National Research Initiative

Competitive Grants Program

Knowledge for Tomorrow's Solutions

Annual Report Fiscal Year 2006

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

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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.

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Message from the CSREES Competitive Programs Extension and Education Advisor:

Colleagues,

As the Extension and Education Advisor with Competitive Programs, it is an honor to discuss the broad and diverse portfolio of programs available through the National Research Initiative (NRI). The NRI funds fundamental and applied, mission-relevant research and integrated research, education, and extension projects. Generating knowledge through fundamental research is an essential element to advance science to a higher level. Equally important is the application of knowledge generated from research to resolve problems facing the Nation. Integrated programs provide the infrastructure and vehicle to distribute knowledge through education and extension. Acting as a bridge between researchers and users, the extension community helps to identify the direction of future research and incorporates knowledge into educational programs delivered to clientele.

In the year that I served as the Extension and Education Advisor, I strove to strengthen the portfolio of integrated projects by working with the extension community. Presentations and discussions at regional meetings facilitated discussions on these topics within the extension community. In addition, extension directors and administrators were encouraged to support extension faculty participation in the development and leadership of NRI applications and projects. Concurrently, the extension community supported extension faculty participation in the peer review process. Finally, CSREES scientific staff and extension specialists developed new evaluation criteria for integrated applications that will be applied in Fiscal Year 2007 panel evaluations.

The 2006 NRI portfolio represents the high quality science projects funded to address the issues facing the Nation. 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.

Bioenergy provides a potential product that will alleviate the Nation's dependence on foreign oil. The NRI Biobased Products and Bioenergy Production program funds research projects that expand science-based knowledge and technologies supporting the efficient, economical, and environmentally friendly conversion of biomass, specifically agricultural residuals, into value-added industrial products and biofuels. In order to use bioproducts effectively, however, there is a need to improve the biodiesel production process and develop alternative approaches for the byproduct glycerol. This program funded a project that will develop a novel, continuous process for biodiesel production while converting glycerol to an acetal derivative. This derivative may be left in the biodiesel product as a performance-enhancing fuel additive or separated from biodiesel and recovered to produce high-purity glycerol. This research may lead to a domestically produced, renewable, and environmentally friendly biofuel.

During the past year, food safety issues captured national interest. The NRI helps to protect the Nation's food supply through a variety of programs. The Improving Food Quality and Value program addresses food safety by examining the freshness of food products. One project funded in Fiscal Year 2006 examines the issue of food freshness from a new perspective. Instead of adding preservatives to food products, scientists are developing new packaging materials that release freshness compounds at controlled intervals. The new packaging will keep food fresh longer extending the product's shelf life. This project may revolutionize the food packaging industry, reducing food borne illnesses and microbial spoilage of packaged foods.

Obesity plagues many citizens in the United States. The NRI Human Nutrition and Obesity Program addresses this concern by funding research and integrated projects that lead to a better understanding of the behavioral and environmental factors that influence obesity and develops interventions to prevent obesity. One project addresses the role of obesity in the lives of the smallest Americans, toddlers. This project will develop a program promoting healthy eating and nutrition habits in toddlers (2-5 years of age) of low-income parents. By offering the 'Healthy Toddlers' intervention in collaboration with parenting and nutrition education programs, this project has the potential to impact a large number of low-income families with young children in the states involved in the study, Colorado, Michigan, and Wisconsin.

Rural Americans are challenged by profound social, economic, technological, and demographic changes. The NRI addresses these concerns through the Rural Development program, which supports research projects that focus on increased economic opportunities and improved quality of life in rural America. One project aims to integrate Latino migrant workers into the fabric of a local Midwest community. A multi-disciplinary team of social scientists will identify individual strategies and rural community institutions and approaches that facilitate economic integration of the immigrants to produce thriving rural communities. Project results will be distributed at workshops, conferences, and through a variety of publications.

I am honored to participate in the 2006 NRI Annual Report, 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 mission of the Cooperative State Research, Education, and Extension Service (CSREES) is 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 promote effective communication among scientific disciplines and bring together stakeholders with similar interests. The National Research Initiative (NRI), the largest competitive program offered through CSREES, was established in 1992 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; and
- Sustaining the quality and productivity of the natural resources upon which agriculture depends.

In Fiscal Year 2003, the NRI expanded its interest beyond those set during the program's inception to include integrated projects, which incorporate research, education, and extension components. The inclusion of integrated projects into the 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.

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. In Fiscal Year 2006, the NRI provided $166,788,575 to states in the form of research and integrated grants.

Identification of Program Priorities

The Competitive Programs staff assimilates the input of diverse stakeholder groups to develop program descriptions that will solicit the highest-quality applications 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. Program priorities are evaluated using several criteria, including 1) mission relevance; 2) scientific opportunity; 3) impact to science and society; 4) linkages to other federal programs; and 5) stakeholder input.

In Fiscal Year 2006, USDA and CSREES addressed 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; and 5) Protect and enhance the Nation's natural resource base and environment. In addition, program priorities remain flexible in order to support projects that are relevant to critical and emerging issues. Program priorities are also relevant to the public and end users, as well a high priority for partners and stakeholders.

Research and integrated program priorities must also address the scientific opportunities available through the project. It is imperative that projects produce work that is innovative and timely to address questions vital to National needs. Projects should take advantage of or contribute to cutting edge science or technology. Projects can be multi-disciplinary, when appropriate, to best address the question at hand. Finally, projects can be designed as research projects or integrated research, education, and/or extension projects to best address the question posed in order to create new approaches or new knowledge, build on existing knowledge, or fill a critical gap in our knowledge.

Resources necessary to fulfill program priorities must be wisely managed. National Program Leaders at CSREES work actively with their counterparts at other Federal agencies to coordinate and leverage funds, as well as to minimize any potential for overlap.

In addition to input from the congressionally established the National Agricultural Research, Extension, Education, Economics Advisory Board (NAREEEAB), CSREES is active in soliciting stakeholder input. The CSREES seeks input from stakeholder activities that are open, transparent and documented. The new stakeholder page on the CSREES Web site illustrates the diverse input used to generate new research and integrated priorities for NRI programs. The stakeholder Web page can be viewed at www.csrees.usda.gov/business/reporting/stakeholder.html. Input from coalitions and stakeholders provide a broad perspective on current research, extension, and education needs and priorities. The 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. The NRI scientific staff members attend scientific and professional meetings and coordinate program priorities with other federal agencies to ensure scientific trends are reflected in the Request for Applications. In addition, the NRI receives input on its programs from academia, including administrators, staff members, and scientists at land grant, and other universities.

Grants Provided

The NRI provides grants that encourage research, education, and extension to address mission relevant goals. Fundamental Awards fund projects that provide basic knowledge, which advances applied research and conceptual breakthroughs in fields relevant to agriculture. **Agricultural Research Enhancement Awards** (AREA) build 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 among 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 the end users, while providing for educational opportunities to ensure the development of agricultural expertise in future generations.

Congress has mandated that NRI 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 awarded to strengthen research capacity of individuals and institutions. In Fiscal Year 2006, Congress designated integrated projects account for up to 22 percent of funds awarded.

Program Implementation

Applications 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 2006 RFA, published in the Federal Register, identified 32 program areas addressing the five strategic goals. Fifteen of the 32 programs in the Fiscal Year 2006 RFA include integrated components: (1) Animal Biosecurity Coordinated Agricultural Projects; (2) Plant Biosecurity; (3) Agricultural Plants and Environmental Adaptation; (4) Managed Ecosystems; (5) Air Quality; (6) Human Nutrition and Obesity; (7) Epidemiological Approaches for Food Safety; (8) Animal Reproduction; (9) Animal Growth and Nutrient Utilization; (10) Animal Genome; (11) Animal Protection; (12) Biology of Weedy and Invasive Species in Agroecosystems; (13) Genetic Processes and Mechanisms of Agricultural Plants; (14) Agricultural Prosperity for Small and Medium-Sized Farms; and (15) Improving Food Quality and Value.

The competitive review process, which favors the funding of important, relevant topics using well-designed and well-organized experimental plans, has proven to be a powerful mechanism for stimulating new scientific ideas. Each year, panels of scientific peers meet to evaluate and recommend applications based on scientific merit, investigator qualifications, and relevance of the proposed work to U.S. agriculture. In Fiscal Year 2006, 37 peer panels reviewed and ranked the applications. 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. A number of scientists and other experts representing a wide variety of fields brought additional expertise to the review process by conducting ad hoc reviews to ensure the highest quality and most meritorious applications were selected for funding. In total, more than 2,000 scientists contributed their time and expertise to the NRI application evaluation process in Fiscal Year 2006.

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 applications for future resubmission. Continuing a practice initiated in 1993, non-technical summaries describing each funded project in Fiscal Year 2006 have been published as Abstracts of Funded Projects and posted on the CSREES Web site on the 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 Dallas, Texas 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 applications, individual program descriptions, recent funding statistics, and the future use of electronic application submission using e-grants. A Granstmanship Workshop for Integrated Programs in Kansas City, Missouri focused on developing, writing, and implementing competitive integrated applications for integrated programs to ensure high quality applications. 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[1] institutions and 1890 Land Grant Institutions.

In an effort to offer better guidance to our applicants, additional funding information is 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. 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

A total of 2312 applications were submitted to the NRI, requesting a total of $894,978,367. As of January 23, 2007, awards totaling $157,645,734 were made to the 474 highest-ranked applications as shown in Table 2. The success rate is calculated in terms of number of applications funded, excluding conferences, supplements, and continuing increments of the same grant, divided by the

[1] EPSCoR (Experimental Program for Stimulating Competitive Research) states include AL, AK, AR, DE, HI, ID, KY, LA, ME, NV, NJ, NM, ND, OK, SC, SD, VT, WV, and WY as well as American Samoa, Guam, Micronesia, Northern Mariana Islands, Puerto Rico, Virgin Islands of the United States, and the District of Columbia.

number of applications submitted for review. The NRI funded approximately 16 percent of the standard research and integrated applications submitted. Funding for 368 standard research projects averaged approximately $340,668 for 2.7 years, excluding Research Career Enhancement Awards, Equipment Grants, Seed Grants, Conference Grants, continuing increments, and supplements. Forty-seven standard integrated research, education, and extension projects were funded averaging $585,616 for 3.3 years, excluding Bridge Grants, Conference Grants, continuing increments, and supplements.

The NRI provided funds totaling $365,288 in partial support of 40 Conference Grants. 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. The NRI provided a total of $17,980,328 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

To make significant progress on issues of major agricultural importance commonly requires the contributions of many disciplines. It is often beyond the scope of one NRI program to effectively support projects that deal with these important issues. The crosscutting areas identified in

Table 4 represent issues or areas that many NRI programs are contributing toward. An example of a crosscutting area addressed by the NRI is forest biology, which includes research on forest diseases, forest insects, forest wildlife, forest practices and water resources, tree physiology and genetics, and management strategies for small and medium forest land owners. The net result is that forest biology related projects were supported by ten NRI programs in 2006. This situation is similar for other crosscutting areas, including eight programs that supported projects for Sustainable Agriculture, five programs supported projects for Water Quality, and six programs supported projects for Global Change. Any crosscutting area of interest can be explored by using the Current Research Information System (CRIS), http://cris.csrees.usda.gov/. The CRIS system has a comprehensive record of all USDA supported awards and activities including those made by the NRI.

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 2006 for these categories is shown in Table 5. As noted earlier, Congress authorized 22% of NRI funds be allocated to integrated projects. In Fiscal Year 2006, integrated projects were awarded over 21% of NRI funds.

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 RFA and representatives of the agencies work together to assemble a panel of scientific peers to identify the most meritorious applications. From this group, representatives of each agency select applications 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 Microbial Genome Sequencing Program has been supported jointly by the USDA/CSREES NRI and the National Science Foundation (NSF) since Fiscal Year 2001. The program currently supports (i) high-throughput sequencing of the genomes of a broad range of microorganisms and (ii) the development and implementation of strategies, tools, and technologies to make currently available genome sequences more valuable to the user community. Over 100 microbial genomes have been sequenced to date as a result of this program. The broad availability of these sequences has led to important insights into how the structure and content of microbial genomes affect the ability of microorganisms to function and adapt to the environments in which they live. The USDA/CSREES and NSF Microbial Genome Sequencing Program will lead to improved breeding strategies, increased disease resistance, and enhanced yield and nutritive value of agriculturally important plants and animals.

The Microbial Observatories Program is jointly offered by USDA/CSREES and NSF with the long-term goal of understanding microbial diversity in different habitats over time and across different environmental gradients. CSREES' specific interest with regard to this program is to characterize microbial communities relevant to agroecosystems. Research supported through this program is expected to discover and characterize novel microorganisms, microbial consortia and communities, and to understand their roles in diverse environments. It is expected that information gained through supported projects will be disseminated via Internet-accessible knowledge networks.

The Climate Change Science Program (CCSP) is supported with funds from several Federal agencies, including USDA/CSREES, National Aeronautics and Space Administration (NASA), National Science Foundation (NSF), the United States Geological Service (USGS), the National Oceanic and Atmospheric Administration (NOAA), the Department of Energy (DOE), Agricultural Research Service (ARS), and the United States Forest Service (USFS). The NRI participates by funding climate change related research in several NRI programs from the Agroecosystems and Rural Prosperity programs and through interagency solicitations funded by NRI's Global Change Initiatives program that focuses on carbon cycle science, ecosystems, land use and land cover change. 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 aid in the reduction of 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, initiated in Fiscal Year 2005, is supported with funds from USDA/CSREES as well as the National Science Foundation (NSF) and Department of Energy (DOE). The interdisciplinary research team draws on the success of other completed sequencing efforts, including the maize genome sequenced to date, the rice genome, and the human genome, to ensure the cost effectiveness, speed, and accuracy of the project. The genome contains an estimated 50,000-60,000 genes among the 2.5 billion bases of DNA that make up its ten chromosomes. The project will provide the complete sequence and structure of all maize genes and their locations on both the genetic and physical maps. The genome sequence will be finished to the highest quality according to current scientific standards. Annotation is being coordinated with the existing maize community and a comparative database will be made publicly available. The information generated by the maize genome project will increase yields, nutritional value, and disease resistance in this very important agricultural crop.

Plant Feedstock Genomics for Bioenergy Program partners CSREES with the Department of Energy (DOE) Office of Science, Office of Biological and Environmental Research in a joint competitive grants program for genomics-based research to improve biomass and plant feedstocks for the production of fuels, such as ethanol or renewable chemical feedstocks. The program focuses on fundamental research on plants that will improve biomass characteristics, maximize biomass yield, and facilitate lignocellulosic degradation. Systems biology approaches will be used to understand the genome structure, function, and organization of plants used as biomass feedstocks. Genetic markers will be identified for plant breeding and manipulation. Projects funded from the program's first year include understanding and manipulating lignin biosynthesis in poplar, alfalfa, and wheat, as well as enabling technologies for structural or enzymatic methods of plant cell wall profiling. The Plant Feedstock Genomics for Bioenergy program will reduce the cost of feedstocks for bioenergy production, as well as improve agriculture and forestry sources for breeding and manipulation. The joint DOE-USDA program will be continued in Fiscal Year 2007. For more information, see www.genomicsgtl.energy.gov/research/DOEUSDA/.)

The Interagency Metabolic Engineering Working Group (MEWG) represents the partnership between eight federal agencies: the National Science Foundation (NSF), the Department of Defense (DOD), Department of Energy (DOE), National Institute of Health (NIH), U.S. Department of Agriculture (USDA), Department of Commerce (DOC), Environmental Protection Agency (EPA), and the National Aeronautic and Science Administration (NASA). The agencies work together to promote application of metabolic engineering principles in a wide range of areas. Metabolic engineering involves the study of metabolic pathways found in an organism to better understand and utilize cellular pathways for chemical transformation, energy transduction, and supramolecular assembly. Information gained from these projects will benefit society by increasing agricultural production, providing new insights into the metabolic basis in order to develop new cures for diseases, and improving our understanding of biological pathways to produce cost effective and environmentally sound processes and products. For more information, visit the group's Web site http://www.metabolicengineering.gov.

Table 1. Characteristics of NRI Peer Review Panels, Fiscal Year 2006

Characteristics	Number Peer Review Panelists	Percent
Geographic Region		
North East[1]	92	19
North Central[2]	138	29
South[3]	144	30
West[4]	106	22
Type of Institution[5]		
Land Grant University		
1862 Land Grant University	290	61
1890 Land Grant University	20	4
1994 Land Grant University	0	0
Hispanic Serving	12	3
Public non-Land Grant	45	9
Private College/University	20	4
Private Research	12	3
Federal	53	11
Industry/Other	28	5
Type of Position		
Professor	166	34
Associate Professor	124	26
Assistant Professor	89	19
Federal	53	11
Industry	28	6
Other (Senior Lecturer)	20	4
Expertise Representation		
Researcher	302	63
Educator	103	21
Extension Educator	40	8
Other	35	8
Gender[6]/Minority Representation		
Non-minority Male	239	50
Non-minority Female	137	28
Minority Male	72	15
Minority Female	32	7

[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]Fifty-five panelists represented EPSCOR states and 54 panelists represented Small and Medium-sized Institutions.

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

Table 2. National Research Initiative Funding Allocations[1], Fiscal Year 2006

Agroecosystems Program Cluster	**Awards**	**Total Dollars Awarded**
Soil Processes	18	3,669,471
Water and Watersheds	17	5,438,000
Air Quality	11	4,970,000
Managed Ecosystems	17	4,265,314
Biology of Weedy and Invasive Species in Agroecosystems	14	3,570,000
Rural Development	13	4,040,150
Agricultural Prosperity for Small and Medium-sized Farms	13	4,806,894
Total	**103**	**30,759,829**
Nutrition, Obesity, Food Safety and Quality Program Cluster		
Bioactive Food Components for Optimal Health	20	4,270,000
Human Nutrition and Obesity	16	10,970,000
Food Safety	16	4,296,200
Epidemiological Approaches for Food Safety	4	3,900,000
Nanoscale Science and Engineering for Agriculture & Food Systems	12	2,500,000
Food Safety Organized Research Unit (FS-ORU)	1	1,000,000
Total	**69**	**26,936,200**
Agricultural Genomics Program Cluster		
Microbial Genome Sequencing	8	5,000,000
Microbial Observatories	2	2,000,000
Animal Genome	23	8,682,645
Suborganismal Biology and Genomics of Arthropods & Nematodes	21	6,112,134
Plant Genome	18	7,089,000
Application of Plant Genomics Coordinate Agricultural Project (CAP)	2	2,396,000
Porcine Genome Sequencing Program	1	5,000,000
Total	**75**	**36,279,779**
Agricultural Biosecurity Program Cluster		
Animal Biosecurity Coordinated Agricultural Project (CAP)	4	3,292,538
Animal Protection	37	9,671,363
Plant Biosecurity	3	3,704,440
Organismal and Population Biology of Arthropods and Nematodes	21	5,930,390
Biology of Plant-Microbe Associations	19	5,235,290
Total	**84**	**27,834,021**
Agricultural Production and Value-Added Processing Program Cluster		
Animal Reproduction	18	4,022,768
Animal Growth and Nutrient Utilization	20	4,530,000
Agricultural Plants and Environmental Adaptation	11	3,070,001
Genetic Processes and Mechanisms of Agricultural Plants	17	4,170,000
Developmental Processes of Agricultural Plants	19	4,270,000
Agricultural Plant Biochemistry	15	4,170,000
Agricultural Markets and Trade	0	-
Improving Food Quality and Value	27	6,342,092
Biobased Products and Bioenergy Production Research	16	5,261,044
Total	**143**	**35,835,905**
Grand Total	**474**	**157,645,734**

[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 2006 appropriated funds as of January 23, 2007, regardless of the year awards were made.

Table 3. Agricultural Research Enhancement Awards, Fiscal Year 2006[1]

Type of Award	Number of Grants Awarded	Total Dollars Awarded
Postdoctoral Fellowships	14	1,687,889
New Investigator Awards	15	3,843,351
Strengthening Awards		
Research Career Enhancement	3	205,127
Equipment Grants	17	652,808
Seed Grants	15	1,471,752
Standard Strengthening Research Projects[2]	30	10,119,401
Total	**94**	**17,980,328**

Table 4. Crosscutting Program Areas, Fiscal Year 2006[1]

Area	Total Awards	Total Dollars Awarded
Animal Genome[3]	21	14,640,889
Animal Health	55	19,575,987
Food Safety	34	16,111,557
Forest Biology	50	15,154,915
Global Change	24	5,908,891
Plant Genome	22	19,909,555
Sustainable Agriculture	36	12,604,200
Water Quality	23	8,483,050
Integrated Pest Management	59	18,984,650

Table 5. Dimensions of NRI Research, Fiscal Year 2006[1]

Dimension	Total Dollars of Support	Percent
Fundamental	93,819,548	60
Mission-linked	63,826,186	40
Multi-disciplinary	94,808,144	60
Single Discipline	62,837,590	40
Integrated Research, Education, and Extension Projects	33,025,478	21
Research Projects	124,620,256	79

[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 2006 appropriated funds regardless of the year awards were made.

[2]Standard Strengthening Awards are provided to institutions of EPSCOR states (AL, AK, AR, DE, HI, ID, KY, LA, ME, NV, NJ, NM, ND, OK, SC, SD, VT, WV, and WY as well as American Samoa, Guam, Micronesia, Northern Mariana Islands, Puerto Rico, Virgin Islands of the United States, and the District of Columbia) and Small and Medium-sized institutions.

[3]Includes Porcine Genome Sequencing Award

The National Research Initiative: Supporting the CSREES Mission

In Fiscal Year 2006, the NRI funded 474 grants. This section provides examples of both research and integrated research, education, and extension projects in support of the mission priorities of USDA and CSREES. An asterisk after the project title indicates the work is an integrated research, education, and extension project. All other projects highlighted in the NRI Annual Report are research projects.

Strategic Goal 1: Enhance Economic Opportunities for Agricultural Producers

CSREES funds projects that promote sustainable agricultural productivity, data analysis, and management capabilities with improved information and technologies. CSREES also sponsors the development, teaching, and dissemination of science-based information to promote market efficiency, overcome barriers to trade, and enhance agricultural sales worldwide. Strategic Goal 1 is divided into five objectives. 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 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 research and integrated research, education and extension projects funded by the NRI that support the objectives of Strategic Goal 1 in Fiscal Year 2006.

Agricultural Plant Biochemistry

Project Title: *Biochemistry of Oilseeds: New Strategies for Improving Oils*

Project Director: John Browse

Lead Institution: Washington State University

Plant seed oil applications include culinary purposes, such as cooking oil and margarine, industrial products, such as industrial lubricants or cosmetics, and fuels, such as biodiesel. This project focuses on characterization and manipulation of desaturases and the related enzyme steps involved in fatty acid biosynthesis in plants. To accomplish this goal, a variety of biochemical, genetic, and molecular approaches will be used to understand the biosynthesis of seed oils and to produce desirable changes in the fatty acid composition. The researchers will examine how the balance between unsaturated and mono-unsaturated oils shifts with changes in substrate during desaturation and how the newly-identified ROD1 gene could mediate this process. In addition, the research will clarify whether oil composition can be altered indirectly through specific mutational changes in other aspects of metabolism. Results from this research will increase our understanding of the enzymatic machinery involved in biosynthesis of seed oil and may lead to new strategies to modify oilseed composition for more healthy food oils, more stable industrial oils, and more efficient use of seed oil as biofuel.

Plant Genome

Project Title: *Comparative Genomics, Nucleotide Diversity, and Karyotypic Evolution in Arachis*

Project Director: Steven J. Knapp

Lead Institution: University of Georgia

Peanut is second only to soybean in national and global economic importance among the food legumes. Worldwide, 36.5 million metric tons of peanuts are produced on 25.2 million hectares. The annual farmgate income for U.S. produced peanuts is $1 billion. Narrow genetic diversity has hindered progress in the development and application of genomics tools and resources to problems of biological and agricultural importance in peanut. The long-term competitiveness of the peanut industry in the U.S. hinges on the ability of breeders to integrate new genomic and molecular technologies into peanut breeding and variety development programs. The wild gene pool of peanut is an important source of genetic diversity for protecting the crop against environmental stresses, insect and disease pests, and for enhancing nutritional quality. This research focuses on the development of genomics resources for accelerating the discovery and utilization of genetic diversity for disease resistance and seed quality traits in the wild gene pool, reducing genetic vulnerability and broadening genetic diversity in the commercial gene pool, and developing genetically superior varieties. The researchers will develop DNA sequence and DNA marker resources to facilitate gene discovery and mapping and marker-assisted selection in breeding programs. Their research will benefit the peanut industry and society through the development of peanut varieties with superior nutritional and agronomic qualities.

Developmental Processes of Agricultural Plants

Project Title: *Ethylene and Auxin in Control of Root Architecture*

Project Director: Gloria K. Muday

Lead Institution: Wake Forest University

Appropriate root growth orientation and extensive branching are essential for efficient nutrient and moisture retention by roots and for maximal plant productivity. Genetic variants of crop plants that enhance root branching are more drought- and stress-tolerant. Similarly, a strong root gravitropic response allows plants to penetrate the soil more deeply, thereby minimizing dehydration and maximizing nutrient recovery. As agriculture expands into regions with greater limitations on moisture and nutrient availability, root architecture plays an even more critical role in plant survival and productivity. The importance of the plant hormone auxin in regulating gravitropism and root branching has long been appreciated. The project will examine the role of the plant hormone ethylene to determine how cross-talk between auxin and ethylene define the architecture of roots. The genetic model plant, *Arabidopsis thaliana*, and the crop plant tomato each offers unique experimental advantages to this study. Additionally, examination of these processes in two species will aid in the understanding of the universality of these findings across the plant kingdom. Knowledge gained from this research will facilitate the development of crop plants with optimal root architecture to maximize stress tolerance and productivity.

Agricultural Plants and Environmental Adaptation

Project Title: *Guard Cell ABA Signaling and Drought Tolerance: Integrating Systems Biology and Whole Plant Physiology*

Project Directors: Sally Assmann and Reka Albert

Lead Institution: Pennsylvania State University

Drought significantly limits crop productivity worldwide. During episodes of drought, plants reduce water loss through the plant hormone abscisic acid (ABA) as well as by closing the stomata, which are regulated by the guard cells surrounding the pores. In previous work, the researchers used a systems biology approach to synthesize current knowledge into a predictive model to explain how the guard cell signal transduction network operates during ABA-induced stomatal closure. The current project will improve on this model and will assay whole plant level responses to drought in two plants, Arabidopsis and Canola. The results of this project will increase our understanding of ABA-mediated stomatal closure, which regulates water loss, and may lead to new approaches for developing plants with improved drought tolerance and water use efficiency. In addition, this research will address how to best use the wealth of current scientific knowledge to predict which genes or proteins should be modified to improve plant performance under drought conditions. The combination of systems biology, predictive modeling, and biological experimentation in this study may lead to a ground-breaking approach to identify important molecular targets affecting plant productivity and yield.

Organismal and Population Biology of Arthropods and Nematodes

Project Title: *Trap, Then Manage: Using Corn Rootworm Behavior to Reduce Producer Inputs and Optimize Resistance Management for Transgenic Corn*

Project Directors: Joseph L. Spencer, Kevin L. Steffey, and Michael E. Gray

Lead institution: University of Illinois

Western corn rootworm (WCR) is the most important insect pest of corn. In the past, crop rotation with soybeans provided a cost-effective tactic to reduce WCR. However, a rotation-resistant variant of WCR, capable of laying eggs in soybeans, limits the effectiveness of crop rotation as a WCR reduction tactic. Consequently, producers returned to the expensive and harmful use of prophylactic insecticide treatments. Researchers will investigate the effectiveness of trap cropping, a cultural management tactic used to limit the insect reproduction area. After limiting the area of insect infestation, the researchers will plant transgenic corn containing *Bacillus thuringiensis* (Bt), which is toxic to WCR, in highly concentrated areas. The transgenic corn will kill the insects feeding on the corn roots. Limiting the area of transgenic corn will reduce selection for WCR resistance to transgenic corn, promote sustainable use of transgenic crops, and reduce costs to control this pest. In addition, the incorporation of economic data will assist cooperating growers to assess profitability of this method. This project promotes an environmentally sound and economic approach to management of a pest that threatens one of the most important field crops in the United States.

Animal Reproduction

Project Title: *Integrating in vitro Embryo Technologies into the Dairy Industry**

Project Directors: George Seidel, Dana Hoag, Peter Farin, and Peter Hansen

Lead Institution: Colorado State University

Over the past three decades, dairy cow fertility declined precipitously and is currently one-half the level held during the 1970s. This decrease in fertility provides a major impediment to profitability in the dairy industry because the initiation of milk production requires the birth of a calf. This integrated research and extension project is designed to circumvent the low rate of fertility in dairy cows though use of assisted reproductive technologies (ART). Application of these technologies is fairly expensive and has been cost prohibitive to wide-spread adoption by the animal production systems. The continued economic changes in the dairy industry, however, suggest application of ART may now be economically beneficial. Data from this work will be incorporated into an economic model to demonstrate the cost-benefit of using ART in the dairy industry and the results will be shared with dairy producers and extension faculty through a variety of extension programs.

Animal Growth and Nutrient Utilization

Project Title: *Quantification of Urea Kinetics in Beef Cattle*

Project Director: Evan Titgemeyer

Lead Institution: Kansas State University

Beef cattle use dietary protein efficiently by conserving nitrogen through the biological process of urea recycling. Microbes within the rumen of cattle synthesize protein from the conserved, recycled nitrogen that meets a substantial portion of the cattle's protein requirement. The efficiency by which urea recycling conserves dietary nitrogen remains unclear. Current cattle diet formulations largely ignore these mechanisms and dietary protein is fed in excess of the true cattle requirements. Excess nitrogen from dietary protein excreted into the environment can damage air and water quality. This project aims to characterize urea recycling to reflect more accurately cattle protein requirements in diet formulation. This study will measure urea metabolism and evaluate factors that affect growth of cattle. The researchers anticipate that factors increasing cattle growth will decrease the amount of urea nitrogen available for recycling. By quantifying this relationship, cattle dietary protein requirements can be calculated with greater precision. This study should improve economics of beef cattle production through reduced feed costs and improve water and air quality by reducing nitrogen release from beef cattle feedlots, ranches, and farms.

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

CSREES supports research and integrated-based information to provide new and innovative economic opportunities for communities and to assist community leaders in their decision-making on rural issues. Strategic Goal 2 is divided into two objectives. 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

research and integrated research, education and extension projects funded by the NRI that support the objectives of Strategic Goal 2 in Fiscal Year 2006.

Rural Development

Project Title: *Rural County Governments, Economic Development, and Public Services: The Impact of Decentralization Over Time*

Project Directors: Linda Lobao and David Kraybill

Lead Institution: Ohio State University

A 2001 national survey of county governments accessed the counties' roles in economic development and public service activities. As a follow up to this survey, the researchers will focus on changes in economic development and public service activities of county governments, specifically comparing the effects of these activities on rural well-being in 2001 and 2006. The researchers will address how county activities changed between the two studies, the relationship between increased economic development and decreased availability of public service provisioning, the widening of rural-urban gaps in county government as national economic conditions declined, and the effect of localized growth and public service on the well-being of residents over time. In addition to using the 2001 study as baseline data, the research team will collect primary data through a national survey in 2006. The study will place an emphasis on small, remote rural counties, indicated as high importance in the 2001 study. This project will build from the earlier longitudinal panel database of county government activities to address debates about decentralization and provide concrete information for county governments to monitor change and set policy.

Rural Development

Project Title: *Asset Accumulation Strategies in Three New Settlement Communities*

Project Directors: Corinne Valdivia and Anne M. Dannerbeck

Lead Institution: University of Missouri

Industries, including food manufacturing, agro-industries, construction, tourism, and services, draw Latino migrants to rural communities in the Midwest. This migration challenges many small communities, but it also provides new opportunities, especially for rural areas successful at integrating new migrants into the economic and social fabric of the community. A multidisciplinary team of social scientists will identify individual strategies and rural community institutions and approaches that facilitate economic integration of Latino immigrants and lead to thriving rural communities. Using a sustainable livelihoods framework, the researchers will examine the strategies newcomers employ to accumulate assets, minimize their vulnerability to risk exposure, and become part of their new community. The researchers will ascertain how immigrants use their capitals, e.g. economic, human, social, and cultural, in income earning strategies and how these capitals are transformed into assets to ease integration. This approach will be applied to three distinct Missouri communities with very different economic bases and community organizations. The project will provide communities with the knowledge and tools to develop institutions and strategies to secure a smooth and lasting integration of new immigrants. Project results will be disseminated at workshops and conferences and through publications, including a handbook on integration indicators for community development, a training manual, policy briefs, and a book of community case studies.

Agricultural Prosperity for Small and Medium-Sized Farms

Project Title: *Developing Economically Sustainable Cropping Strategies for Small and Medium-sized Farms in an Increasingly Scarce Water Environment**

Project Directors: James Pritchett, Neil Hansen, Dwayne Westfall, and Reagan Waskom

Lead Institution: Colorado State University

In the West, the economic sustainability of small and medium-sized farms is tightly woven with water availability. Irrigation shelters farm income from drought and boosts crop yields. In addition, irrigation permits small and medium-sized farms to produce crops, e.g. corn, alfalfa, onions, and sugar beets, that otherwise could not be grown competitively in a semi-arid environment. The project's goal is to assist small and medium-sized farms in identifying economically sustainable cropping strategies in the face of limited water resources, while demonstrating best management practices and recognizing the regional impacts of water reallocation. The researchers will conduct an innovative outreach program that assists small and medium-sized farms when making water allocation and crop rotation decisions.

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. Strategic Goal 3 is divided into two objectives. 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 research and integrated research, education and extension projects funded by the NRI that support the objectives of Strategic Goal 3 in Fiscal Year 2006.

Plant Biosecurity

Project Title: *Combating the Threat of the Plant Pathogenic Bacterium Xylella fastidiosa Using Genome-Based Methods Linked to National and International Monitoring**

Project Directors: Leonard Nunney, Richard Stouthamer, Robert Luck, Donald Cooksey, and Francis Wong

Lead Institution: University of California, Riverside

Xylella fastidiosa is a plant-pathogenic bacterium that causes scorch diseases in a wide range of economically important crops, including grapevines, peach, and almond. The bacterium infects the xylem, or the water-conducting tissue, of plants and is transmitted by xylem-feeding insects, typically leafhoppers, such as the glassy-winged sharpshooter (GWSS). This bacterium poses an increasing threat to U.S. agriculture due to the possibility that Xylella will infect additional economically important plants and/or exhibit a trend of increasing virulence on current hosts. There are five distinct forms of *X. fastidiosa*, some of which are found only in foreign countries and infect a different range of economically important hosts. The situation is further complicated

because different forms of Xylella are known to recombine to create new varieties covering a new host range, many infections don't show clear symptoms, and the disease vector, GWSS, is efficient and spread easily. These complications make coping with the disease threat a challenge. The project will investigate the geographical distribution of Xylella outside of the U.S. as well as study the host range. A nationwide monitoring program will be established to identify Xylella samples and a genetic database of known Xylella variants will be created and maintained. The project will facilitate the development of early detection and monitoring tools for this potentially invasive pathogen and protect the Nation's economically important crops against disease outbreak.

Biology of Plant-Microbe Associations

Project Title: *Novel Tombusvirus P19-Mediated Virus-Host Interactions*

Project Director: Herman Scholthof

Lead Institution: Texas A&M University

A process occurs in the cell biology of many eukaryotes, e.g. plants, animals and humans, in which fragments of double-stranded ribonucleic acid, RNA, interfere with the expression of a gene or genes whose sequence is complementary. This process is known as RNA interference or RNAi. Using RNAi, plants can defend themselves against attacks from a virus by specifically destroying the genetic material of an invading virus. Some viruses evolved ways to circumvent this plant defense. One such virus is tomato bushy stunt virus, or TBSV. This virus produces a protein called P19 that is involved in several biological activities, including virus spread, symptom induction, and suppression of the RNA degradation associated with RNAi. This project will examine the mechanisms by which P19 carries out these activities. The outcome from this research has the potential to benefit plant biotechnology and to develop an environmentally safe and effective virus control strategy for crop plants.

Suborganismal Biology and Genomics of Arthropods and Nematodes

Project Title: *Interactions of Cry1A Toxins with Midgut Membrane Receptors*

Project Directors: Sarjeet Gill, Alejandro Bravo, and Mario Soberon

Lead institution: University of California, Riverside

In an effort to combat crop damage, many transgenic crops include the toxin-producing genes from *Bacillus thuringiensis* (Bt). It is imperative to better understand the mechanism of toxicity of Bt toxin. This project aims to evaluate how insects evolve resistance to the Bt toxin by focusing specifically on crop pests, including *Heliothis virescens* (the cotton budworm), *Manduca sexta* (tomato horn worm), and the genetic lab rat *Drosophila melanogaster*. To combat the development of resistance and also to alleviate safety concerns with the use of proteins in Bt-toxin, it is essential to better understand their mode of action. Such research will not only help elucidate the molecular basis for host selectivity of these bacterial toxins, but also will define the mechanism(s) by which such resistance can occur. Furthermore, the identification of domains on the receptor molecules will allow the synthesis of probes for resistance monitoring and of model substrates to assess novel Bt-toxin constructs.

Animal Protection

Project Title: *B Cells Are Active Phagocytes in Teleost Fish: A Novel Role for B Cells in the Fish Immune Response*

Project Director: J. Oriol Sunyer

Lead Institution: University of Pennsylvania School of Veterinary Medicine

In mammals, B cells secrete antibodies in response to triggers provided by other parts of the immune system and have no known phagocytic function. Phagocytosis refers to the innate immune function whereby microbes are engulfed and enzymatically destroyed protecting the host from infection. Knowledge of the immune system of boney fishes is very limited. In rainbow trout, a subset of B cells that are part of the immune system retains a phagocytic function. In trout, over 57% of all circulating blood leucocytes are phagocytic B cells. This suggests an important role for these cells in the recognition and clearance of microbes as well as induction of other immune responses. Results from this project will increase our understanding of immunity in salmonid fishes, provide new strategies for fish immunization, and elucidate the evolution of human immune systems.

Animal Genome

Project Title: *Genetic Control of Response to Salmonella in Chickens*

Project Director: Susan Lamont

Lead Institution: Iowa State University

The U.S. poultry industry, a multibillion-dollar industry, loses 10 to 15% of its potential income to disease annually. Additionally, pathogens that infect poultry represent a major human health risk, specifically salmonella which causes over one million cases of illness and results in 500 deaths in the U.S. each year. All measures, including the permanent and environmentally friendly approaches of genetic resistance and non-antibiotic health enhancement, should be applied to resolve these problems as quickly as possible. Understanding the identity, molecular variation, and functional associations of genes that control response to salmonella will provide the necessary information for genetic enhancement of disease resistance in poultry via classical genetic selection techniques and administration of exogenous regulatory factors. Currently, only a few specific genes associated with pathogen response in poultry have been identified and generally their complete mechanisms of action are not understood. Microarray technology will be used to identify candidate genes and to unveil metabolic and regulatory pathways that control important biological traits. Detailed knowledge of immune-related gene structure and function will increase disease resistance in poultry, aid in the rational design of vaccines, and define resistant genotypes to provide a tool to maximize genetic disease resistance and production efficiency.

Epidemiological Approaches for Food Safety

Project Title: *Food Production, Food Safety, and the Global Food Supply**

Project Directors: George Maldonado, Craig Hedberg, Jeffrey Bender, and Claudia Munoz-Zanzi

Lead Institution: University of Minnesota

This project will develop a U.S.-Latin American network of research and education to reduce the occurrence of food-borne illness associated with imported food products. The research will focus

on methods to reveal the role of imported foods in U.S. food-borne illnesses as well as designing interventions for reducing these risks. This project will use novel statistical sampling methodologies to detect and quantify the occurrence of food-borne pathogens in imported food. The data on salmonella and *E. coli* in the U.S. and in Latin America will be used to design quantitative microbial risk assessments and attribution analyses. The multi-national, multi-disciplinary food safety education program will train U.S. and Latin American veterinary and graduate students on molecular epidemiology in food safety and public health, as well as establish a food safety network in the Americas. This project will enhance knowledge regarding the role of imported food products in the local and global dissemination of food-borne pathogens.

Food Safety

Project Title: *Investigation of the Campylobacter jejuni CadF Protein as an Agent for Reducing Campylobacter Carriage in Chickens*

Project Directors: Michael Konkel, D. R. Call, A.S. Dhillon, and J. Smit

Lead Institution: Washington State University

Researchers estimate that approximately two million cases of food-borne illness occur in the United States each year, however, many food safety experts believe this number is a gross underestimate. *Campylobacter jejuni*, a Gram negative bacterium found in the intestines of poultry, is the leading cause of gastroenteritis in the United States. Recent reports suggest approximately 70% of chicken available for sale in the U.S. contain Campylobacter. Since chicken is the primary vehicle for transmission of *C. jejuni* to humans, targeting and reducing the colonization of the bacterium in chicken gut prior to harvest is an economical and effective way to mitigate this pathogen. The researchers plan to take advantage of a protein, termed CadF, required for *C. jejuni* to attach to the intestines of poultry. Another bacterium, *Caulobacter crescentus*, which is known from the environment but is not associated with animals, will be genetically modified to present the CadF protein. This bacterium will be applied as a probiotic to block the binding sites along the intestinal wall. The project will develop a *C. crescentus* cell line that expresses CadF in sufficient amounts to block intestinal binding and add this modified bacterium to chicken feed. A reduction in carriage of this pathogen should result in a decreased number of food-borne illnesses and increased safety for the Nation's food supply.

Nanoscale Science and Engineering for Agriculture and Food Systems

Project Title: *Luminous Edible Nanoparticles as Sensors of Food Quality and Safety*

Project Director: Richard D. Ludescher

Lead Institution: Rutgers University

Ensuring the quality and safety of foods during processing, manufacturing, shipping, and storage is a complex, yet critically important issue in the food industry. Recent developments in sensor technology improved monitoring of specific components of food associated with safety and quality. This project will develop a novel class of luminescent edible food sensors based on nanoparticles treated with molecules having defined food compatible fluorescence and phosphorescence properties. The nanoparticles have several advantages as food sensors. The relative large surface area of nanoparticles provides space for a many luminescent molecules and the nanoparticles are

readily dispersable in foods. Nanoparticles are versatile, selective, and provide a specific signal readily measured with inexpensive hand-held optical devices. The luminous edible nanoparticles will provide specific measurements of local oxygen concentration, temperature, pH, water activity, and the presence of food-borne pathogens or food spoilage organisms. Given their characteristics and components, the sensors developed during this project should qualify as food-grade additives. The nanoparticle sensors have the potential to be used in a wide range of food industry activities, from fundamental research to product development, through shipping and storage to point of sale. The sensors will have the capability of identifying food safety and quality issues in a rapid, inexpensive, and easy manner, thus identifying and preventing food-borne illnesses.

Improving Food Quality and Value

Project Title: *Development of Novel Food Packaging for Controlled Release of Active Compounds: Polymer Blend Morphology and Composition Effect*

Project Directors: Kit Yam, Karen Schaich, D. Zumbrunnen, and Mikhail Chikindas

Lead Institution: Rutgers University

The routine addition of antimicrobials, antioxidants, and other active ingredients to food products inhibit the growth of microorganisms and/or increase shelf-life by preventing the oxidation of fats. Currently, the addition of active compounds occurs before food formulation. The shelf-life of these compounds, however, is short and their effect fades with time. A new approach integrates active components into the packaging material, where they will be released slowly over a period of time (Active Packaging). The investigators propose to develop a new generation of packaging materials, known as controlled release packaging (CRP) material. This new material releases active compounds at predetermined rates in order to replenish active compounds and enhance the quality and safety of food. A previously developed framework will be applied to study the relationship between composition-processing-structure of the polymer and CRP property. Various levels of natural antioxidants and antimicrobials will be incorporated into polymer blend films. Mathematical models will be constructed to describe the relationships between release kinetics of active compound, polymer composition, and film morphology. The results of this project may provide the stepping stone to revolutionize the food packaging industry by reducing food-borne illnesses and microbial spoilage of packaged foods.

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

CSREES strives to improve nutrition and health by promoting healthy diets and childhood intervention strategies, ensuring access to healthy food, and improving food and diet decisions. Strategic Goal 4 is divided into two objectives. 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 research and integrated research, education and extension projects funded by the NRI that support the objectives of Strategic Goal 4 in Fiscal Year 2006.

Bioactive Food Components for Optimal Health

Project Title: *Effect of Folate Status on Genetic/Epigenetic Stability and Tumorigenicity*

Project Director: Jimmy W. Crott

Lead Institution: Jean Mayer USDA Human Nutrition Research Center on Aging at Tufts University

Folate, a B-complex vitamin, is one of the nutrients most strongly implicated in the prevention of colorectal cancer. Based on epidemiologic studies, it is estimated that the risk of developing colorectal cancer in people consuming the largest amounts of dietary folate is 30-40% lower than in people consuming the lowest amounts of folate. The investigators plan to characterize the cellular responses to dietary folate depletion, especially the modulation of genetic pathways associated with cancer development. The researchers will use a novel animal model system that combines both cell culture and whole animal techniques. Mouse embryonic cells will be cultured under folate replete and moderately depleted conditions and will then be injected into nude mice whose immune systems are suppressed. A major advantage of this approach is the ability to study the effect of moderate folate depletion, equivalent to dietary intakes of many Americans, on early and late changes in tumor development. Understanding the mechanisms through which folate modulates the development of cancer is a necessary first step in developing effective public health measures that will utilize folate in the prevention of this disease. Results from this research may provide evidence for increasing the Dietary Reference Intake values for folate as cancer preventive measures, thereby improving the Nation's health.

Bioactive Food Components for Optimal Health

Project Title: *Bioactive Dietary Polyphenols that Promote Health by Direct Actions in the Gut**

Project Director: Mark Shigenaga

Lead Institution: Children's Hospital Oakland Research Institute

Obesity is a health condition that has reached crisis proportions in the United States. In 2003-2004, the Centers for Disease Control and Prevention estimated that two-thirds of American adults were either overweight or obese. Obesity is associated with development of chronic health problems, including inflammation of visceral adipose tissue, which can lead to insulin resistance in peripheral tissues and impaired glucose tolerance. The investigators plan to determine whether two dietary polyphenols, grape seed extract and epigallocatechin-o-gallate (EGCG) found in green tea, reduce the visceral adipose tissue inflammation and peripheral insulin resistance frequently associated with consumption of a "western-style" diet high in refined carbohydrates and saturated fat, but deficient in fiber. A mouse model will be used and the animals fed one of three diets, a control chow, a refined diet, or a refined diet supplemented with either EGCG or grape seed extract, for up to 16 weeks. The researchers will study the impact of adding these compounds to the diet on the type and amount of gastrointestinal bacteria, the ability of bacterial antigens to penetrate the intestinal wall, and the extent of visceral adipose inflammation and peripheral insulin resistance. This research will attempt to explain the mechanisms by which dietary polyphenols produce widespread systemic health benefits in humans.

Human Nutrition and Obesity Program

Project Title: *Healthy Toddlers and Strong Families through a Positive Feeding Environment**

Project Director: Susan Baker

Lead Institution: Colorado State University

Childhood overweight is becoming a problem of increasing concern in the United States. According to the Centers for Disease Control and Prevention, almost 14% of preschool children, ages 2-5 years, are now classified as overweight. This project will provide an intervention to prevent children from becoming overweight by linking parenting and nutrition education to low income parents, at or below 185% of the federal poverty level. The intervention will be implemented with this economically, educationally, and medically underserved group in three states, Colorado, Michigan, and Wisconsin, and will incorporate successful aspects of existing Cooperative Extension parenting and nutrition education. The project results will contribute to curbing the rising rates of childhood obesity through effective nutrition and parenting education that promotes the development of healthy eating habits at an early age. By offering the 'Healthy Toddlers' intervention in collaboration with parenting and nutrition education programs, such as Building Strong Families, Healthy Families, and the Expanded Food and Nutrition Education Program (EFNEP), this project has the potential to impact a large number of low-income families with young children in the affected states.

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. Strategic Goal 5 is divided into two objectives. 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 environmental preservation. The following highlights illustrate research and integrated research, education and extension projects funded by the NRI that support the objectives of Strategic Goal 5 in Fiscal Year 2006.

Microbial Observatories

Project Title: *Microbial Consortia in the Rhizosphere of Prairie Plants*

Project Directors: Linda Kinkel, James Bradeen, and Deborah Samac

Lead Institution: University of Minnesota

Soil microbes are significant to the fitness of all plants by fulfilling numerous roles that act to the benefit and detriment of plants. In turn, plants have substantial impacts on soil microbial communities, especially as one of the primary contributors of carbon to the soil environment. It remains unclear how to manipulate microbes to facilitate plant establishment and growth. This research will systematically explore the microbial community in, on, and around plant roots, or the rhizosphere, of long-lived perennial relatives of crop plants in natural habitats. The project will characterize the members of the microbial community in the rhizosphere and determine the interaction between individual rhizosphere communities to understand their impact on plant growth. Molecular tools as well as traditional and non-traditional culturing will be used to

identify species that cannot be readily grown in culture. This approach will allow the researchers to understand the communities of microbes in association with long-lived native perennial plant species over time. In addition, the microbial communities associated with native perennial plants will be compared to those associated with agriculturally important plants. The results from this study will provide a foundation to understand the role of microbes in the sustainability of the agroecosystems that provide our food, feed, and fiber.

Biobased Products and Bioenergy Production

Project Title: *A Novel Process for Improved Biodiesel Production*

Project Directors: Dennis Miller and Carl Lira

Lead Institution: Michigan State University

Biodiesel produced from plant oils and animal fats is undergoing rapid expansion of production in the United States. Biodiesel is currently expensive to produce because of high feedstock costs, high manufacturing costs, and the requirement to dispose of a low-purity glycerol byproduct. There is a need to improve the biodiesel production process and develop alternative approaches for the by-product glycerol. This project will develop a novel, continuous process for biodiesel production that involves reactive distillation and use of a solid acid catalyst. In addition, the process will convert glycerol to an acetal derivative that may either be left in the biodiesel product as a performance-enhancing fuel additive or separated from biodiesel and recovered to give high-purity glycerol. The proposed process will lower manufacturing costs of biodiesel, lead to a better-quality biodiesel product that exceeds ASTM standards, reduce waste formation, and eliminate the challenge of a low-purity glycerol byproduct. Ultimately, the research may lead to a domestically produced biofuel product elevating the Nation's dependence on foreign oil products.

Soil Processes

Project Title: *Colloid Interfacial Reactions in Open Micro Channels Representing Unsaturated Soil Capillaries*

Project Directors: Yan Jin and Lian-Ping Wang

Lead Institution: University of Delaware

Soil colloids are particles small enough to form a stable suspension in water and can move through sub-millimeter sized pores. Soil colloids can be organic, mineral, organo-mineral complexes, or living organisms, such as spores, bacteria, and viruses. How a colloid moves through unsaturated soils and is retained on soil particles remains unclear. This project will clarify how contaminants, nutrients, pathogenic microorganisms, and manufactured nanoparticles migrate to both ground and surface water supplies. This information may be useful for predicting and controlling soil colloids. This project will focus on developing models to experimentally examine colloid interfacial interactions at the pore scale. The project will also develop a simulation tool using a non-traditional approach and provide physically based explanations for the hydrodynamic effect on colloid retention. This research will have an important impact on prediction and control of pathogen and contaminant transport in the Nation's soils and water supplies by providing a mechanistic understanding and tools to model this important process.

Water and Watersheds

Project Title: *Survival Kinetics of Cryptosporidium Oocysts in Swine Facility Wastes of the Southern Piedmont and Coastal Plain Watersheds*

Project Directors: Dwight Bowman, M. Jenkins, and R. Sharpe

Lead Institution: Cornell University

Cryptosporidium is a protozoan that infects livestock, wildlife, and humans. It persists in soil and water in a resistant stage known as an oocyst. When ingested, this parasite can cause severe diarrhea, fever, and vomiting and may lead to death in the very young, elderly, immune compromised, or malnourished. This project will focus on survival of oocysts after application to swine waste lagoons and to swine waste applied to the land under southern piedmont conditions. The effectiveness of primary and secondary lagoon treatment on oocyst inactivation will be examined. In addition, the researchers will examine the effectiveness of pre-treating swine waste in lagoons on the survival of oocysts after land application. Oocysts of cryptosporidia are more resistant than other disease organisms, such as salmonella, enteric bacteria, and viruses. Developing an effective treatment to entrap, remove or inactivate cryptosporidia oocysts may prove to be an effective control mechanism to deal with all pathogens, including salmonella, enteric bacteria, and viruses. The results from this study may provide an additional layer of protection to the Nation's water and food supply.

Biology of Weedy and Invasive Species in Agroecosystems.

Project Title: *Ecological and Evolutionary Factors Influence Invasion Success**

Project Director: Jane Molofsky

Lead Institution: University of Vermont and State Agricultural College

Introduction history may influence whether or not a plant species becomes invasive. Specifically, the number and types of introductions may influence the genetic structure of invasive populations, providing a mechanism whereby introduced species may become invasive and weedy. Previous work on the invasive grass species, *Phalaris arundinacea*, shows changes in the genetic structure of invasive populations in North America compared to native European populations. More resilient North American populations may result from genetic mixing with the disparate European populations producing traits that confer an advantage to invasive genotypes, such as earlier emergence, higher tillering rate, and greater final biomass. The increased genetic variance for important invasive traits indicates a greater evolutionary potential for continued range expansion. The researchers will experimentally test whether the higher genetic variance and the reshuffling of genetic material between two geographically distinct European populations create genotypes that can survive and grow in a greater range of conditions. The study will directly address whether the genetic mixing of populations can create genotypes that may be more aggressive than ones found in the native range. If genetic mixing results in "aggressive" traits in invasive plant species, management can enact strict controls on the importation of any horticulturally or agronomically important plant species.

Managed Ecosystems

Project Title: *Synergistic Effects of Grazing, Fire and Pasture Management on Wetlands in Cattle Ranches*

Project Directors: Patrick Bohlen, David G Jenkins, John E. Fauth, and Pedro Quintana-Ascencio

Lead Institution: Archbold Biological Station

Wetlands provide essential ecosystem services, such as wildlife habitat, flood protection, and nutrient filtration, however, the conversion of natural systems to agriculture landscapes may degrade or even eliminates these services. Conservation programs in agriculture promote wetland restoration and management, but little information exists on the success of the restoration process. South Florida is one region where extensive wetlands overlap with areas of agricultural production. Millions of wetlands dot the landscape in this region and they comprise approximately 15 per cent of the land area in the Lake Okeechobee watershed. Cattle ranching is the dominant agricultural land use in this region and one component to impairing the wetland and water systems. This project examines how wetland ecosystems respond to three major management factors in this region: pasture intensification, prescribed fire, and grazing. These factors will be applied to small seasonal wetlands, separately and in combination, to evaluate their effects on forage production, biodiversity conservation, and food web support. The research findings are necessary to meet recognized policy needs. The results will assist in development of state and regional land stewardship and conservation plans, will evaluate the impact of land use changes on wetland systems, and will determine the impacts of environmental policy and conservation incentives on wetland systems in the greater Everglades watershed and beyond.

Managed Ecosystems

Project Title: *Adaptively Managing Agricultural Production for Future Climate and Land Use Changes in Montana's Flathead River Basin**

Project Directors: Tony Prato, Dan Fagre, Zeyuan Qiu, and Duane Johnson

Lead Institution: University of Missouri

Little information exists to assist agricultural producers and service providers in the Flathead River Basin of northwest Montana to evaluate the impact of future climate and/or land use changes on agricultural production and the quality of natural resources. The researchers will develop plausible future climate change scenarios for the next 50 years in terms of agriculturally-relevant climate variables, i.e. precipitation, temperature, and atmospheric CO_2 concentration. In addition, the researchers plan to develop an analytical framework for identifying the best agricultural systems for adapting three representative farms to the developed climate change scenarios and create a web-based, interactive, decision support tool that is easily accessible to agricultural producers and other stakeholders. The project is expected to increase awareness and understanding of the possible positive and negative impacts of climate and land use change on agricultural production and natural resources. In addition, the research will enhance the capacity of agricultural producers to adapt agricultural systems to future climate change.

Air Quality

Project Title: *Physical and Chemical Properties of Particulate Matter Emissions from Large Animal Feed Lots*

Project Directors: Sarah D. Brooks and Gunnar Schade

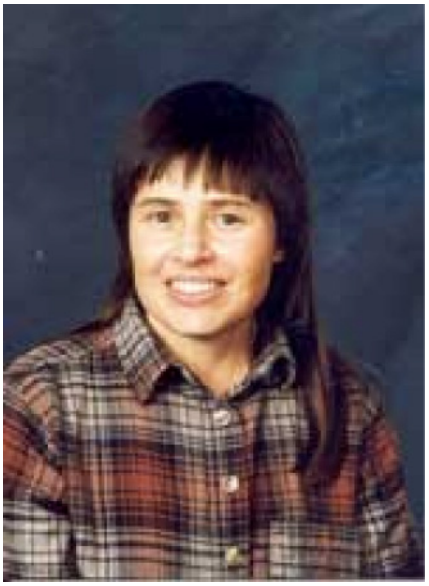
Lead Institution: Texas A&M University

The EPA recently increased the stringency of National Ambient Air Quality Standards for particulates. Changes in ambient atmospheric conditions, such as temperature and humidity, alter the chemical characteristics of the particulate matter which in turn affects chemical emissions on the particulate matter. Novel chemical methods to speciate the particulate matter and scanning electron microscopy in controlled environments are employed to evaluate how the physical characteristics of the particulates change when subjected to ambient atmospheric conditions under potential best management practices. Knowing the dynamic properties of the particulate matter will help to formulate better management practices to control emissions. The knowledge generated from this project will aid in understanding how cattle feedyard dust affects ambient air quality, such as impairing visibility and generating odor. The information will be immediately useful to local producers in controlling dust and odors. In addition, the project will provide new insights into Federal Reference Methods that the EPA employs in regulating particulate matter. Ultimately the results from this project will lead to new methods for improving air quality downwind of cattle feedyards as well as other commodities that deal with agricultural dust.

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

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 awardee from the most meritorious investigators funded through the National Research Initiative (NRI) Competitive Grants Program. The CSREES 2006 PECASE nominee will be finalized in May 2007.

The National Research Initiative (NRI) Discovery Award



Dr. Tanya Pankiw, of Texas A&M University, was awarded the National Research Initiative Discovery Award for 2006. This award recognizes outstanding researchers in agriculture who 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 was presented to Dr. Pankiw by Dr. Gale Buchanan, USDA Deputy Undersecretary for Research, Education, and Economics, and Dr. Colien Hefferan, USDA CSREES Administrator, on January 9, 2007 during a site visit to the project director's institution. The honor includes a $10,000 supplement and a one year extension of the investigator's research project.

Dr. Pankiw was nominated for her excellence in research and contributions to the field of entomology. Currently, the U.S. honeybee industry provides approximately $14.6 billion each year in added pollination services to the agriculture industry, however, the recent decline in honeybee populations threatens agriculture production. Dr. Pankiw's long-term goal is to understand mechanisms of growth regulation in honey bee colonies. A developing colony must balance between food resources and its various working castes to further colony growth functions. For social insect colonies, colony growth and reproduction are the principal sources of fitness for individual members. Colony growth is achieved through increased brood rearing. Dr. Pankiw's NRI funded project, entitled *Pheromone Regulation of Brood Rearing in the Honey Bee (Apis mellifera L.)*, examines the putative regulatory mechanisms of brood pheromone on colony brood rearing. Her work focuses on the effects of pheromones on honey bee neurosensory physiology, endocrinology, behavior, ontogeny, and gene expression. Dr. Pankiw's research results enable existing colonies to be more efficient pollinators despite reduced brood size. Her patented procedure significantly increased the number of pollen and other foragers in the honeybee colony and increased colony growth rate. Dr. Pankiw earned her Bachelor's and Master's degrees in plant science and entomology from the University of Manitoba and a Doctorate degree in biology from Simon Fraser University in British Columbia, Canada, in 1996.

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