202)401-6488, E-mail: jsherwood@csrees.usda.gov

Agricultural Plants and Environmental Adaptation- Dr. Gail McLean, National Program Leader, Phone: (202) 401-6060, Fax: (202) 401-6071, E-mail: gmclean@csrees.usda.gov

Managed Ecosystems – Dr. Diana Jerkins, National Program Leader, Phone: (202) 401-6996, Fax : (202) 401-6071, E-mail: djerkins@csrees.usda.gov

Microbial Genome Sequencing (offered in partnership with the National Science Foundation) - Dr. Ann Lichens-Park, National Program Leader, Phone: (202) 401-6460, Fax: (202) 401-6488, E-mail: apark@csrees.usda.gov

Microbial Observatories (offered in partnership with the National Science Foundation) – Dr. John L. Sherwood, National Program Leader, Phone: (202)690-1659, Fax: (202), E-mail: jsherwood@csrees.usda.gov

Soil Processes - Dr. Nancy Cavallaro, National Program Leader, Phone: (202) 401-4082, Fax: (202) 401-6071, E-mail: ncavallaro@csrees.usda.gov

Water and Watersheds- Mary Ann Rozum, National Program Leader , Phone: (202) 401-4533, Fax: (202) 401-1706, E-mail: mrozum@csrees.usda.gov

Air Quality – Dr. Ray Knighton, National Program Leader, Phone: (202) 401-6417, Fax: (202) 401-1706, E-mail: rknighton@csrees.usda.gov

Bioactive Food Components for Optimal Health - Dr. Etta Saltos, National Program Leader, Phone: (202) 401-5178, Fax: (202) 205-3641, E-mail: esaltos@csrees.usda.gov

Human Nutrition and Obesity – National Program Leaders: Dr. Etta Saltos, Phone: (202) 401-5178, Fax: (202) 205-3641, E-mail: esaltos@csrees.usda.gov; Dr. Susan Welsh, Phone: (202) 720-5544, Fax: (202) 720-9366, E-mail: swelsh@csrees.usda.gov

Food Safety – Dr. Chris Wozniak, National Program Leader, Phone: (202) 401-6020, Fax: (202) 401-6156, E-mail: cwozniak@csrees.usda.gov

Epidemiological Approaches for Food Safety - Dr. Mary Torrence, National Program Leader, Phone: (202) 401-6357, Fax: (202) 401-5179, E-mail: mtorrence@csrees.usda.gov

Animal Reproduction - Dr. Mark Mirando, National Program Leader, Phone: (202) 401-4336, Fax: (202) 205-3641, E-mail: mmirando@csrees.usda.gov

Animal Growth and Nutrient Utilization - Dr. Mark Mirando, National Program Leader, Phone: (202) 401-4336, Fax: (202) 205-3641, E-mail: mmirando@csrees.usda.gov

Animal Genome- National Program Leaders: Dr. Peter Burfening, Phone: (202) 401-5823, Fax: (202) 401-6488, E-mail: pburfening@csrees.usda.gov; Dr. Muquarrab Qureshi, Phone: (202)401-4895, Fax: (202) 401-1602, E-mail: mqureshi@csrees.usda.gov

Animal Protection – National Program Leaders: Dr. Peter Brayton, Phone: (202) 401-4399, Fax: (202) 401-6071, E-mail: pbrayton@csrees.usda.gov; Dr. Peter Johnson, Phone: (202) 401-1896, Fax: (202) 205-3641, E-mail: pjohnson@csrees.usda.gov

Functional Genomics of Agriculturally Important Microorganisms - Dr. Ann Lichens-Park, National Program Leader, Phone: (202) 401-6460, Fax: (202) 401-6488, E-mail: apark@csrees.usda.gov

Organismal and Population Biology of Arthropods and Nematodes - Dr. Mary Purcell-Miramontes, National Program Leader, Phone: (202) 401-0222, Fax: (202) 401-6488, E-mail: mpurcell@csrees.usda.gov

Suborganismal Biology and Genomics of Arthropods and Nematodes - Dr. Mary Purcell-Miramontes, National Program Leader, Phone: (202) 401-0222, Fax: (202) 401-6488, E-mail: mpurcell@csrees.usda.gov

Biology of Plant-Microbe Associations - Dr. Ann Lichens-Park, National Program Leader, Phone: (202) 401-6460, Fax: (202) 401-6488, E-mail: apark@csrees.usda.gov

Biology of Weedy and Invasive Species in Agroecosystems – Dr. Michael Bowers, National Program Leader, Phone: (202) 401-4510, Fax: (202) 401-1706, E-mail: mbowers@csrees.usda.gov

Plant Genome - Dr. Ed Kaleikau, National Program Leader, Phone: (202) 401-1931, Fax: (202) 202-401-6071, E-mail: ekaleikau@csrees.usda.gov

Genetic Processes and Mechanisms of Agricultural Plants - Dr. Liang-Shiou Lin, National Program Leader, Phone: (202) 401-5042, Fax: (202) 401-6488, E-mail: llin@csrees.usda.gov

Developmental Processes of Agricultural Plants - Dr. Liang-Shiou Lin, National Program Leader, Phone: (202) 401-5042, Fax: (202) 401-6488, E-mail: llin@csrees.usda.gov

Agricultural Plant Biochemistry - Dr. Gail McLean, National Program Leader, Phone: (202) 401-6060, Fax: (202) 401-6488, E-mail: gmclean@csrees.usda.gov

Agricultural Markets and Trade – Dr. Pat Hipple, National Program Leader, Phone: (202) 401-2185, Fax: (202) 401-6071, E-mail: phipple@csrees.usda.gov

Rural Development – Dr. Pat Hipple, National Program Leader, Phone: (202) 401-2185, Fax: (202) 401-6071, E-mail: phipple@csrees.usda.gov

Agricultural Prosperity for Small and Medium-Sized Farms – National Program Leaders: Dr. S. (Suresh) Sureshwaran, Phone: (202) 720-7536, Fax: (202) 401-6070, E-mail: ssureshwaran@csrees.usda.gov; Dr. Diana Jerkins, Phone: (202) 401-6996, Fax: (202) 401-6488, E-mail: djerkins@csrees.usda.gov

Improving Food Quality and Value – National Program Leaders: Dr. Ram Rao, Phone: (202) 401-6010, Fax: (202) 401-4888, E-mail: rrao@csrees.usda.gov; Dr. Hongda Chen, Phone: (202) 401-6497, Fax: (202) 401-4888, E-mail: hchen@csrees.usda.gov

Biobased Products and Bioenergy Production Research – Dr. Chavonda Jacobs-Young, National Program Leader; Phone: (202) 401-6188, Fax: (202) 401-6071, E-mail: cjacobs@csrees.usda.gov

Nanoscale Science and Engineering for Agriculture and Food Systems – Dr. Hongda Chen, National Program Leader, Phone: (202) 401-6497, Fax: (202) 401-4888, E-mail: hchen@csrees.usda.gov