United States Department of Agriculture

Cooperative State Research, Education, and Extension Service

Competitive Programs

National Research Initiative Competitive Grants Program

Annual Report

Fiscal Year 2004

"Knowledge for Tomorrow's Solutions"

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 Competitive Programs Science Advisor

Dear Colleagues,

The National Research Initiative (NRI) funds research and integrated activities across an impressive range of topics in support of the agricultural enterprise of the United States. One would expect to find research on crop improvement or control of agricultural pests within the portfolio, but simply examining the list of programs of the NRI reveals its much broader extent. Several programs apply modern genomic techniques to address a variety of goals that collectively seek to improve the competitiveness of U.S. agriculture. Programs on Human Nutrition and Obesity, and Improving Food Quality focus on the consumer end of the agricultural food chain. The program on Biobased Products and Bioenergy Production Research explores non-conventional uses of agricultural products. These are but a few examples of the breadth of the NRI portfolio that supports our Nation's agriculture, environment, human health and well-being, and communities.

Not surprisingly, a number of programs share a common goal of seeking to understand and diminish the impacts of different types of threats to agriculture and our food supply. While agriculture in the U.S. always has had to deal with pests, pathogens, and the vagaries of weather, it now is facing an unusually diverse array of serious challenges. At the same time that agriculture will be expected to provide ever more food and fiber, it will have to deal with problems ranging from new and existing diseases, and threats from terrorism, to climate change, loss of prime farming land, and ensuring access to adequate, safe water resources. While all areas of NRI research and integrated activities are critically important, it is timely to highlight those programs dealing with such threats. A review of the NRI portfolio reveals programs and projects that will be crucial in enabling agriculture to face these types of threats.

For example, programs such as Animal and Plant Biosecurity focus on understanding and controlling diseases and pests that threaten agricultural productivity, including those already present in the U.S. and those that could spread from overseas. Deliberate attacks on our food supply represent a relatively new issue facing our country, and the NRI seeks to provide knowledge and resources that will aid the country in countering deliberate bioterrorism efforts to disrupt our food supply. The globalization of the world economy and the associated increase in the movement of people and goods among countries also means that there is a much greater risk that weedy species will invade the U.S. from other countries. Invasive species already cause economic losses of billions of dollars. The program in the Biology of Weedy and Invasive Plants supports projects aimed at controlling the spread of such plants.

Global climate change represents both a threat and a potential opportunity for agriculture. The obvious threat is that particular crops and varieties may not be able to grow where they currently are raised. The potential costs for farmers and ranchers depend on how much climate change occurs in a particular area and whether other varieties or crops can be substituted cheaply for current crops. They also depend on factors such as whether the farming community in a region recognizes that climate change is occurring and plans for it. One potential opportunity for agriculture associated with climate change is through management practices that enhance the storage of carbon in soils, thus helping to offset fossil fuel emissions. The NRI Global Change

program works with other Federal agencies under the aegis of the U.S. Climate Change Science Plan to fund projects on this growing threat to both natural and managed ecosystems.

An issue of growing national and international concern is our fresh water supply. With increasing demands on that supply and increasing threats to it, how can we ensure that we will have enough water in the future to meet the various needs of people, including agriculture, while also sustaining terrestrial and freshwater ecosystems? Research supported by the program in Watershed Processes and Water Resources seeks to improve our understanding of how farmers and ranchers most efficiently can use their local water resources and also minimize the impacts of agricultural operations on water supplies. In addition, the program in Managed Ecosystems supports research on issues such as the effects of land-use change on ecosystem properties.

Of course, in the program areas of the NRI the ultimate goal is to provide the knowledge base to support agriculture and to create opportunities to build on this knowledge. A critical priority of CSREES through its extension and education activities always has been the transfer of results of agricultural research into practical technologies that can be utilized by the agricultural enterprise. However, in spite of all the good intentions, it can be difficult to achieve the efficient transfer of research results to potential users, especially when the research is done by scientists usually ensconced in university research labs, and the technology transfer is left to extension agents and educators who may or may not have good contacts with the scientists. Thus, I would like to highlight a relatively new type of project within the NRI – Integrated Projects - that seek to improve the efficiency and effectiveness of technology transfer. As defined for the NRI, "Integrated" means to bring together at least two of the three components of the agricultural knowledge system (research, education, and extension) around a single problem or activity, with the researchers, educators and extension agents working collectively to ensure the efficient transfer of useful results. The NRI began supporting Integrated Projects in FY 2003, and in FY 2004, 16 percent of NRI funds went to support these types of projects. Because the program was authorized to spend up to 20% of funds on integrated activities, the NRI encourages increased submission of these projects in the future.

The FY 2004 annual report includes descriptions of a number of research projects as well as integrated projects that support U.S. agriculture. These are just a small sample taken from the much larger array of projects supported by the NRI. I hope that readers will be impressed with the quality, relevance, and diversity of NRI projects.

Louis F. Pitelka, Ph.D.
Science Advisor
Competitive Programs

The National Research Initiative: An Overview

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

- 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.

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

Competitive Review Process

For research proposals, the NRI competitive review process encourages innovative ideas that are likely to open fundamentally new research approaches to enhancing agriculture, food, forestry, and the environment. A proven mechanism for stimulating new scientific research, the competitive review process increases the likelihood that investigations addressing important, relevant topics using well-designed and well-organized experimental plans will be funded. Each year, panels of scientific peers meet to evaluate and recommend proposals based on scientific merit, investigator qualifications, and relevance of the proposed research to U.S. agriculture. For integrated proposals, the process is expanded. The panel selected includes peers with the appropriate expertise in education and outreach/extension. Integrated proposals are also judged on the administration and planning of the project including the approach used for project evaluation and monitoring.

At least 10 percent of NRI funds support Agricultural Research Enhancement Awards. These awards enhance the U.S. agricultural research system through funding of postdoctoral fellowships and research by new investigators as well as through Strengthening Awards.

Strengthening Awards include Research Career Enhancement Awards, Equipment Grants, Seed Grants, and Strengthening Standard Research Projects. These grants fund researchers at small and mid-sized institutions ($\leq$ 15,000 total enrollment) with limited institutional success or in states and other entities that are part of the Experimental Program for Stimulating Competitive Research (EPSCoR).

The NRI encourages multi-disciplinary research, which is needed to solve complex problems, and seeks to initiate research in new areas of science and engineering that are relevant to agriculture, food, forestry, and the environment. The NRI also supports scientific conferences to facilitate the exchange of information necessary to achieve the most rapid advances in these areas. Both mission-linked research and fundamental research are supported by the NRI. Mission-linked research targets specific problems, needs, or opportunities. Fundamental research – the quest for new knowledge about agriculturally important organisms, processes, systems, or products – opens new directions for mission-linked research. Integrated projects go a step further and bring together the three components of the agricultural knowledge system (research, education, and extension). Mission-linked research, fundamental research, and integrated projects are essential to the sustainability of agriculture.

Identification of Program Priorities

Setting program priorities is an important means of facilitating the scientific and technological advances needed to meet the challenges facing U.S. agriculture. Congress sets the basic budgetary framework for the NRI. In the legislation that authorized the establishment of the NRI, Congress defined high-priority research as basic and applied research that focuses on both national and regional research needs (and methods for technology transfer). The authorizing legislation requires that, as appropriate, grants be consistent with the development of systems of sustainable agriculture. Congress further has specified that no less than 30 percent of funds be used to support multi-disciplinary team research, no less than 40 percent be used for mission-linked research, and no less than 10 percent 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. Members of Congress also 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 into the NRI priority-setting process is sought from a wide range of NRI customers, stakeholders and end-users. The scientific community provides direction for the NRI through the proposals it submits each year, as well as through the proposal evaluations and funding recommendations of individual scientific peer review panels. In addition, the NRI receives comments on its programs from academic administrators, other staff members, and scientists from universities; the Experiment Station Committee on Organization and Policy; and the research and extension administrators of the land-grant and other institutions and agencies.

NRI scientific staff members play an important role in providing continuity of programmatic leadership and scientific administration from year to year. Staff members attend scientific and professional meetings to stay current on scientific trends that need to be reflected in the *Request for Applications* and in the coordination of priority setting with other federal agencies. NRI staff also participate in meetings with representatives of key commodity groups and other user groups to discuss these stakeholders' current research priorities, to learn ways the NRI can assist in meeting their needs, and to solicit comments and suggestions on NRI program priorities.

Input from several coalitions has proved to be an important source of information. NRI staff members meet with groups such as the Institute of Food Technologists, CoFARM, C-FARE, the

Animal Agriculture Coalition, and others to gain a broad perspective on current research needs and priorities.

In Competitive Programs, the Science Advisor, the Education and Extension Advisor, Deputy Administrator, and 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, and the environment. The NRI program areas, which are evaluated and updated each year, are listed in the *Request for Applications* issued annually. The *Request for Applications* is accessible to the public – both in printed form and on the Internet via the NRI home page (http://www.csrees.usda.gov/funding/nri/nri.html).

Request for Applications

The NRI published a standard Request for Applications (RFA) for FY 2004. The standard RFA states the purpose of the NRI is to support high priority fundamental and mission-linked research and integrated activities of importance in the biological, environmental, physical, and social sciences relevant to agriculture, food, and the environment. For this purpose, the following definitions apply:

- **Fundamental Research:** Research that tests scientific hypotheses and provides basic knowledge which allows advances in applied research and from which major conceptual breakthroughs are expected to occur.

- **Mission-linked Research:** Research on specifically identified agricultural problems which, through a continuum of efforts, provides information and technology that may be transferred to users and may relate to a product, practice, or process.

- **Multidisciplinary Projects:** Projects (research or integrated) in which investigators from two or more disciplines are collaborating closely. These collaborations, where appropriate, may integrate the biological, physical, chemical or social sciences.

- **Integrated Projects:** Integrated means to bring the three components of the agricultural knowledge system (research, education, and extension) together around a problem or activity.

The purpose of NRI Integrated Programs is to support research, extension, and education grants that address critical emerging U.S. agricultural and rural issues. In awarding these grants, priority was given to projects that bring together two of the three components of the agricultural knowledge system (research, education, and extension). Integrated projects hold the greatest potential to produce and transfer knowledge directly to end users, while providing for educational opportunities to assure agricultural expertise in future generations.

In FY 2004, the NRI Integrated Program supported the following eleven program areas: (1) Animal and Plant Biosecurity; (2) Managed Ecosystems; (3) Air Quality; (4) Human Nutrition and Obesity; (5) Animal Reproduction; (6) Animal Protection; (7) Biology of Weedy and Invasive Plants; (8) Application of Plant Genomics Coordinated Agricultural Project; (9) Rural

Development; (10) Improving Food Quality, and (11) Enhancing the Profitability and Vitality of Small Farms and Rural Communities.

Integrated Programs in the NRI are unique in their emphasis on integration of research, extension and education, and their goal of supporting relatively large projects that provide more intensive support to the research, extension, and education system.

Section 737 of the General Provisions of the Consolidated Appropriations Resolution, 2003 (Division A of Pub. L. 108-7) provided CSREES with the authority to use up to 20 percent of the amount made available in the Act for the National Research Initiative Competitive Grants Program (NRI), to carry out a competitive grants program under the same terms and conditions as those provided in Section 401 of the Agricultural Research, Extension, and Education Reform Act of 1998 (AREERA) (7 U.S.C. 7621). Section 401 of AREERA established in the Treasury of the United States an account and authorized the Secretary of Agriculture to establish a research, extension, and education competitive grants program to address critical emerging U.S. agricultural and rural issues related to future food production; environmental quality and natural resource management; farm income; or rural, economic, business, and community development policy.

The NRI continues to support fundamental research while expanding on that foundation to address issues important to the future success of U.S. agriculture. The selection of issue areas to be addressed is a dynamic process that is designed to be responsive to changing priorities in agriculture, while ensuring that the NRI supports a foundation set of programs that provide the fundamental knowledge required for response to important issues as they emerge. Decisions about which issue areas to pursue are based on stakeholder input, congruence with Presidential initiatives, and two recent reports from the National Academy of Sciences' Board on Agriculture (2000 and 2002). These issues are further designed to address the purposes of section 401 of AREERA including all statutorily-identified critical emerging agricultural and rural issues and priority mission areas.

The NRI programs support the five Strategic Goals that are articulated in the CSREES Strategic Plan for FY 2004-2009. These are:

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.

The research and integrated projects funded through the NRI directly address one and often several of the strategic goals.

Program Implementation

The *NRI Request for Applications* is distributed widely within the scientific community and among other interested groups. The FY 2004 *Request for Applications,* published in the *Federal Register,* identified 32 program areas.

A total of 3,392 proposals were considered for funding in FY 2004. Forty-four peer panels reviewed and ranked the proposals, evaluating them on scientific merit, the qualifications of proposed project personnel, the adequacy of the proposed facilities, and the relevance of the proposed project to long-range improvements in – and the sustainability of – U.S. agriculture.

Each peer panel was composed of individuals with the expertise required to review each proposal thoroughly and fairly. 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, and gender and minority status (see 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, most meritorious proposals for funding.

More than 9,000 scientists contributed their time and expertise to the NRI proposal evaluation process in FY 2004. Participation in the panels and in writing *ad hoc* reviews provided many individuals the opportunity to gain experience in the review process and to become more familiar with the nature of the science supported by the NRI. The pool of *ad hoc* reviewers also provided a resource from which future panel members may be selected.

At the conclusion of the review process, a summary of the panel 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 were important for purposes of refining the proposals for future resubmission.

Continuing a practice begun in 1993, non-technical summaries describing each project funded in FY 2004 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).

Grantsmanship Workshops

NRI program staff conducted a number of workshops in FY 2004 to increase applicants' and administrators' understanding of the philosophy, directives, and procedures of the NRI competitive review process. In FY 2004, CSREES staff held five well-attended grant-writing workshops. The workshops were hosted by the Louisiana State University Agricultural Center and the Southern University Agricultural Research and Extension Center (Southern Region); the North

Central Cooperative Extension Association (NCCEA) and North Central Regional Association (NCRA) of Agricultural Experiment Station Directors (North Central Region); the Western Association of Agricultural Experiment Station Directors (WAAESD) and the University of Nevada, Reno (Western Region), and Pennsylvania State College of Ag Sciences (Northeast Region). The University of Arkansas, Pine Bluff also hosted a workshop in Little Rock, Arkansas, for the 1890 Land Grant Institutions. These workshops focused on CSREES funding opportunities in competitive research and integrated programs. 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.

Funded Projects

In FY 2004, a total of 3,392 proposals were submitted to the NRI, requesting a total of $1,396,701,037. Awards totaling $149,467,036 were made to the 524 highest-ranked proposals (see Table 2).

The success rate (in terms of number of proposals funded and excluding conferences, supplements, and continuing increments of the same grant) was approximately 14 percent. The average grant award for standard research projects (excluding Research Career Enhancement Awards, Equipment Grants, Seed Grants, conferences, continuing increments, and supplements) in FY 2004 was $338,828 for 2.9 years. The average grant award for standard integrated projects (excluding Bridge Grants, conferences, continuing increments, and supplements) in FY 2004 was $525,976 for 2.7 years.

The NRI provided funds totaling $640,633 in partial support of 54 conferences in FY 2004. These conferences brought scientists together to identify research needs, provide an update on research information, and/or advance an area of science important to U.S. agriculture, food, forestry, and the environment.

In FY 2004, the NRI provided funds totaling $15,952,724 in Agricultural Research Enhancement Awards. This support included Postdoctoral Fellowships, New Investigator Awards, and Strengthening Awards (see Table 3).

Crosscutting Areas

A number of topics of major importance to USDA involve several program areas. NRI support for these crosscutting program areas in FY 2004 is indicated in Table 4. The data show 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 and Soil Biology. The Integrated Pest Management area includes projects funded from the programs on Biologically Based Pest Management, Entomology and Nematology, 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 integrate the biological, physical, chemical, and social sciences. NRI funding in FY 2004 for these three categories is shown in Table 5.

Interagency Research

NRI National Program Leaders work closely with their research-funding counterparts in other federal agencies to avoid duplication and maximize interagency cooperation. An example of cooperation is seen in the research that NRI funds jointly with other federal agencies, including:

- The CSREES, USDA NRI, in partnership with the National Human Genome Research Institute (NHGRI) at the National Institutes of Health (NIH) and the USDA ARS provided funding to initiate the International Bovine Genome Sequencing Project. The goal of the interagency and international effort is to produce an 8X draft sequence of the bovine genome by December 2005. The bovine genome is being sequenced at Baylor College of Medicine. Additional funding for this project was provided by Canada (Genome Canada), Australia (The Commonwealth Scientific and Industrial Research Organization), and New Zealand (Agritech Investments Ltd., Dairy Insight, Inc., and AgResearch Ltd.). The state of Texas, the Kleberg Foundation, and the beef industry in the United States (National Beef Checkoff Funds, South Dakota Beef Checkoff Funds, and Texas Beef Checkoff Funds) also contributed funding for this project. The International Bovine Genome Sequencing Project was officially launched at a reception in Washington, D.C. on December 12, 2003.
- The Interagency Metabolic Engineering Program, established in 1998 with the Department of Energy (DOE), the National Science Foundation (NSF), the Department of Commerce (DOC), and 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. FY 2004 is the seventh year of this program. More information is available at the metabolic engineering website (www.metabolicengineering.gov).
- The Microbial Genome Sequencing Program has been supported jointly by the CSREES, USDA NRI and the National Science Foundation (NSF) since FY 2001, building on a Microbial Genome Sequencing Program offered by the USDA/CSREES in FY 2000. In FY 2004, the CSREES, USDA / NSF Microbial Genome Sequencing Program jointly supported the sequencing of over 20 microorganisms including plant and animal pathogens and other microorganisms which are important to agriculture, food, forestry and the environment.

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.

Table 1. Characteristics of NRI Peer Review Panels, FY 2004

Characteristic	Number Peer Review Panelists	Percent
Geographic Region		
Northeast [1]	112	20
North Central[2]	157	28
South[3]	157	28
West[4]	121	22
Type of Institution		
Land Grant University		
1862 Land Grant University	337	60
1890 Land Grant University	17	3
1994 Land Grant University	1	0
Hispanic Serving Institution	4	1
Public University	64	11
Private University	31	6
Private Research	9	2
Federal	62	11
Industry/Other	35	6
Type of Position		
Assistant Professor	107	19
Associate Professor	150	27
Professor	186	33
Federal	59	10
Industry	30	5
Other	31	6
Gender/Minority[5] Representation		
Non-minority Males	300	53
Non-minority Females	140	25
Minority Males	85	15
Minority Females	41	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]Minorities include: Asians, African Americans, Hispanics, Pacific Islanders, and Native Americans

Table 2. National Research Initiative Funding Allocations[1], FY 2004

Research Area	Number of Grants Awarded	Total Dollars Awarded
Natural Resources and Environment		
Plant and Environmental Adaptation	17	3,805,000
Watershed Processes and Water Resources	15	4,319,090
Soils and Soil Biology	18	4,663,142
Managed Ecosystems	13	3,708,982
Air Quality	11	5,000,000
Total: Natural Resources and Environment	**74**	**21,496,214**
Nutrition, Food Safety, and Health		
Bioactive Food Components for Optimal Health	22	4,418,000
Food Safety	23	4,678,990
Epidemiological Approaches to Food Safety	2	2,205,000
Human Nutrition and Obesity	13	8,239,727
Food Safety Organized Research Unit	2	2,295,000
Total: Nutrition, Food Safety, and Health	**62**	**21,836,717**
Animals		
Animal Reproduction	23	3,997,420
Animal Protection	40	11,123,668
Animal Genome	16	4,508,591
Animal Genome Reagent and Tool Development	2	1,614,481
Animal Growth and Nutrient Utilization	23	4,805,649
Total: Animals	**104**	**26,049,809**
Biology and Management of Pest Beneficial Organisms		
Arthropod and Nematode Gateways to Genomics	15	3,779,495
Integrative Biology of Arthropods and Nematodes	23	5,636,605
Biology of Plant-Microbe Associations	24	5,392,500
Biology of Weedy and Invasive Plants	14	3,564,000
Total: Biology and Management of Pest Beneficial Organisms	**76**	**18,372,600**
Plants		
Plant Genome, Bioinformatics and Genetic Resources	16	4,000,000
Genetic Processes and Mechanisms of Crop Plants	15	4,158,000
Developmental Processes of Crop Plants	22	4,153,000
Biochemistry of Plant and Plant Symbionts	30	4,405,000
Application of Plant Genomics Coordinated Agricultural Project	6	1,000,000
Total: Plants	**89**	**17,716,000**

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Markets, Trade, and Rural Development		
Markets and Trade	5	1,921,000
Rural Development	5	1,996,800
Enhancing the Profitability and Vitality of Small Farms and Rural Communities	9	2,500,000
Total: Markets, Trade, and Rural Development	**19**	**6,417,800**
Enhancing Value and Use of Agricultural and Forest Products		
Biobased Products and Bioenergy Production Research	11	3,200,000
Improving Food Quality	32	5,971,143
Improved Utilization of Wood and Wood Fiber	12	2,184,006
Total: Enhancing Value and Use of Agricultural and Forest Products	**55**	**11,355,149**
Emerging Issues		
Animal and Plant Biosecurity	9	6,647,004
Functional Genomics of Agriculturally Important Organisms	16	7,511,668
Total: Emerging Issues	**25**	**14,158,672**
Inter-Agency Programs		
Metabolic Engineering Program	2	460,000
Microbial Genome Sequencing Project	7	5,000,000
Bovine Genome Sequencing Program	1	5,000,000
Geospatial Extension Specialist	6	480,769
Carbon Cycle Science	2	806,306
Total: Inter-agency Programs	**20**	**12,064,075**
Grand Total	**524**	**149,467,036**

[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 FY 2004 appropriated funds regardless of the year awards were made.

Table 3. Agricultural Research Enhancement Awards, FY 2004[1]

Type of Award	Number of Grants Awarded	Total Dollars Awarded
Postdoctoral Fellowships	26	2,792,258
New Investigator Awards	25	6,832,879
Strengthening Awards		
Research Career Enhancement Awards	5	440,142
Equipment Grants	23	625,736
Seed Grants	26	2,419,353
Standard Strengthening Research Projects	13	2,842,356
Total	**118**	**15,952,724**

Table 4. Crosscutting Program Areas, FY 2004[1]

Research Topic	Number of Grants Awarded	Total Dollars Awarded
Plant Genome	53	12,947,000
Forest Biology	31	4,815,602
Global Change	24	4,908,737
Sustainable Agriculture	30	7,211,223
Animal Genome[2]	44	11,437,567
Animal Health	86	25,794,287
Water Quality	51	11,128,212
Food Safety	78	15,306,909
Integrated Pest Management	33	13,286,809

Table 5. Dimensions of NRI Research, FY 2004[1]

Dimension	Amount of Support	Percent
Fundamental	103,271,714	54
Mission-linked	87,422,887	46
Multi-disciplinary	72,798,205	60
Single Discipline	47,945,718	40

[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 FY 2004 appropriated funds regardless of the year awards were made.
[2]Includes Bovine Genome Sequencing Program

The National Research Initiative: Supporting the CSREES Mission

In FY 2004, the NRI funded 524 grants. This section provides examples of projects targeted at priorities important to the USDA mission, funded through 44 peer review panels, and related to the five broad Strategic Goals outlined in CSREES Strategic Plan for FY 2004-2009.

Strategic Goal 1: Enhance Economic Opportunities for Agricultural Producers

Program: Animal Genomics
Project Title: *Biological Basis of Muscle Hypertrophy Due to the Callipyge Mutation*
Project Directors: Christopher A. Bidwell, Noelle E. Cockett
Lead Institution: Purdue University

Callipyge sheep have an altered carcass composition due to increased muscle, decreased fat, and small livers. This project builds on previous work that established that the "callipyge" mutation in sheep is located on chromosome 18. The mutated gene results in increased muscle mass in the loin and hindquarters and decreased fat deposition. It is also the only gene thus far described in mammals that exhibits polar over-dominant inheritance patterns (i.e., the gene is only expressed in offspring if the mutated gene comes from the male parent rather than the female parent). The mutation is due to a single-base substitution in the identified gene. This study will look at the expression patterns of the gene as compared to the normal gene and how this has an impact on growth and meat quality. The results obtained will describe a basic biological phenomenon and provide a useful screening tool for the sheep industry.

Program: Genetic Processes and Mechanisms of Crop Plants
Project Title: *Verification of the Identity and Functionality of Candidate DNA Sequences for Wheat Vernalization Genes Vrn1 and Vrn2*
Project Director: Jorge Dubcovsky
Lead Institution: University of California – Davis

Wheat is one of the most important grains consumed by humans, and it grows in a wide variety of environments. Winter wheat, unlike spring wheat, requires a long exposure to low temperatures in order to flower. This vernalization process prevents flower development during the winter months, providing protection for the cold-sensitive floral organs. Researchers have cloned one of the wheat vernalization genes *VRN2* and have shown that its activity is reduced (down-regulated) by vernalization. Loss of function of the *VRN2* gene, whether by natural mutations or deletion, resulted in spring lines which do not require vernalization to flower. These results confirm the function of this gene as a repressor of flowering that is regulated by the vernalization process. This work has resulted in a publication in the March 12, 2004 issue of the prestigious journal, *Science*. The capacity of temperate cereals (wheat and barley) to generate spring forms through natural mutation at these genes allows them to maintain their wide

adaptability. This work will provide breeders with a tool to select the best vernalization gene combination for particular regions. An additional application will be the manipulation of cereals' flowering time. A delay in flowering time could also be of value for forage grasses. Recent studies by other groups have shown that the *VRN-1* and *VRN-2* genes cloned in this project are also critical for the regulation of flowering time in temperate forage grasses (oats, ryegrass, and fescue). Therefore, the information generated for wheat *VRN-1* and *VRN-2* genes can be used to design experiments aimed at the manipulation of flowering time in temperate forages, a trait that has a huge economic impact in forages.

Program: Applied Plant Genomics – Coordinated Agricultural Project (Integrated)
Project Title: *A Coordinated Research, Education and Extension Project for the Application of Genomic Discoveries to Improve Rice n the United States*
Project Directors: James C. Correll, Karen A. Moldenhauer, Yinong Yang, J. Neil Rutger, Anna M. McClung, Pamela C. Ronald, Scott H. Hulbert, James H. Oard, Henry T. Nguyen, Guo-Liang Wang, Jan E. Leach, Sally A. Leong, Robert G. Fjellstrom, Yulin Jia
Lead Institution: University of Arkansas

The goals of this integrated project titled RiceCAP (Rice Coordinated Agricultural Project), are to 1) improve rice crops by using new genomic-based tools; 2) build a community of researchers trained in the application of new genomics-based tools to address the issue of quantitative inheritance in rice, and 3) create a novel extension program to engage rice extension and industry personnel in agricultural genomics research and explore the potential of the technology. It is a multi-state, multi-institutional project that encompasses research, education, and extension to utilize new information from genomics to help solve two historically difficult rice problems: milling quality stability and sheath blight disease resistance. High, stable milling quality of rice remains a difficult issue for conventional rice breeders because many genes control this trait in rice and their identity is not known. RiceCAP scientists will identify genes involved in milling quality and test their function in order to provide markers for conventional rice breeders to use in breeding for better milling quality. Sheath blight is one of the most devastating diseases of rice, showing up each year to cause damage to the crop. It is the number one disease of southern U.S. rice production areas. Control is difficult because strong, stable resistance has not been identified in rice, resulting in the use of fungicides, now applied to about 40% of southern U.S. rice acreage at a cost of $25 - $30 per acre. In 2004, these fungicide costs in Arkansas, the largest rice production state, were over $16 million. The final product of this grant should lead to development of improved U.S. rice cultivars and extension personnel to educate the public on the merits of applying genome information to improve agricultural crops.

Program: Microbial Genome Sequencing Program
Project Title: *Whole Genome Sequence of Meloidogyne hapla as the Reference Tylenchid Nematode*
Project Directors: Charles H. Opperman, David M. Bird, Byron R. Sosinski, Nathan Lakey
Lead Institution: North Carolina State University

This project will produce a draft sequence of the root knot nematode (*Meloidogyne hapla*) genome. The *Meloidogyne* genus contains the world's most damaging and economically important plant-parasitic nematodes. These nematodes attack major food crops, including rice,

potato, cereal grains, and other widely grown crops. It has been estimated that root knot nematode causes more than $50 billion worth of damage to crops and other plants annually. This project will produce the first genome sequence of a plant-parasitic nematode. The genome sequence will be made available publicly so that researchers will be able to use the sequence to enhance understanding of how the nematode infects plants and evades plant defenses. The sequence is also expected to help identify novel targets for chemical controls.

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

Program: Agricultural Prosperity for Small and Mid-Sized Farms (Integrated)
Project Title: ***Forestry and Community: Creating Local Markets for Local Resources***
Project Directors: Conner Bailey, Valentine Hartarska, Mark R. Dubois, Bruce Lindsey
Lead Institution: Auburn University

Hundreds of thousands of forestland owners with parcels less than 50 acres have limited or no opportunity to market their timber. This is because contemporary logging operations require larger parcel sizes to economically justify harvests. This project funded at Auburn University uses a multidisciplinary approach to examine the relationship between poverty and forestry in the South. It is designed to create market opportunities, and thereby expand forest management options, for owners of small forestland parcels. The project integrates research, extension, and instructional activities. Disciplines that are involved are: rural sociology, agricultural economics, forestry, and architecture. Architecture students will incorporate locally produced building materials into designs for housing construction and rehabilitation. These designs also will address the problem of substandard housing, which is a common feature of counties with persistent rural poverty. Use of local products also will increase income and employment in the region. The goal is to create demand for forestry products produced by limited resource landowners and foresters. Extension programs will be designed to promote those technologies which show greatest potential for development.

Program: Biobased Products and Bioenergy Production Research
Project Title: ***Conversion of Soy Protein to a Strong and Water-resistant Wood Adhesive***
Project Director: Kaichang Li
Lead Institution: Oregon State University

Wood adhesives currently in commercial production are made from petroleum, which is a non-renewable resource, and formaldehyde, which is hazardous to human health. This research investigated how to convert soy protein to a strong and water resistant wood adhesive using marine adhesive protein as a model. A new healthy and environmentally friendly wood adhesive has been developed based on tofu and the proteins mussels use to adhere to rocks. The marine adhesive protein, a superior adhesive in seawater, contains high amounts of phenolic hydroxyl groups (especially catechol moiety), di-sulfur linkages, and amino groups. The results revealed that introduction of these key functional groups in marine adhesive protein to soy protein can convert soy protein to a strong and water-resistant wood adhesive. The new adhesives could be use to make wood composite panels, ranging from plywood to oriented strand board, particle

board, and laminated veneer lumber products, all major components of home construction. They also could replace current formaldehyde-based wood adhesives that are associated with some health problems, including eye and throat irritation. Three patents are pending on the adhesives.

Program: Nanoscale Science and Engineering
Project Title: *Photosystem I Nanoscale Photodiodes for Creating Photoelectrochemical Devices*
Project Director: G. Kane Jennings
Lead Institution: Vanderbilt University

The development of affordable and renewable energy sources that supplant our reliance on fossil fuels is one of the most important challenges facing our society today. This project will use nanoscale agricultural components from spinach for conversion of solar energy. If successful, this product will to help fill the increasing energy demand in years ahead. The project is attempting to create a photochemical device that incorporates one of nature's optimized nanoscale photodiodes, a Photosystem I (PSI) reaction center. It is based on new techniques to control the orientation, immobilization, and electrical transfer of PSI on organic films assembled on metallic surfaces. Given the state of knowledge, it is estimated that the amount of area for a PSI system to produce 1000 MW is actually quite small and is specifically less than that required with existing technology of photovoltaic panels to produce the same amount of electricity. Given the potential of utilizing agriculturally materials as a means of producing electrical energy, this project presents an exciting vision for the USDA in the field of nanoscale science and engineering. The project has made significant progress. The key results to date are: 1) PSI adsorption can be directed at patterned surfaces and imaged with scanning electrochemical microscopy; 2) first demonstration of direct electron transfer to an adsorbed monolayer of PSI, and 3) a 10% increase in light/dark current with PSI indicates conversion of light to electrical current.

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

Program: Animal and Plant Biosecurity – Coordinated Agricultural Project (Integrated)
Project Title: *Prevention and Control of Avian Influenza in the U.S.*
Project Director: Daniel Perez
Lead Institution: University of Maryland

Photo Credit: www.agnr.umd.edu/aicap

The world community is increasingly concerned about Avian Influenza. Not only does this disease cause millions of dollars in losses to poultry producers and consumers around the globe each year, but a specific bird flu type has recently crossed over into the human population with loss of human life. With FY 2004 funds, the NRI Animal Biosecurity Program initiated an Avian Influenza Coordinated Agricultural Project ($5.0 Million / 3 years) in January 2005 that is working on a strategic response for Avian Influenza

(www.agnr.umd.edu/aicap). The Avian Influenza Coordinated Agricultural Project integrates research, education, and extension specialists representing academia, producers, veterinarians, pharmaceutical and other biologics companies, federal agencies, state partners, and international institutions. Currently, the award brings together 18 states and 22 U.S. institutions, including representation from the Netherlands. Objectives of the research project include: 1) determination of the molecular basis for the emergence of influenza A viruses in poultry; 2) surveillance and evolution of influenza A viruses in waterfowl of the four major U.S. and live bird markets in California, Minnesota, and New York; 3) implementation of education and biosecurity programs for live bird markets and gamebird producers, and 4) development of diagnostic tests and vaccines. This project links directly to the recently funded Department of Homeland Security "National Center for Foreign Animal and Zoonotic Disease Defense" which includes work on four diseases, one of which is Avian Influenza. Relevant partners and stakeholders are included, either on the Scientific Advisory Board, the Stakeholder Advisory Board, or the Executive Committee.

Program: Functional Genomics of Agriculturally Important Organisms
Project Title: *Microarray Analysis of Agriculturally Relevant Gene Expression in the Peach-potato Aphid, Myzus persicae*
Project Directors: Georg Jander, Stewart M. Gray, Nancy A. Moran, Alexandria C. Wilson
Lead Institution: Boyce Thompson Institute for Plant Research

The peach-potato aphid, *Myzus persicae* is one of the world's most important vectors of virus diseases in vegetables, fruit trees and ornamental plants, and consequently is the most extensively studied aphid in plant agriculture. This project is the first to propose a genome-wide expression analysis of an agriculturally important aphid species. The investigators are taking an interdisciplinary approach utilizing their expertise in aphid biology, insect functional genomics, and plant-microbe-insect interactions by proposing to sequence cDNA from the aphid, identify a set of over 6,000 genes that are turned on (expressed) as a result of acquiring and transmitting the potato leaf-roll virus. They will place the cDNA on glass slides (microarray) and use these microarrays to study different aspects of gene expression. Investigators will focus on the genes that are induced in aphids infected with the potato leaf-roll virus. They will use microarrays to: 1) discover how genes vary among different aphid life stages; 2) explore the genes that are expressed when feeding on tomato plants and *Arabidopsis*, and 3) identify genetic changes in the aphid that are induced by exposure to naturally occurring plant chemicals involved in host plant resistance. The 25,000 or more gene sequences that the project directors will generate will be deposited in GenBank and thus will be accessible to the public. It is expected that the results of this project potentially will lead to new approaches to genetically engineer plants to more effectively fend off devastating plant diseases vectored by insects.

Program: Arthropod and Nematode Gateways to Genomics
Project Title: *Molecular Basis of Pheromone Degradation in the Japanese Beetle: Exploring New Frontiers in Pest Control*
Project Director: Walter S. Leal
Lead Institution: University of California – Davis

Environmentally sound and effective approaches are urgently needed to control insect pests which threaten the nation's food supply and agricultural biosecurity. There is tremendous potential in identifying naturally-produced chemicals that interfere with an insect's ability to locate mates. Insects commonly use specific odors or pheromones emitted by the antennae of insects of the opposite sex to locate them. In addition, studies indicate that pheromones must then be inactivated to assure sustained flight and proper orientation of insects toward their potential mates. These compounds which inactivate pheromones are called odorant binding proteins. This project is studying the molecular basis of the odorant-degrading enzyme of the Japanese beetle, which is a major invasive species in the U.S. Researchers are finding that the pheromone degrading enzymes are responsible for fast inactivation of pheromones. In the long term, these compounds could be used as novel and environmentally benign strategies to manage these and other pests. Results have shown that the pheromone degrading enzyme is an antennae-specific esterase and that the Japanese beetle pheromone R-Japonilure is degraded by this enzyme. Researchers successfully have isolated and cloned the cDNA encoding this pheromone-degrading enzyme and recently obtained genetic expression of the Japanese beetle pheromone degrading enzyme using a baculovirus gene vector system.

Program: Biology of Weedy and Invasive Plants
Project Title: ***An Integrated Empirical and Theoretical Investigation of the Factors Affecting the Establishment of Invasive Carduus Thistles***
Project Director: Katriona Shea
Lead Institution: Pennsylvania State University

Bagging thistle seedheads to test the efficacy of biocontol by the thistle receptacle weevil, *Rhinocyllus conicus* – Photo Credit: Katriona Shea, Pennsylvania State University

Invasive, exotic thistles are an enormous problem for both production agriculture and rangelands. It is estimated that several states, including Virginia and Maryland, spend approximately $1 million annually to control thistle (this figure does not include the loss in crop yield). In a combination of modeling and experimental field studies, this project has been studying thistle population dynamics under different and/or changing management scenarios. Results have shown that under most conditions thistle abundance is most closely related to seed production. There are two means of controlling thistle: 1) using the biocontrol agent, the thistle head weevil, which is an introduced species that eats the developing seeds and 2) mowing. Many management plans combine the two methods. Results also have indicated that while mowing reduced the number of flowering thistle, it also tended to delay flowering to a time when the biocontrol insects have stopped being active. Thus, even though there are slightly fewer flowers, the flower heads have not been attacked and destroyed by the insect. Consequently, seed production of mowed plants is higher than for unmowed plants because of the reduced effectiveness of the biocontrol agent. The best strategy is to let the biocontrol agent do take effect without interruption. This is an example of two management strategies interacting negatively, to reduce the net efficacy of control.

Program: Markets and Trade
Project Title: *Reducing the Risk of Foot and Mouth Disease in the United States and Disease Control Abroad*
Project Director: Alex E. Winter-Nelson
Lead Institution: University of Illinois

Foot and mouth disease (FMD) is a highly contagious affliction of cloven-hoofed animals that has the potential to inflict billions of dollars of losses to an economy. Since eradicating the disease in 1929, the U.S. remained FMD-free primarily by restricting the importation of animal products from FMD-endemic regions, a strategy that is employed by all other FMD-free countries. However, technical and institutional changes have accelerated the volume of international trade, and the failure of import controls to prevent the spread of the virus to the United Kingdom, France, South Korea, and Japan during the past few years has heightened concerns about the appropriateness of the current U.S. strategy. This project considers an alternative approach by assessing the economics of reducing the risk of a FMD outbreak in the United States by investing in animal disease control in FMD-endemic countries. With focus on the impacts of animal disease control in Argentina, Brazil, Uruguay, and Paraguay, this research seeks to assess the net benefits to the United States from reducing the incidence of FMD in South America. While elimination of FMD in other regions would reduce the risk of an outbreak in the U.S., it also would imply greater competition in the global meat market from countries that become free from the virus. Therefore, the researchers will examine the potential costs of an FMD outbreak in the U.S., ascertain the reduction in the probability of such an outbreak through reduced disease incidence in South America, determine the impacts on international trade due to FMD eradication in South America, and assess the economics of FMD eradication in South America. Do the volume and distribution of internal and external benefits of FMD control warrant joint U.S./host country financing of FMD control in the host country? Initial results suggest divergent control strategies and costs in these four countries. Because FMD control in the South America requires international cooperation, researchers have assessed the institutional constraints on coordination among countries. In terms of practical implications, the research highlights specific factors that serve as barriers to international cooperation to address FMD in South America. Thus, it suggests issues that could be addressed to improve the probability of successful interventions to control the disease. The anticipated impact of the work is in improved management of animal disease control efforts in the United States and globally.

Program: Improving Food Quality
Project Title: *Technology of Combined X-ray and Laser Imaging Detection of Bone Fragments in De-Bone Poultry Meat*
Project Directors: Yang Tao, Lewis E. Carr, Fred W. Wheaton
Lead Institution: University of Maryland

White boneless poultry meat is a major meat product in consumers' grocery bags. The poultry industry is especially concerned about hazardous materials such as metal and bone fragments embedded in boneless meat. Bone fragments and physical contaminants in de-boned poultry must be removed during the process to ensure consumer safety. Based on earlier studies, a new

technology under development uses the synergism of x-ray and laser imaging for detection of bone fragments in poultry meat. Through intensive experiments, the results supported the theory and demonstrated the capability of detecting various frequent and hard-to-detect bone fragments in chicken fillets. The technique overcomes the weakness of conventional x-ray technology due to uneven thickness and eliminates false image patterns by x-ray absorption compensation. The overall objective of this project is to extend the results of the existing project to the next stage leading to an automated system, with tasks including multi-task concurrent image processing, optical and algorithm optimization, pattern recognition, and on-line system controls. These research tasks will lead to the development of an effective hazard detection technology. With the U.S. producing over 40.8 billion pounds of poultry annually and boneless meat accounting for over 41% of the total product (USDA, 2000), this advanced x-ray technology will have a positive impact on the industry in bringing quality, safe, and cost-effective poultry products to American consumers.

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

Program: Human Nutrition and Obesity (Integrated)
Project Title: *Randomized, Controlled Community Intervention to Reduce the Risk of Type 2 Diabetes in Overweight African Amerian Children*
Project Directors: Sharon E. Fleming, Joanne P. Ikeda
Lead Institution: University of California – Berkeley

The prevalence of overweight children has increased dramatically in the U.S. According to the CDC, 16 percent of American children and adolescents are overweight. The prevalence is even higher in African American children. A child's risk of developing type 2 diabetes mellitus increases as weight increases. The goal of this project is to reduce the risk of type 2 diabetes in overweight 9 to 10 year old African American children through a community-based program in Oakland, CA. The investigators have recruited 140 children and randomly assigned them to intervention or control groups. Both groups will attend a 2-week summer camp and follow-up visits over a 2 year period. The controls will receive the standard YMCA day camp experience, with follow up visits that are not focused on diet and physical activity. The intervention group will attend a YMCA camp, which emphasizes physical activity and includes activities to increase self-esteem and dietary intake of fruits and vegetables, low fat dairy products, and whole grain breads and cereals, with follow up visits that focus on diet and physical activity. Anthropometric, laboratory (e.g. fasting blood glucose and insulin levels), and dietary variables have been measured at baseline, and will be repeated 3 months after the camp, and at 1 and 2 years after the camp. The camps are being conducted in the summer of 2005. If successful, this project can serve as a model for future interventions with this target audience.

Program: Food Safety – Coordinated Agricultural Project
Project Title: *Food Safety Research and Response Network*
Project Directors: Jay F. Levine, Craig A. Altier, Lee-Ann Jaykus
Lead Institution: North Carolina State University

Food-borne pathogens are a major cause of human morbidity and mortality worldwide. In the U.S., acute gastroenteritis is the second most common household illness, and more than 70 million food-related illnesses are estimated to occur each year. Although the majority of these bouts of gastroenteritis resolve spontaneously, the illnesses still result in hundreds of thousands of hospitalizations and thousands of deaths. The cumulative societal cost of medical expenses, and lost wages and productivity profoundly affect our economy. Food safety is a complex research issue involving multiple foods, multiple organisms, and a food production process that ranges from on-farm to the consumer. The complexity of the food production continuum necessitates a multi-disciplinary approach that takes advantage of teams of researchers with a wide breadth of expertise. It necessitates that food-safety microbiologists and food-safety epidemiologists work together to design broad longitudinal studies that build on the synergy that is possible when researchers combine their ideas and talents. The Epidemiologic Approaches to Food Safety program has brought together food-safety epidemiologists and microbiologists by establishing a Food Safety Coordinated Agricultural Project (CAP). This multi-investigator, multi-disciplinary, multi-institutional approach is the critical feature of the Food Safety CAP. In FY 2004, the Food Safety CAP was awarded to the Food Safety Response and Research Network, which consists of over 18 universities and 50 investigators committed to food safety research. Research will be conducted that will take advantage of multiple collaborations and universities that will help build food safety science. The consortia of universities includes a broad food-safety expertise in epidemiology, microbiology, and production animal systems; geographic diversity that provides an opportunity to conduct similar studies in different regions; species diversity that provides an opportunity to conduct similar studies in different species; breadth of expertise working with specific pathogen detection assays and substantial collective laboratory resources, and investigators with a strong history of productivity working together on large-scale projects. This organized network has helped other Federal agencies fulfill their mission. For example, epidemiologists and other experts have agreed to help FSIS with a peer review of a risk assessment for *Listeria.* This network also has aided CDC and FDA in research involving tomatoes and *Salmonella*. Collaborations are underway with other Centers (e.g. the Department of Homeland Security Food Safety and Defense Center) to implement projects that will span the food safety continuum on domestic and international issues. This multi-disciplinary, multi-institutional effort will facilitate leveraging of expertise and resources to complete complex research more efficiently as well as contribute to improvement of microbiological and epidemiologic methods.

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

Soils and Soil Biology
Project Title: ***Detrital Controls on SOM Dynamics in an Old-growth Douglas-fir Soil***
Project Directors: Kate Lajtha, Phillip Sollins
Lead Institution: Oregon State University

Understanding the belowground component of ecosystems remains one of the great challenges for ecology and agricultural science. Despite the critical roles played by soil organic matter (SOM) in ecosystems and in the global carbon cycle, the controls on SOM balances remain

poorly understood. The role of SOM in enhancing agricultural and forest productivity long has been known. Now, an additional motivation for research on SOM is its role in controlling fluxes of carbon between the atmosphere and terrestrial ecosystems, and consequently, in helping to control the rate and magnitude of climate change. This research explores the dynamics of the conversion of new organic debris to stable organic matter that may remain in forest soils for centuries. This core Detritus Input and Removal Treatments (DIRT) project, with two sites (Oregon and Harvard Forest Long Term Ecological Research sites), has attracted funding from other agencies to create a network of 4 national and 2 international sites. Also, the National Academy of Sciences has contributed undergraduate research experience money to include students in the network, and a recent NSF Small Grants for Exploratory Research (SEGR) grant is funding a side project to investigate some unexpected results from the core DIRT project. Major findings relate directly to our understanding of how SOM is stabilized in forested soils and how changing detrital inputs (types of organic debris) to forests via global changes in forest growth or forest management will impact carbon storage in soils. Dissolved organic matter from forest litter, woody debris, and below ground material has different mobility in forest soils depending on the nitrogen content and degree of hydrophobicity (water repellency) of the compounds. Inputs of woody debris produce dissolved organic matter that is lower in nitrogen and higher in carbon stabilized against leaching losses and decomposition. Stabilization seems to be due to physical protection through interaction with soil particles.

Program: Managed Ecosystems
Project Title: ***Ecosystem Carbon and Nitrogen Pools in Managed Rangelands: A Spatial Accounting of Management Influences***
Project Directors: Steven R. Archer, Heather L. Throop, Mitchel P. McClaran
Lead Institution: University of Arizona

Vegetation changes on the same desert grassland site at the Santa Rita Experimental range in Southeastern Arizona between 1902 and 2003 – Photo Collage Created by Rob Wu, Santa Rita Experimental Range, AZ

Management of rangelands has traditionally focused on livestock/wildlife production and soil/water conversation. However, due to concerns about rising levels of atmospheric carbon dioxide, there is a pressing need to improve our understanding of how rangelands and rangeland management practices influence carbon (C) sequestration. Recent increases in woody plant abundance on rangelands have been widely reported, but the rates and patterns of change have not been well quantified. Hence, little is known about how this vegetation change has affected plant and soil organic C and total nitrogen (TN) pools. A recent synthesis reveals these pools may increase, decrease or remain unchanged in response to woody plant encroachment, but current theory cannot account for these variable responses. The discrepancies may be due to a failure to account for spatial and temporal patterns in C storage, and the influence of grazing, brush management, and precipitation variability on these patterns. Researchers at the University of Arizona will quantify the spatial distribution of ecosystem C and TN pools in the context of brush management and grazing interactions. In conjunction with field work, the research project will use a dynamic, process-based simulation model to assess, reconstruct and extrapolate the

interactive effects of woody plant encroachment, brush and grazing management, and precipitation variability on ecosystem C and TN pools. This research will provide insight into implications of rangeland management on atmospheric carbon dioxide concentrations and thus provide guidelines for informed management decisions that take both livestock/wildlife production and C sequestration into account.

Program: Watershed Processes and Water Resources
Project Title: *Natural Attenuation of Cryptosporidium parvum During Transport in Watersheds*
Project Director: Thomas Harter
Lead Institution: University of California – Davis

Understanding the transport and fate of microorganisms in surface waters is of vital concern in protecting the integrity and safety of water supplies. The oocyst-forming pathogen *Cryptosporidium parvum* is the leading cause for waterborne disease in the United States. It is resistant to chlorination, the most widely used drinking water disinfectant. Many small community water systems, as well as several very large municipal water systems that depend on surface water, cannot afford expensive filtration technology for the removal of *C. parvum*. Farm animal operations have been implicated as one of the primary sources of this pathogen in streams. As a result, agricultural operations have been increasingly forced to implement strategies to control pathogen delivery to surface waters. Requirements for best management practices (BMPs) such as buffer strips are based on the assumption that pathogens may be transported readily downstream to water supply intakes once runoff reaches a stream. Results from this research have shown that settling out of *C. parvum* oocysts was enhanced greatly by a variety of suspended sediment types, but the extent of oocyst removal varied depending on the type of background sediment and the presence of microbial coatings of biofilms. Once in the sediments, filtration efficiency depended on conditions of the solution and the velocity of water movement through the sediments. The investigators found that after the oocysts are retained, they could be remobilized under certain conditions. On the basis of these experiments, tools will be developed to predict the net attenuation; however, the oocyst-suspended sediment-microbial film-water chemistry interactions demonstrate the need for understanding of mechanisms of retention, remobilization, and viability of this important pathogen in natural waters and streambed sediments.

Program: Global Change
Project Title: *CO_2 Fluxes Between Agricultural Lands and the Atmosphere: Towards More Complete Accounting by Integrating Remote Sensing with Simulation Modeling*
Project Directors: Stephen M. Ogle, Christopher S. Potter, Keith H. Paustian, F. Jay Breidt
Lead Institution: Colorado State University

In 2004, the NRI Global Change program funded research in the area of Carbon Cycle Science in a joint solicitation with NASA and DOE. Historically, agriculture has been a major source of CO_2 emissions, but management changes during the past few decades are believed to have stabilized the carbon balance. Moreover, recent policy is encouraging producers to adopt practices that are known to sequester carbon in soils, and quantifying the resulting changes in carbon sinks is needed for evaluating factors regulating current terrestrial carbon sources and

sinks. The objective of this project is to advance and improve current inventory assessments for agricultural fluxes (uptake and release of CO_2 from agricultural lands) by incorporating remotely sensed data products into an existing assessment tool. With the latest land use and management activity data and more detailed climate data, the tool can produce the most complete accounting of U.S. agricultural management impacts on soil organic carbon. This will increase the accuracy and confidence in estimates of sources and sinks for carbon in North America. Accuracy will be assessed using ground-based observations and an existing network of agricultural experiments. The potential for carbon sequestration (storage) in the future will be evaluated based on simulations of management scenarios from current baseline conditions.

Program: Air Quality
Project Title: *Modeling the Source of Gaseous Emissions from Animal Feeding Operations*
Project Director: Wendy J. Powers
Lead Institution: Iowa State University

Monitoring ammonia emissions of swine in an atmospherically controlled chamber after diet modification – Photo Credit: Wendy Powers, Iowa State University

The current approach for estimating emissions of various gases from swine, poultry, and dairy cattle operations often uses poorly defined baseline data. This project will measure emissions of ammonia, hydrogen sulfide, nitrogen oxides, sulfur oxides, methane, and specific volatile organic carbons from swine, poultry, and dairy cattle when fed typical diets in a controlled atmospheric environment. The investigators at Iowa State University have been successful in identifying promising feed strategies that have resulted in emission reductions in ammonia. Specifically, they have found that inclusion of five synthetic amino acids reduced the ammonia emission factor by 22% when three amino acids were supplemented and 48% when five amino acids were supplemented, compared to just lysine. They found no impact on hydrogen sulfide emissions. The same replicated experiments will be conducted with broiler chickens, turkeys and dairy cattle over the next several years. This work has the potential to dramatically reduce emissions from concentrated animal feeding operations. The data generated from this project will be used in a farm-emissions model to provide a mass-balance of nutrients, such as nitrogen, to help inform U.S. regulatory policy.

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

Dr. Devin Peterson of the **Pennsylvania State University** was the FY 2004 recipient of the Presidential 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. The Cooperative State Research, Education, and Extension Service selects its awardees from among the most meritorious investigators funded through the National Research Initiative (NRI) Competitive Grants Program New Investigator Award Program. He was nominated by the NRI for his current and potential future excellence in research. He received funding for his proposal entitled *Control of Maillard-Type Flavor Formation Pathways by Bioactive Flavonoids: Influence of Radical Mechanisms* and was recognized by the review panel for outstanding research in improving our understanding of how specific bioactive flavonoids alter the chemical pathways responsible for Maillard-type reactions important for flavor generation in food products and commodities. This research could demonstrate that bioactive components may have multiple roles in foods in addition to potential health benefits. Results of his work will address the national priorities related to the fates of bioactive compounds and nutrients in health-promoting or disease-preventing foods and food ingredients during processing, storage, and distribution.

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22.1 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
23.1 Managed Ecosystems – Dr. Diana Jerkins, National Program Leader, Phone: (202) 401-6996, Fax : (202) 401-6071, E-mail: djerkins@csrees.usda.gov

23.2 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
23.3 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
25.0 Soil Processes - Dr. Nancy Cavallaro, National Program Leader, Phone: (202) 401-5176, Fax: (202) 401-6071, E-mail: ncavallaro@csrees.usda.gov
26.0 Water and Watersheds- Mary Ann Rozum, National Program Leader , Phone: (202) 401-4533, Fax: (202) 401-1706, E-mail: mrozum@csrees.usda.gov
28.0 Air Quality – Dr. Ray Knighton, National Program Leader, Phone: (202) 401-6417, Fax: (202) 401-1706, E-mail: rknighton@csrees.usda.gov
31.0 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
31.5 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
32.0 Food Safety – Dr. Chris Wozniak, National Program Leader, Phone: (202) 401-6020, Fax: (202) 401-6156, E-mail: cwozniak@csrees.usda.gov
32.1 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
41.0 Animal Reproduction - Dr. Mark Mirando, National Program Leader, Phone: (202) 401-4336, Fax: (202) 205-3641, E-mail: mmirando@csrees.usda.gov
42.0 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

43.0 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
44.0 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
45.0 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
51.2 Organismal and Population Biology of Arthropods and Nematodes - Dr. Mary Purcell-Miramontes, National Program Leader, Phone: (202) 401-5114, Fax: (202) 401-6488, E-mail: mpurcell@csrees.usda.gov
51.3 Suborganismal Biology and Genomics of Arthropods and Nematodes - Dr. Mary Purcell-Miramontes, National Program Leader, Phone: (202) 401-5114, Fax: (202) 401-6488, E-mail: mpurcell@csrees.usda.gov
51.8 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
51.9 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
52.1 Plant Genome - Dr. Ed Kaleikau, National Program Leader, Phone: (202) 401-1931, Fax: (202) 202-401-6071, E-mail: ekaleikau@csrees.usda.gov
52.2 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
53.0 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
54.3 Agricultural Plant Biochemistry - Dr. Gail McLean, National Program Leader, Phone: (202) 401-6060, Fax: (202) 401-6488, E-mail: gmclean@csrees.usda.gov

61.0 Agricultural Markets and Trade – Dr. Pat Hipple, National Program Leader, Phone: (202) 401-2185, Fax: (202) 401-6071, E-mail: phipple@csrees.usda.gov
62.0 Rural Development – Dr. Pat Hipple, National Program Leader, Phone: (202) 401-2185, Fax: (202) 401-6071, E-mail: phipple@csrees.usda.gov
66.0 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
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71.2 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
75.0 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