United States Department of Agriculture
Cooperative State Research, Education, and Extension Service,
Office of the Administrator

Self-Review for 2003/2004

Portfolio Review Expert Panel

Portfolio 1.5A: Plant Production

Supporting Objective 1.5A: Contribute Science-Based Information, Analysis, and Education to Promote the Efficiency of Agricultural Production Systems (Plant Production)

CSREES *Goal 1: Enhance Agricultural Opportunities for Agricultural Producers*

For the period 1998-2004

TABLE OF CONTENTS

INTRODUCTION

This report was developed by the Plant Production Unit, Plant and Animal Systems (PAS), Cooperative State Research, Education, and Extension Service (CSREES), USDA. It is submitted to the Portfolio Review Panel convened by the CSREES Administrator, as a pilot, to assess the effectiveness of the Plant Production Unit as it leads efforts to address national problems or concerns in the plant-related agricultural fields. The report describes broadly a wide variety of programs operated and managed under the Plant Production portfolio.

The first part of the report contains general description of CSREES, its vision, mission, and functions, as well as funding authorities for all CSREES programs. The second part of the report is a general description of the Plant Production portfolio, followed by descriptions of the following six Problem Areas (PA) covered in the portfolio: Plant Genome, Genetics, and Genetic Mechanisms (PA201); Plant Genetic Resources (PA202); Plant Biological Efficiency and Abiotic Stresses (PA203); Plant Product Quality and Utility –Preharvest (PA204); Plant Management Systems (PA205), and Basic Plant Biology (PA206). These descriptions make references to numerous evidentiary materials regarding funding and other issues, contained in several accompanying volumes available to the Panel for examination in Washington, DC.

During the meetings, National Program Leaders (NPL) with responsibility for each Program Area will provide the Panel with a brief presentation on the main points of the description and clarifications should the Panel have further questions.

It is CSREES' expectation that the Panel review this report before meeting in Washington, DC; ask the NPLs questions for clarifications during their presentations; deliberate assessment of the portfolio based on the evidentiary materials, and score the portfolio on the basis of the criteria developed by the Office of Management and Budget for Relevance, Quality, and Performance. A scoring tool will be provided to aid the Panel in this regard.

It also is CSREES' expectation that the Panel provide recommendations to the Administrator and NPLs on how to better manage the portfolio.

SECTION ONE: ORGANIZATIONAL OVERVIEW

USDA
The mission of the United States Department of Agriculture (USDA) is to provide leadership on food, agriculture, natural resources, and related issues based on sound public policy, the best available science, and efficient management. USDA's vision is to be recognized as a dynamic organization that is able to efficiently provide the integrated program delivery needed to lead a rapidly evolving food and agriculture system. Goal 1 of the USDA strategic plan is to enhance economic opportunities for agricultural producers.

CSREES
The Cooperative State Research, Education and Extension Service (CSREES) is USDA's primary link with the Land-Grant University System and with other higher education institutions. CSREES invests public funds, as authorized and appropriated by the Congress, in basic, applied, and developmental research, extension, and teaching activities in food and fiber, agricultural, renewable natural resources, forestry, and the physical and social sciences. Through the distribution and management of formula funds, competitive grants and special grants, CSREES achieves its mission to advance knowledge for agriculture, the environment, human health and well being, and communities. Specifically, CSREES provides national program leadership to identify, develop and manage programs to support university-based and other institutional research, education, and extension, and provides fair, effective, and efficient administration of Federal assistance implementing research, education and extension awards and agreements. See the draft CSREES Strategic Plan in the Evidence Volume.

VISION
Agriculture is a knowledge-based, global enterprise, sustained by the innovation of scientists and educators.

MISSION
To advance knowledge for agriculture, the environment, human health and well being, and communities.

FUNCTIONS
Program leadership to identify, develop, and manage programs to support university-based and other institutional research, education, and extension. Fair, effective, and efficient administration of Federal assistance implementing research, education, and extension awards and agreements.

Current Trends and Opportunities

The Land-Grant University System was established by the Morrill Act of 1862 "to teach such branches of learning as are related to agriculture and the mechanic arts . . . in order to promote the liberal and practical education of the industrial classes in the several pursuits and profession in life." At that time the scientific basis of agriculture was rudimentary, and focused primarily on increasing the productivity of lands and animals. Plant and animal breeding, nutrient management are significant milestones in the spectrum of scientific investment in agricultural productivity.

As agriculture matured and became more fully integrated into the social, political and economic structure of the Nation, broader issues, including positive and negative environmental and economic externalities, access to and the distribution of the benefits of public investment in agriculture and rural communities, and the sustainability of the scientific workforce have emerged. Breakthroughs in fundamental science, including genomics, microbiology and nanotechnology have raised the bar for the application of science, technology, and practice in producing, marketing and distributing food and fiber products. These sometimes produced additional questions regarding long term risks and benefits, ethics, and domestic and international consumer acceptance. In the post-9/11 environment, the aggregate safety and security of the food and fiber supply, terrorism aimed at food and fiber products, and protecting public health and well being have become paramount.

The increasingly global nature of contemporary agricultural products offers the world the benefit of a more varied food supply, but is accompanied by increased risks of food-borne disease and invasive pests. The information available from the sciences of plant and animal genomics, remote sensing, disease epidemiology, animal and human nutrition, and market and policy analysis have transformed agriculture into a high-tech, environmentally sustainable, and profitable industry that can address the world's accelerating food and fiber needs. Expanding the scientific base beyond the production sciences to also address human health, environmental sustainability, and community and economic development is crucial to increase distribution of food and fiber to growing international markets.

Adequate nutrition is needed to promote human health, maintain a healthy body weight, and to avoid the risk of chronic disease related to food consumption. State-of-the-art scientific techniques document optimal nutritional nutrition needs from pre-birth through old age. Technological advancements like sequencing of the human and other genomes, allow scientists to develop individual nutrient requirements as determined by age, environment, gender, genetics, lifestyle, and physiology.

Partners/Stakeholders/Customers

CSREES provides federally-mandated funding to support extramural research, education and extension programming throughout the United States and its territories.

CSREES' primary partners are public institutions of higher learning, particularly the 1862, 1890 (Historically Black) and 1994 (Tribal) land-grant colleges and universities, and the "non land-grant" public institutions whose missions include basic, applied and developmental research, extension, and teaching activities in food and fiber, agricultural, renewable natural resources, forestry, and physical and social sciences. The scope of partner activities is broad—all aspects of agriculture, including soil and water conservation and use; plant and animal production, protection, and health; processing, distribution, safety, marketing, and utilization of food and agricultural products; forestry, including urban forestry; aquaculture; home economics and family life, human nutrition; rural and community development; sustainable agriculture; molecular biology; and biotechnology.

CSREES' ultimate customers are citizens. CSREES works with land-grant and other institutions and industry to create and transfer the know-how and the technology from the laboratory to farmers, consumers, and agribusiness. The Cooperative Extension System provides information to every county in the Nation, offering education that links research, science, and technology to people where they live and work. Topics range from community economic development, health care, food safety, water quality, sustainable agriculture, and the environment to programs for children, youth, and families.

SECTION TWO: FUNDING AUTHORITIES FOR CSREES ACTIVITIES

Research and Education Activities

Research and Education programs administered by CSREES are USDA's principal connection to the university system of the U.S. for the purpose of conducting agricultural research and education programs as authorized by the Hatch Act of 1887, as amended (7 U.S.C. 361a-361i); the Cooperative Forestry Research Act of 1962, as amended (16 U.S.C. 582a-7); Public Law 89-106, Section (2), as amended (7 U.S.C. 450i); the National Agricultural Research, Extension, and Teaching Policy Act of 1977, as amended (7 U.S.C. 3101 et seq.); the Equity in Educational Land-Grant Status Act of 1994, (7 U.S.C.PA 301); the Agricultural Research, Extension, and Education Reform Act of 1998; and the Farm Security and Rural Investment Act of 2002. Through these authorities, USDA participates with state and other cooperators to encourage and assist the state institutions in the conduct of agricultural research and education through the State Agricultural Experiment Stations (SAES) of the 50 states and the territories; by approved Schools of Forestry; the 1890 Land-Grant Institutions and Tuskegee University and West Virginia State College; Colleges of Veterinary Medicine; and other eligible institutions. The funds appropriated provide Federal support for research and education programs at these institutions.

Appropriations for research and education activities are authorized under the following Acts:

Payments to agricultural experiment stations under Hatch Act Agricultural Experiment Stations Act of August 11, 1955, Hatch Act of 1887 as amended – 7 U.S.C. 361a-361i, Public Law 92-318; Public Law 93-471; Public Law 95-113, as amended; Public Law 95-134; Public Law 96-205; Public Law 96-374; Public Law 96-597; Public Law 97-98; Public Law 98-213; Public Law 98-454; Public Law 99-198; Public Law 99-396; Public Law 101-624; Public Law 104-127; Public Law 105-185; and Public Law 107-171.

Funds under the Hatch Act are allocated to the State Agricultural Experiment Stations (SAES) of the 50 States, DC, Puerto Rico, Guam, the Virgin Islands, Micronesia, American Samoa, and Northern Mariana Islands for research to promote a sound and prosperous agriculture and rural life.

The foundation of the Federal-State partnership in agricultural research is financed through formula Hatch funding and matching State revenue. Hatch funding supports sustained research activities in agricultural priority areas to address pre-commercial and/or non-funded technologies of public need. Hatch funded research is complementary to the Agricultural Research Service (ARS) National Research Programs and State-based research, addressing technology gaps through coordinated programs. This mixed portfolio of activities completes a well-rounded national agricultural research agenda that has, for the past century, allowed US agriculture to become the envy of the world.

In accordance with the Agricultural Research, Extension, and Education Reform Act of 1998, Public Law 105-185, eligible State institutions are required to submit a five-year Plan of Work to CSREES for approval before Hatch Act funds are distributed. The Hatch Act provides that the distribution of Federal payments to States for fiscal year 1955 shall become a fixed base and that any sums appropriated in excess of the 1955 level shall be distributed in the following manner:

- 20% shall be allotted equally to each State.
- Not less than 52% shall be allotted to the States as follows: one half in an amount proportionate to the relative rural population of each State to the total rural population of all States, and one-half in an amount proportionate to the relative farm population of each State to the total farm population of all States.
- Not less than 25% shall be used for multi-State, multi-disciplinary, multi-institutional research activities to solve problems concerning more than one state.
- 3% shall be available to the Secretary of Agriculture for the administration of this Act.

Federal funds provided under the Hatch Act to State institutions must be matched with non-federal funding on a dollar-for-dollar basis.

In accordance with provisions of the Agricultural Research, Extension, and Education Reform Act of 1998, at least 25% of available Hatch Act funds must be used to support multi-state research; states also must use up to 25% of Hatch Act funds for activities that integrate cooperative research and extension.

The 3% of funds appropriated by the Hatch Act for administration includes disbursement of funds and a continuous review and evaluation of the research programs of SAES.

Cooperative Forestry Research: (McIntire-Stennis) – The Cooperative Forestry Research Act of October 10, 1962, 16 U.S.C. 582a-7; Public Law 96-374; Public Law 97-98; Public Law 99-198; Public Law 101-624; Public Law 104-127.

The Act authorizes funding of research in State institutions certified by a State representative designated by the governor of each State. The Act provides that appropriated funds be apportioned among States as determined by the Secretary of Agriculture after consultation with the legislatively mandated Forestry Research Advisory Council. The council consists of not fewer than 16 members representing Federal and State agencies concerned with developing and utilizing the Nation's forest resources, the forest industries, the forestry schools of the State-certified eligible institutions, SAES, and volunteer public groups concerned with forests and related natural resources. Determination of apportionments follows consideration of pertinent factors including areas of non-federal commercial forest land, volume of timber cut from growing stock, and the non-Federal dollars expended on forestry research in the State. The Act also provides that payments must be matched by funds made available and budgeted from non-Federal sources by the certified institutions for expenditure on forestry research. Three percent of funds appropriated under this Act are set-aside for Federal administration.

Payment to 1890 Colleges and Tuskegee University and West Virginia State College – The National Agricultural Research, Extension, and Teaching Policy Act of 1977, Section 1445, Public Law 95-113; Public Law 95-547; Public Law 97-98; Public Law 99-198; Public Law 101-624; Public Law 104-127; Public Law 105-185; and Public Law 107-171.

In accordance with the Agricultural Research, Extension, and Education Reform Act of 1998, Public Law 105-185, eligible State institutions are required to submit a Plan of Work to CSREES for approval before these formula funds are distributed. The agricultural research programs at the 1890 Land-Grant Colleges and Universities are designed to generate new knowledge which will assist rural underprivileged people and small farmers obtain a higher standard of living. Therefore, there is a high concentration of research effort in the areas of small farms, sustainable agriculture, rural economic development, human nutrition, rural health, and youth and elderly.

Special Research Grants – Section 2(c), Act of August 4, 1965, 7 U.S.C. 450i (c), as amended by Public Law 95-113; Public Law 97-98; Public Law 99-198; Public Law 101-624; Public Law 104-127; and Public Law 105-185.

Section 2(c) of the Act of August 4, 1965, as amended, authorizes Special Research Grants for periods not to exceed three years to SAES, all colleges and universities, other research institutions and organizations, Federal agencies, private organizations or corporations, and individuals. Previously, grants were made available for the purpose of conducting research to facilitate or expand promising breakthroughs in areas of the food and agricultural sciences. However, the Agricultural Research, Extension, and Education Reform Act of 1998 expanded the purposes under this authority to include extension or education activities. Grants funded in this account are only for research projects. Special Research Grants are awarded on discretionary basis as well as through the use of competitive scientific peer and merit review processes.

National Research Initiative Competitive Grants – Section 2(b), Act of August 4, 1965, 7 U.S.C. 450i(b), as amended by Public Law 95-113; Public Law 97-98; Public Law 99-198; Public Law 101-624; Public Law 104-127; and Public Law 107-171.

Section 2(b) of the Act of August 4, 1965, as amended, authorizes Competitive Research Grants for periods not to exceed five years to SAES, all colleges and universities, other research institutions and organizations, Federal agencies, private organizations or corporations, and individuals to further the programs of the Department of Agriculture. The purpose of the National Research Initiative Competitive Grants Programs (NRICGP) is to support research with the greatest potential for expanding the knowledge base needed to solve current problems as well as meet unforeseen issues that will face the future agricultural and forestry enterprise.

1994 Institutional Research – The Equity in Educational Land-Grant Status Act of 1994, Public Law 103-382, as amended, authorizes a competitive grants program for the 30 institutions designated as 1994 institutions. Section 7201 of the Farm Security and Rural Investment Act of 2002 adds a new institution, increasing the number of recipients eligible to receive funding under this program to 31. The program allows scientists at the 1994 institutions to participate in agricultural research activities that address tribal, National, and multi-state priorities.

Federal Administration (direct appropriation) – Authority for direct appropriations is provided in the annual Agriculture, Rural Development, Food and Drug Administration and Related Agencies Appropriation Act. These funds are used to provide support services in connection with planning and coordination of all research and education programs administered by CSREES, including the Research, Education, and Economics Data Information System.

Higher Education – The National Agricultural Research, Extension, and Teaching Policy Act of 1977, Section 1417, Public Law 95-113; Agricultural Public Law 97-98; Public Law 99-198; Second Morrill Act of 1890; Public Law 100-339; Public Law 101-624; Public Law 103-382; Public Law 104-127; Public Law 105-185; Public Law 106-78, and Public Law 107-71.

Pursuant to Section 1417(b)(6), Higher Education-Graduate Scholarships Grants are awarded on a competitive basis to colleges and universities to conduct graduate training programs to stimulate the development of food and agricultural scientific expertise in targeted national need areas. This program strengthens higher education in the food and agricultural sciences by producing graduates capable of fulfilling the Nation's requirements for professional and scientific expertise.

Pursuant to Section 1417(b)(1), Institution Challenge Grants are designed to stimulate and enable colleges and universities to provide the quality of education necessary to produce graduates capable of strengthening the Nation's food and agricultural scientific and professional workforce. The program is designed to strengthen institutional capacities, including curriculum, faculty, scientific instrumentation, instruction delivery systems, and student recruitment and retentions, to respond to identified state, regional, national, or international educational needs in the food and agricultural sciences, or in rural economic, community, and business development. All Federal funds competitively awarded under this program must be matched by the universities on a dollar-for-dollar basis from non-federal sources.

Pursuant to Section 1417(b)(5), the Higher Education Multicultural Scholars Program increases the ethnic and cultural diversity of the food and agricultural scientific and professional workforce and advances the educational achievement of minority Americans. This competitive program is designed to help the food and agricultural scientific and professional workforce achieve full participation by members of traditionally underrepresented racial and ethnic groups, and open to all colleges and universities with baccalaureate or higher degrees in Agriculture, Forestry, Natural Resources, Home Economics, Veterinary Medicine, and closely allied fields.

Pursuant to Section 1417(b)(4), the 1890 Institutional Teaching and Research Capacity Building Grants Program stimulates the development of high quality teaching and research programs at the 1890 land-Grant Institutions and Tuskegee University and West Virginia State College to build their capacities as full partners in the mission of the Department to provide more, and better trained, professionals for careers in the food and agricultural sciences. This program is designed to strengthen institutional teaching and research capacities, through cooperative programs with Federal and non-Federal entities, including curriculum, faculty, scientific instrumentation, instruction delivery systems, student experimental learning, student recruitment and retention, studies and experimentation, centralized research support systems, and technology delivery systems, to respond to identified State, regional, national, or international educational needs in the food and agricultural sciences, or rural economic, community, and business development.

Pursuant to Section 1455(a), the USDA-Hispanic Serving Institutions Education Partnerships Grants Program is the foundation for USDA efforts to better serve Hispanic Americans and to prepare them for careers in agriscience and agribusiness. This competitive program expands and strengthens academic programs in the food and agricultural sciences at Hispanic-serving colleges and universities, including two-year community colleges, that have at least 25% Hispanic enrollment.

The Equity in Educational Land-Grant Status Act of 1994, Public Law 103-382, as amended, authorizes the use of funds to benefit those entities identified as the 1994 land Grand Institutions, through the Tribal Colleges Education Equity Grants Program. Section 7202 of the Farm Security and Rural Investment Act of 2002 increases the authorized amount each of those 31 institutions is eligible to receive from $50,000 to $100,000. Funds may be used to support teaching programs in the food and agricultural sciences in the targeted need areas of curricula design and instructional materials development; faculty development and preparation for teaching; instruction delivery systems; student experimental learning; equipment and instrumentation for teaching, and student recruitment and retention.

Authorized by the National Agricultural Research, Extension, and Teaching Policy Act of 1977, Section 1417(j), as amended (7 U.S.C. 3152(j)), the Secondary and Two-year Postsecondary Agriculture Education Challenge Grants Program is designed to promote and strengthen secondary education in agribusiness and agriscience and to increase the number and/or diversity of young Americans pursuing college degrees in the food and agricultural sciences. The intent of the program is to encourage teachers to creatively incorporate elements of agriscience and agribusiness into secondary education programs.

Authorized by Section 759 of Public Law 106-78, the Alaska Native Serving and Native Hawaiian-serving Institutions Education Grants Program is aimed at recruiting, supporting and educating minority scientists and professionals, and advancing the educational capacity of Native-serving institutions.

Authorized by Public Law 103-382, as amended, the Native American Institutions Endowment Fund provides for the establishment of an endowment for the 1994 land-grant institutions. In accordance with Section 7128 of the Farm Security and Rural Investment Act of 2002, there are authorized to be appropriated such sums as necessary to carry out program for each fiscal years 1996 through 2007. The interest derived from the endowment is distributed to the 1994 land-grant institutions on a formula basis.

Extension Activities

Cooperative Extension work was established by the Smith-Lever Act of May 8, 1914, as amended. This work is further emphasized in Title XIV (National Agricultural Research, Extension, and Teaching Policy) of the Food and Agriculture Act of 1977, as amended. Partners in the Extension System are: CSREES, Cooperative Extension Services at land-grant universities throughout the U.S. and its territories, and Cooperative Extension Services in nearly all the Nation's 3,150 counties.

Smith-Lever 3 (b) & (c) Formula Funds of the Smith-Lever Act of 1914 (as amended) – These comprise approximately two-thirds of the total Federal funding for extension activities. These funds are allocated to the States on the basis of the rural and farm population of each State and the territories. Formula funding permits a consistent, stable, and reliable programming source for State and county Extension cooperators and allows maximum flexibility in addressing national, regional, and local problems and issues.

States must spend 25% or two times the level spent in FY 1997 (whichever is less), on cooperative extension services in which two or more States cooperate to solve problems that concern more than one State. States must expend up to 25% of Smith-Lever 3(b) and (c) funds for activities that integrate cooperative research and extension. Smith-Lever 3(b) and (c) funding provided to an 1862 Land-Grant Institution must be matched with non-Federal funding on a dollar-for-dollar basis.

Smith-Lever 3(d) – These targeted funds are allocated to the States to address special programs or concerns of regional and national importance and are primarily distributed according to the extent of the problem that requires attention in each State. The following Extension programs are supported: Expanded Food and Nutrition Education Program (EFNEP); Pest Management; Farm Safety; Children, Youth and Families at Risk; Indian Reservations; Sustainable Agriculture.

Payments to 1890 Colleges and Tuskegee University and West Virginia State College – Public Law 95-113, as amended, provides support to the 1890 Land-Grant Colleges and Universities for fostering, developing, implementing and improving extension educational programs to benefit their clientele. In accordance with the Agricultural Research, Extension, and Education Reform Act of 1998, Public Law 105-185, eligible State institutions are required to submit a five-year Plan of Work to CSREES for approval before these formula funds are distributed.

The Renewable Resources Extension Act of 1978 – This act provides funding for expanded natural resources education program. Funds are distributed by formula to all States for educational programs.

The Rural Health and Safety Education Act of 1990 – Helps rural residents avoid the numerous obstacles to maintaining their health status. This program maintains the ongoing rural health projects in Mississippi and Louisiana that focus on training health care professionals in rural areas.

1890 Facilities (section 1447) – The National Agricultural Research, Extension and Teaching Act of 1977: These funds are used to upgrade research, extension, and teaching facilities at the 1890 land-grant colleges, including Tuskegee University and West Virginia State College.

Extension Services at the 1994 Institutions – The Equity in Education Land-Grant Status Act of 1994 authorizes appropriations for Native American communities and Tribal Colleges for extension activities as set forth in the Smith Lever Act. Funding is awarded on a competitive basis.

Federal Administration (Direct Appropriation) – provides a portion of the general operating funds from the Federal staff, and national program planning, coordination, and program leadership for the extension work in partnership with the states and territories.

Integrated Activities

Water Quality – This program assists SAES and the Cooperative Extension System to become viable partners with other State and Federal agencies in addressing water quality problems of national importance. These funds are provided under competitive awards.

Food Safety – Provides for research, extension, and education programs to improve the safety of food products and to create a public that is more informed about food safety issues. These funds are provided under competitive awards.

Regional Integrated Pest Management (IPM) Centers – These centers will be the focal point for team building efforts, communication networks, and stakeholder participation within a given region. The centers will bring together and help focus the institutional and individual expertise needed to successfully address a range of pest management issues confronting farmers and other pest managers.

Crops at Risk from FQPA Implementation – This program is an intermediate-term research and extension program with the at-risk cropping system as the focus. The goal of the program is developing new multiple-tactic IPM strategies designed to assist in the transition period for certain pesticides affected by the implementation of the Food Quality Protection Act of 1996. These funds are provided under competitive awards.

FQPA Risk Mitigation Program for Major Food Crop System – This program emphasizes development and implementation of new and innovative pest management systems designed to maintain the productivity and profitability of major acreage crops while meeting or exceeding environmental quality and human health standards as the Food Quality Protection Act of 1996 is implemented.

Methyl Bromide Transitions Program – This program is designed to support the discovery and implementation of practical pest management alternatives for commodities affected by the methyl bromide phase-out. The program focuses on short-to medium term solutions for all commodities at risk using either combinations of presently available technologies or some newly developed practices. These funds are provided under competitive awards.

Integrated Organic Program – The Integrated Organic Program seeks to solve critical organic agriculture issues, priorities, or problems through the integration of research, education, and extension activities in two program areas: (1) the Organic Transitions Program (ORG); and (2) the Organic Agriculture Research and Extension Initiative (OREI). ORG funds the development and implementation of research, extension and higher education programs to improve the competitiveness of organic producers. OREI funds research and extension programs that enhance the ability of producers and processors who have already adopted organic standards to grow and market high quality organic food, feed, and fiber.

International Science and Education Grants Program – This is a competitive program focused on incorporating substantive international activities into programs related to food systems agriculture and natural resources at US land-grant colleges and universities.

Critical Issues Program – This program supports the development of early prevention strategies to prevent, manage or eradicate new and emerging diseases, both plant and animal, which would prevent loss of revenue to growers and producers. These funds are provided under competitive awards.

Rural Development Centers – This program provides funds at four regional centers in Pennsylvania, Mississippi, Oregon, and Iowa. Programs are designed to improve the social and economic well-being of rural communities in their respective regions. These funds are distributed according to the extent of the problem that requires attention in each state.

Homeland Security Program – This program provides support for a unified network of public agricultural institutions to identify and respond to high risk biological pathogens in the food and agricultural system. The network will be used to increase the ability to protect the nation from disease threats by identifying, containing, and minimizing disease threats.

Section 2501: Outreach and Assistance for Socially Disadvantaged Farmers and Ranchers Activities

This program provides outreach and technical assistance to encourage and assist socially disadvantaged farmers and ranchers to own and operate farms and ranches and to participate in agricultural programs. CSREES assumed the responsibility for the grant making aspects of this program beginning in FY2003. Competitive grant awards will be made for multiple year projects.

SECTION THREE: GOAL 1 – ENHANCE ECONOMIC OPPORTUNITIES FOR AGRICULTURAL PRODUCERS

Potential Impact of Plant Science Discovery, Learning, and Outreach

Sustaining and expanding new markets for U.S. agricultural products is critical for the long-term economic health and prosperity of the food and agricultural sector. American plant producers have superior natural resources, cutting-edge technology, a high level of learning and management skill, and a supporting infrastructure resulting in plant production capacity that exceeds domestic needs. U.S. agricultural productivity expands global markets, and results in a consistently positive balance of agricultural trade. Our plant production capability is the basis for new uses for agricultural resources in industrial and pharmaceutical markets, as well as the world's lowest percentage of disposable income spent for food. CSREES plant science discovery, learning, and outreach provides leadership and funding support to the land-grant university system in the pursuit of five goals on which on which contemporary agriculture depends for future growth and development.

1. PROVIDE INFORMATION, KNOWLEDGE, AND LEARNING TO HELP EXPAND MARKETS AND REDUCE TRADE BARRIERS.
   Timely, reliable, and valid discovery, along with education and outreach leading to adoption of new technologies and their resulting economic advantage, help the U.S. maintain its net positive agricultural balance of trade by expanding international markets. CSREES and its partners develop and distribute plant science technologies that sustain agricultural management capabilities and productivity.
   Plant science discovery, learning, and outreach can help improve the efficiency of American producers so that they may continue to compete in the face of downward price pressure, expand international markets by improving product quality, and provide science based safety assurance for technological innovations to America's trading partners.

2. SUPPORT INTERNATIONAL ECONOMIC DEVELOPMENT AND TRADE CAPACITY BUILDING THROUGH DISCOVERY, LEARNING, AND OUTREACH.
   CSREES supports the production and dissemination of plant science-based information, and provides education and technical assistance to foster economic growth and capacity building in developing countries, including those that are now transitioning to more free market economies. Access to these markets is important to U.S. growers.
   Plant science discovery, learning, and outreach helps these countries make better use of tropical or arid land through the developing of climate-tolerant varieties, increasing the amount and variety of nutrients yielded per hectare, and providing sustainable fertility options for growers of developing nations.

3. GENERATE AND PROVIDE THE SCIENCE-BASED KNOWLEDGE AND TECHNOLOGIES TO NEW OR IMPROVED HIGH QUALITY PRODUCTS AND PROCESSES TO EXPAND MARKETS FOR THE AGRICULTURAL SECTOR.
   CSREES underwrites important discovery and development contributions for plant quality improvements enhance market opportunities for agricultural and forest products.

CSREES and its partners effectively demonstrate and transfer to users the knowledge to produce new marketable plant products, generate new plant uses, and enhance plant product quality.
Plant science discovery, learning, and outreach assists in expanding markets through increasing the utility, transportability, and shelf life of plant products.

4. PROVIDE SCIENCE-BASED INFORMATION, KNOWLEDGE, AND EDUCATION TO FACILITATE RISK MANAGEMENT BY FARMERS AND RANCHERS.
   CSREES contributes to the improvement and strengthening of this dynamic system through sponsored research into alternative methods to identify, assess, and manage risk, providing relevant education, and extending information and practices to improve plant production.
   plant science discovery, learning, and outreach assists in managing risk by providing less capital intensive and more sustainable plant production practice options, developing varieties that are less susceptible to normal annual weather variations, and fostering adoption of management techniques that help assure more consistent product quality.

5. CONTRIBUTE SCIENCE-BASED INFORMATION, ANALYSIS, AND LEARNING TO PROMOTE THE EFFICIENCY OF AGRICULTURAL PRODUCTION SYSTEMS.
   CSREES funds higher education, discovery, and outreach programs to develop and transfer technology, practices, and skills to support economically viable growing operations of various size and scale. This work reduces production costs, increases production efficiency, improves yields, improves marketing and management decisions, develops new products and uses for by-products, and finds new ways of adding value to traditional crops.
   Plant science discovery, learning and outreach assists in promoting the viability of operations of various size and scale by developing attributes that are conducive to value added operations, providing lower input growing options, and improving crop yields.

The dynamic and fast changing agricultural industry requires equally flexible leadership. CSREES provides this leadership so that its partners may continue to enhance the economic viability of plant producers.

SECTION FOUR: PLANT PRODUCTION PORTFOLIO

PLANT SYSTEMS PORTFOLIO VISION
A vibrant, globally competitive, technologically advanced, and consumer driven American plant agriculture industry that is based on and supported by high quality, innovative, and relevant research, extension and educational programs provided by USDA through partnerships with universities and the private sector as well as the in-house research programs of the Department.

PLANT SYSTEMS PORTFOLIO MISSION
To provide strong research, extension, and educational program to promote the efficiency of plant production systems that are economically competitive, environmentally sound, and socially acceptable, and produce high quality and safe products for the American consumer and international markets.

The CSREES Plant Production Portfolio (PPP) is a major component of a broader Plant Systems portfolio. The Plant Systems Portfolio includes both the Plant Production and Plant Protection Portfolios. The CSREES Plant Production Portfolio has been defined as those research, extension, and education programs aligned with six problem areas (PAs) related to the efficiency of plant productions systems, . The CSREES Plant Protection Portfolio includes new, emerging, and reemerging plant diseases, plant agricultural security, biosecurity, and toxicology. In describing and reporting on the performance of the portfolio, it is important to recognize that an integrated systems approach is utilized in planning, developing, and implementing programs.

The CSREES National Program Leadership Team for Plant Systems recognizes that these two components are closely linked and interdependent in terms of program development, implementation, and delivery. The Team also recognizes that these components are linked to other major programs areas such as product quality (post harvest), food safety, engineering, waste management, marketing, and economics.

The PPP is diverse in terms of commodities covered. The portfolio includes research and extension activities directed at plant production systems. While broad goals and needs are similar across the various commodities, there are specific needs and priorities within these commodities that are addressed in the portfolio. Program goals and delivery systems also recognize the diversity of needs across and within these commodities in terms of size, concentration, regional differences, levels of integration, and external factors impacting these systems.

The PPP encourages multi-disciplinary approaches to address the needs of plant agriculture and the American consumer. The portfolio contains a balance of discipline-based components including plant reproduction, genetics, physiology, and product quality. The portfolio also includes integrated system-based research and extension programs.
Program integration may occur at a commodity-based system level (e.g., rice or corn), as well as a biological/discipline system level (e.g., genetics). As much of the research is very applied in nature, the extension component is highly integrated and not always evident as a separate effort.

The Team recognizes that the long-terms goals of the programs within this portfolio can best be achieved through strong research, extension, and education programs that are clearly integrated. While the portfolio represents a very complex system in terms of functions and integration of these functions, there is a critical need to develop new models and delivery systems that are effective and performance based. Integrated program functions for the PPP include:

- Originate fundamental knowledge from basic research at the frontiers of the biological, physical, and social sciences in plant agriculture.
- Produce, apply, and adopt applied research-based knowledge in innovative ways to address problems and issues in plant agriculture.
- Provide developmental research and technology transfer to promote the commercialization and transfer of technologies and practices to potential users in a timely, cost-effective manner.
- Provide leadership in the delivery of research-based knowledge through extension, outreach, and information dissemination to strengthen the capacity of public and private decision makers impacting plant agriculture.
- Strengthen the capacity of institutions of higher education to develop the skills of the Nation's workforce in the food and agricultural sciences.
- Assure the quality, relevancy, and performance of programs supported through federal funding in plant agriculture.
- Optimize collaboration and cooperation across institutions and agencies in order to achieve broad strategic goals addressing the needs of farmers, ranchers, and the American consumer.

The logic model shown in Figure 4.1 illustrates the way in which the PPP responds to situations to achieve outcomes.

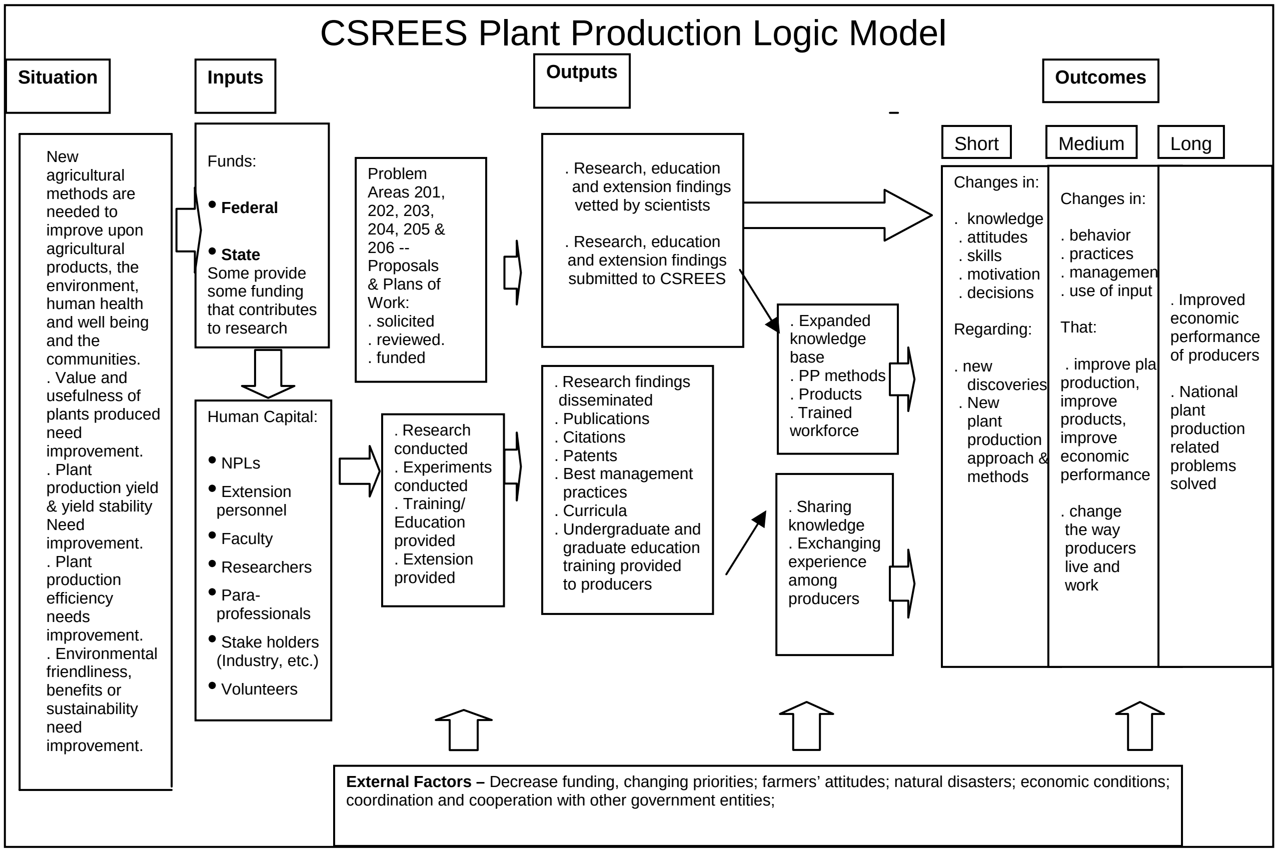


Figure 5.1 – CSREES Plant Productions Portfolio LOGIC model.

SECTION FIVE: THE PARTNERSHIP

CSREES programs are based completely on a dynamic and vibrant relationship with our university and private sector partners. The PPP demonstrates the linkages and interdependence between the Federal and State components of a broad-based, national agricultural research, extension, and higher education system. The agency's mission is carried out through this unique and dynamic partnership. The university-based system is critical to assuring relevancy, quality, and performance of the programs administered and led by the agency in plant agriculture. CSREES Program Leadership serves as both the catalyst and focal point for national research, extension, and education programs in plant production conducted throughout the university systems and other partners.

The Plant Systems Team (PST) supports strong program linkages with the USDA's Agricultural Research Service (ARS). It is clear that the plant agricultural industries and the American consumer are best served by closely linking and integrating the programs administered by CSREES with those of ARS. A strong university-based research, education, and extension system, linked to the in-house research programs of ARS, will help ensure a globally competitive plant industry. The PST works closely with our counterparts in ARS in program planning and implementation, ensuring that these programs are complementary.

The Evidence Volume for this Portfolio contains *Appendix D: Cross-Cutting Programs* from the USDA FY 2004 Annual Performance Plan and Revised Plan for FY 2003. This appendix identifies programs or activities that USDA agencies are undertaking with other organizations to achieve a common purpose or objective.

SECTION SIX: COOPERATIVE EXTENSION SERVICE FUNCTIONS

Various state and federal government agencies have education/outreach agendas, but their capacity to deliver programs is extremely limited or nonexistent. The Cooperative Extension Service (Extension) retains its comparative advantage for delivering science-based, consumer-driven programs to help individuals and communities adopt new practices and respond to change. In addition, the Extension system is built on a unique infrastructure that includes the presence of local educators (county agents) in rural, urban, and suburban communities across the country, and their partnerships with land-grant universities, state governments, and the federal government. Extension has been successful in achieving its mission of serving the agricultural sector, rural families, and rural communities. These accomplishments have made the U.S. food supply the safest, cheapest, and most abundant in the world. Both universities and their local offices are supported by CSREES, the federal partner in the Cooperative Extension System. CSREES plays a key role in the land-grant extension mission by distributing annual Congressionally appropriated formula funding to supplement state and county funds. CSREES affects how these formula funds are used through national program leadership to help identify timely national priorities and ways to address them.

The United States' ability to produce plants for food, feed, fiber, forest products, recreation, and aesthetic pleasure is unparalleled. Examples of the progress made during the latter part of the 21st century by American those who produce plant products and manage vegetative space include:

- Rice yields have increased from average trends of less than 4500 pounds per acre in 1975 to over 6500 pounds per acre in 2003
- Corn yields have increased from average trends of less than 85 bushels per acre in 1975 to over 140 bushels per acre in 2003.
- Cotton yields have increased from average trends of less than 500 pounds per acre in 1973 to over 700 pounds per acre in 2003.
- The over 2.6 million trees planted annually in the United States, 87% of which are planted by private owners and forestry companies, exceeds the ten year total of 2.3 million trees planted during the Civilian Conservation Corps tree planting program earlier in the 20th century.
- The number of non-private golf facilities has increased from 6600 in 1975 to 10,649 in 1998.
- The total wholesale value of bedding and garden plants, herbaceous perennials, cut cultivated greens, and propagative materials sold by the green industry (by operations with more than $100,000 of gross sales) totaled $4.85 billion in 2003.

This monumental progress is the result of many factors. One major factor is the ability of plant producers and vegetative space managers to bring the research and technology developed in the public and private sectors to bear on problems encountered and opportunities presented. The Cooperative Extension System is a leading partner in translating this public and private research and technology to profitable action. The 1122 crop county agents, 866 horticulture county agents, and 755 general agriculture county agents, as well as the campus based specialists that support them, are on the front lines of this effort.

Land grant university extension activity is funded by federal, state, and county government. CSREES is the main federal partner that supports these efforts. The extension portion of the FY 2004 CSREES budget, along with FY 2004 and FY 2005 presidential requests, is summarized in Table 6.1.

Extension Programs	FY 2004 President's Budget	FY 2004 Approp. Act	FY 2005 President's Budget
Formula Programs:			
Smith-Lever Formula 3(b) & (c)	275,940	277,742	275,940
1890 Institutions	32,117	31,720	32,117
Subtotal	308,057	309,462	3 08,057
Smith-Lever 3(d) Programs:			
Expanded Food & Nutrition Education Program	60,909	52,057	57,909
Pest Management	10,759	9,563	10,759
Farm Safety	0	4,911	0
Children, Youth, & Families at Risk	8,481	7,538	8,481
Youth Farm Safety Education & Certification	499	444	499
Sustainable Agriculture	3,792	4,333	3,792
Extension Indian Reservations Program	1,996	1,774	1,996
Subtotal	86,436	80,620	83,436
Other Extension Programs:			
Extension Services at the 1994 Institutions	3,273	2,929	3,273
Renewable Resources Extension Act	4,093	4,040	4,093
Rural Health & Safety	0	2,331	0
1890 Facilities (Section 1447)	13,500	14,912	14,912
Grants for Youth Servings Institutions	0	2,667	0
Federal Administration:			
Other	6,159	21,542	6,653
Ag in the Classroom	750	622	750
Subtotal	27,775	49,043	29,681
Total, Extension Activities	422,268	439,125	421,174

Table 6.1 – Extension portion of FY 2004 CSREES budget as enacted and FY 2004-5 Presidential requests

Though the influence of extension efforts is difficult to quantify, evidence exists that the land grant university extension system is a trusted and well used source of information in this regard. A 1998 national survey of corn, soybean, wheat, and cotton growers by the Conservation Technology Information Center at Purdue University indicates that university extension is the greatest influence on grower's adoption of nutrient management practices. In addition to influencing the growers directly, extension is the most often consulted source for others that communicate with growers, which includes: independent crop consultants, retailers, and conservation district employees.

The expected outcomes of land grant university plant sciences extension efforts include, but are not limited to:

1) Increased value and usefulness of the plants produced
2) Increased plant production yield and yield stability
3) Increased plant production efficiency
4) Increased environmental friendliness, benefits or sustainability

Selected Examples

The following are individual CSREES extension impact reports that provide examples of efforts that work toward these outcomes.

North Dakota > Competitive Agricultural Systems in a Global Economy

Planting sunflowers earlier in western North Dakota

2003 S&E Impact Report 2003-068-01-019

Issue (Who cares and why?)

Producers have traditionally planted sunflowers at the end of May or Early June to make labor available for other farm tasks and to reduce the risk of frost. While a later planting date was not a large factor with most sunflower varieties, yield and quality of NuSun sunflower varieties with high oleic oil content are improved with earlier planting

What has been done?

The area extension cropping systems specialist and the Slope County extension agent developed a demonstration to show producers the effect that moving the planting date from late to early has on yield and quality of NuSun sunflower oil produced. In the three years that this demonstration has been conducted, plant stand establishment for late-April and early-May seeding dates was significantly lower than for sunflower planted after mid-May. Seed yields were greatest two out of the three years when sunflower was sown May 23. In terms of oleic content, a desirable fatty acid, mid-May to early-June planting was significantly higher than either the early seeding dates or planting dates after early-June. The information gained from the demonstration has been shared with producers during tours of the demonstration plot as well as at producer meetings.

Impact

Twenty-three producers indicated they have adjusted sunflower planting dates to occur at or about May 23. It is estimated that these 23 producers increased income based on yield and quality factors by $35 per acre or a total of $241,500.

Primary impact area(s)

research extension

Funding sources

- Smith-Lever 3(b) & (c)
- State (Appropriated Funds)

Florida A&M University > Competitive Agricultural Systems in a Global Economy

Small Farm Outreach Training & Assistance

2003 S&E Impact Report 2003-021-01-005

Issue (Who cares and why?)

A competitive advantage for small-scale farms can be realized through the application of appropriate research and extension activities, the stimulation of new and alternative market opportunities and a supportive framework of public and private initiatives. There is a need for specific assistance in marketing strategies, production technologies and management systems that are appropriate for small-scale operations to maintain competitiveness. Market development for traditional, specialty and value-added agricultural products has shown tremendous economic opportunities for diversification of small-scale operations. There also exists the potential for strong public-private networks for small farm economic development.

What has been done?

FAMU Extension Program has been working in collaboration with various public and private entities to address the marketing difficulties facing small and limited resource farmers. Opportunities have been developed with rural and urban school districts in Florida, Georgia, Alabama, Mississippi, and Arkansas. Market trials and full-year deliveries, in collaboration with the New North Florida Cooperative, were conducted with such products as leafy greens, muscadines, value-added peas and beans, and sweet potatoes. Farmer groups have been trained enterprise production, quality control requirements, value-added processing and packaging, and transportation logistics. Other opportunities include the Department of Defense, grocery chains, retail and wholesale markets for traditional, specialty and value - added products. Through collaborative partnerships, an effective mechanism for educational programming, farmer networking and outreach and assistance has been established for small-scale farmers, producer groups and cooperatives. Collaborative partners include Heifer Project International, University of Florida IFAS, RC&D Councils, USDA agencies and other public and private entities. Activities and accomplishments include farmer and group training, acquisition of financial resources, specialty market trials and alternative market outlets, value-added production, and increased income potential. Eleven (11) producer groups and cooperatives, serving over 100 farmers, have participated in program activities. Over 500 persons have been reached through training and assistance activities in marketing and cooperative development, alternative enterprises and value-added production, and risk management.

Impact

Small and limited resource farmers have provided over 60,000 pounds of fresh agricultural produce to 20 school districts, serving over 550,000 children, in Florida, Georgia, Alabama, Mississippi, and Arkansas

Two (2) minority farmer groups established and conducting normal cooperative business activities (holding meetings, electing officers, offering services to membership, etc.)

Four (4) minority producer groups/cooperatives have received funding for marketing and agricultural production, value-added production, transportation and distribution

Collaborative partnerships and working relationships have resulted in 100% increase in participation of 2501 Program activities

Funding sources

- 1890 Extension

West Virginia > Competitive Agricultural Systems in a Global Economy

Grassland Management Saves Money, Protects Water

2003 S&E Impact Report 2003-104-01-010

Issue (Who cares and why?)

Grassland is the basis for agriculture in West Virginia. The primary agriculture industries - ruminant livestock and poultry - require grassland for their sustainability. Livestock producers require grassland for the production of pasture and hay. Poultry producers use grassland to dispose of 80 percent of the poultry litter produced by confined birds.

The highest-quality and least-cost forage is produced under good grazing management. To control production cost, it is important to extend the grazing season as long as possible and manage for droughts that often occur during the summer. To improve pastured animals' performance and health, it is important to know the quality of pasture forage and the effects management has on forage quality.

What has been done?

Goals and Objectives:

The 2001 Plan of Action goals were set to improve grassland management to increase profits of West Virginia's farmers. The West Virginia University Extension Service's (WVU-ES) goals are:

-- Increase adoption of rotational grazing as a way to increase forage quality and quantity and to protect water quality.

-- Increase management practices that increase legumes in pastures to increase forage quality and reduce nitrogen fertilizer cost.

-- Increase calf weaning on high-quality pasture to reduce feed cost and increase calf value.

-- Optimize winter feed by evaluating the economics and quality of hay and haylage production and extending the grazing season.

Methods:

Coordinated educational meetings were conducted across the state during the winter. On-farm demonstrations were incorporated into field days and pasture walks to show producers the effectiveness of improved pasture management. On-farm research was conducted to evaluate the effects of management on hay quality and production cost and to evaluate management effects on performance of weaning calves on pasture. Extension fact sheets and bulletins were developed and distributed. Educational meetings provided farmers information on using quality grass-legume pastures to reduce the cost of weaning calves, stockpiling of cool-season grasses for out-of-season grazing, and using management-intense grazing to improve pasture yield and quality and to improve forage availability during the summer slump.

On-farm demonstrations featured using poultry litter as an environmentally safe low-cost fertilizer and extending the grazing season by using rotational grazing and stockpiled tall fescue. Pasture walks and field days were held during the summer. Several pasture walks were held in January and February to show the effectiveness of stockpiling tall fescue to extend the grazing season.

Pasture-Based Beef Systems for Appalachia is a cooperative program among WVU, USDA/ARS (Beaver Laboratory), and Virginia Tech. As a part of this program, WVUES is evaluating the effects of weather and management on production and animal performance risk in forage-livestock systems.

Impact

--Outcomes

1. A major outcome of the initiative is the set of winter educational meetings conducted at 11 locations throughout the state. In 2002, the sessions attracted 3,000 participants. At these meetings, key individuals provided educational programs for farmer audiences about the methods used in forage management and the increasing need for improved management.

West Virginia > Competitive Agricultural Systems in a Global Economy (cont.)

2. Several extended grazing season demonstrations were established across the state. These were used for educational programs during the fall and winter to show the practical value of extended grazing.
One aspect of extending the grazing season is to properly use fertilizers such as poultry litter to stimulate fall pasture growth in an environmentally friendly manner. In Pendleton County, for example, 9,000 tons of poultry litter is being applied properly, and a group of 80 farmers is saving between $125,000 and $175,000 annually by using poultry litter as a fertilizer.
3. Commercial fertilizers continue to be important in forage production especially in parts of the state where poultry litter is not readily available. Educational programs train farmers how to take soil samples, interpret the laboratory report, and apply the correct types and amounts of fertilizer to meet crop needs in an economical and environmentally safe manner. Work also continues in identifying crop response to nitrogen fertilizer using additives that conserve the nitrogen, making it available to the plants over time so that there is less risk to the environment. In Putnam County, a comparison is being made between urea, urea + Agrotain, ammoniated complete fertilizer, mixed complete fertilizer, compared to no fertilizer. This is the third year in this study. Data from this study will be shared with farmers throughout West Virginia.
4. In Mason County, a grazing demonstration was started in 2001 to demonstrate extended managed grazing, fencing, renovating pastures, sod seeding, using pasture herbicides, comparing forage species and varieties, and using endophyte-free tall fescue. This includes large plots for grazing studies. A total of 44 acres of pasture has been renovated to include various varieties of fescue, orchardgrass, bromegrass, and clover. Grazing is being extended because of intensive grazing management. Ampac and Pennington Seed companies have been involved in the project. Three officials from Wrightson Research of New Zealand toured the site this past summer. Information will be provided to producers across the state as it becomes available.
5. Figures for 2002 include:
--Evaluation:
The grassland management team sought to determine program productivity by measuring improved yields (tons/acre), increasing grazing season length, and improving summer grazing through the use of management-intense grazing, legumes, and warm-season grasses.
--Outcome indicators:
Following are the range and mean values for the outcome indicators. Numbers in parenthesis are the number of counties reporting.
Outcome indicator Range Mean Units
Improved forage yield (13) 0.1 – 5.0 1.8 tons/acre
Increased grazing season (19) 1 – 12 3.8 weeks
Improved summer grazing (10) 1 – 6 2.7 weeks
Reduced cost of animal production (13) 0.5 – 60 17.35 $/head
Increase summer forage availability (11) 1 – 4000 887 lbs. DM/a
Increased pasture legume content (12) 1 – 20 17 % DM
Increased cattle performance (11) 1 – 200 39 lbs./head
Reduced weaning costs (4) 0.2 – 25 7.80 $/head

Primary impact area(s)

extension

Funding sources

- Smith-Lever 3(b) & (c)

Arizona > Enhance Economic Opportunities for Agricultural Producers

Reducing Nitrogen Applications in Irrigated Cotton

2004 S&E Impact Report 2004-004-01-005

Issue (Who cares and why?)

The traditional approach to nitrogen management in irrigated cotton has been to push for maximum high yields by applying large amounts of nitrogen fertilizer. Historically, in many parts of Arizona, nitrogen application rates have exceeded 200 pounds per acre per season. Although yields may increase, there are serious drawbacks to this practice. Over the last 10-15 years the luxuriant vegetative growth resulting from these high nitrogen applications has harbored damaging insect populations and diseases in Arizona's cotton fields. Studies during the same period have shown that aggressive nitrogen fertilizer application can actually increase the loss of nitrogen from the soil. In the past, nitrogen fertilizer has been relatively inexpensive for Southwest desert growers, but in 2001 those costs rose approximately 30 percent and more or less remained at that level during 2002 and 2003.

What has been done?

To help Arizona cotton growers reduce their reliance on high nitrogen applications in their fields, University of Arizona researchers studied and documented nitrogen uptake patterns and requirements in the crop at three UA agricultural centers. At each location, treatments varied from a conservative to a more aggressive approach to nitrogen management. Results at each location revealed a strong relationship between the crop fruit retention levels and nitrogen needs for the crop. Results showed that the higher, more aggressive N application regimes did not consistently benefit yields at any location. Generally, the more conservative, feedback approach to N management provided optimum yields at all locations.

UA College of Agriculture and Life Sciences researchers have designed nitrogen management guidelines and recommendations that pinpointed the best times to apply nitrogen in the proper amounts. Over the last 14 years this comprehensive nitrogen management strategy has been implemented in a statewide extension education plan for cotton growers that include bulletins, reports, articles and grower meetings.

Impact

The cost of cotton production has been high during the last several years, but the market price has been low. UA demonstration projects on cooperating cotton farms have realized yields equivalent to commercial yields, using less nitrogen input, which has saved approximately $30 per acre in nitrogen application costs. If adopted statewide, the annual savings, at February 2003 nitrogen prices, would be about $15-$25 per acre. If 200,000 acres of the total cotton acreage in Arizona were affected, this would equate to $3 to $4 million in savings to the growers. Growers would be using approximately 150 pounds per acre, compared to a more common rate of about 200 pounds per acre, a 25 percent reduction. In 200,000 acres of cotton, this means 5,000,000 pounds of nitrogen fertilizer would be withheld, resulting in less rampant vegetative growth, fewer insect problems and improved plant use of residual nitrogen in the soil. It would also protect groundwater from excess leaching of nitrogen compounds, thereby protecting the environment.

Difficult market conditions, which are the worst they've been since the Great Depression, have no doubt served as a stimulus in encouraging growers to make these changes. Approximately 60 percent of the cotton growers in Arizona are using more conservative nitrogen management strategies than they were five to ten years ago. Fortunately, the information in the educational program associated with these management decisions was already in place.

Funding sources

- Hatch Act
- Smith-Lever 3(b) & (c)

SECTION SEVEN: STAKEHOLDER FEEDBACK TO ENSURE RELEVANCE

The Plant Production Portfolio is targeted to address critical national needs, issues, and priorities relevant to plant agriculture production. Research and extension programs must also demonstrate relevancy in terms of science. CSREES utilizes a variety of processes and networks to provide feedback to the agency in terms of relevancy to the industry and relevancy within a field of science. The Plant Systems Program Leaders have effective links to researchers, professional societies, county agents, extension specialists, farmers and ranchers, Experiment Station and Extension leadership, commodity organizations, consumer groups, advocacy organizations, advisory committees, other federal agencies, the Office of Science and Technology Policy, and Congress. All serve to provide feedback either directly or indirectly to assist CSREES in identifying needs and establishing priorities to assure the relevancy of programs within the Portfolio.

Processes utilized are both formal and informal, and may include stakeholder workshops, symposia, technical reviews, peer panel recommendations, white papers, Presidential directives, interagency strategic plans for research and development, regulatory policies impacting plant production systems, industry plans and priorities. These processes and networks help the agency to evaluate the relevancy of programs relative to local, state, regional and national needs. Critical national needs and priorities are generated through aggregation of problems and issues first identified at the local or state level.

All of the programs managed by CSREES use relevancy as a criteria for pre-award evaluation of projects. Relevancy may be evaluated in terms of industry or consumer needs and priorities as well as relevancy within the field of science. As science evolves it is critical that the Plant Production Portfolio keep pace the emerging opportunities and advancements in science. The current portfolio is dynamic and ever changing to address the national needs consistent with cutting edge science. Program descriptions, progress reports, and requests for applications, reflect/demonstrate this change and responsiveness within the portfolio.

Selected Examples

"CROPS-99": The Plant Systems leadership in CSREES initiated the concept and planned the workshop "Coalition for Research on Plant Systems" (CROPS) to identify priorities for crop and plant research for the 21st century. This coalition of more than 75 organizations included producers, processors, consumers, environmentalist, scientists and policy makers. The participants agreed on four goals for plant research; (1) Improve crop production systems, (2) Improve processing, quality, and nutritional value of plants, (3) Enhance protection of natural resources, and (4) Enhance economic opportunities for U.S. agriculture. Three research priorities were identified; (1) Expand the science and application of genomics, (2) Develop practical, sustainable production management systems, and (3) Develop mechanisms to enhance producer profitability and ensure food safety and security. CROPS-99 serves as guidance to CSREES Plant Systems including the Plant Production Portfolio.

Plants and Pest Biology stakeholder workshop, Crystal City VA, November 14, 2002: Provided a forum for stake holders to review and contribute feed back on the agency's research priority issue areas that CSREES is considering multi year funding. The issue areas are; (1)Agricultural and Environmental Quality, (2) Agricultural Security, (3) Genomics and Food and Fiber Production, (4) Obesity, Human Nutrition and Food Security, (5) Food Safety, and (6) Rural and Community Development. Feedback from this workshop helps to focus CSREES portfolios including the Plant Production Portfolio.

National Research Council Review: Responding to Congressional mandate, the National Research Council's Board on Agriculture and Natural Resources (BANR) convened four *ad hoc* committees to evaluate the quality of research in USDA's Research, Education, and Economics (REE) mission area and recommend future research efforts. The panels represented a wide array of expertise, including those with knowledge of public and private agricultural research and those who use or are affected by the results of the research. The full report can be found in: National Research Council. 2003. *Frontiers in Agricultural Research: Food, Health, Environment, and Communities.* Committee on Opportunities in Agriculture (Washington, D.C. National Academies Press).

Facilitating regulatory consideration of small-market biotechnology crops: A national expert workshop. A collaboration of CSREES, ARS, ERS, and the National Center for Food and Agricultural Policy. Oct/Nov 2004. CSREES state agricultural experiment station partners and ARS conduct research to develop transgenic crops to benefit producers, the environment, and consumers. In particular, public research serves crops having small acreage or small markets, whose market size is not sufficient to create financial returns for private investors. As biotech crop varieties for smaller markets near readiness, regulatory approval of food and environmental safety is necessary. A number of small-market projects have been cancelled, for a variety of reasons; the cost to move a variety through the regulatory process appears to be one of the limiting factors. This can result in loss of benefits from existing research investments, and from biotechnology applications that may not be developed because of regulatory costs.
Based on feedback from an April 15, 2004 planning meeting with state AES stakeholders, workshop will be held with these objectives: identify barriers to regulatory consideration of small-market biotech crops, and identify models for overcoming these barriers. It is not the purpose of the workshop to suggest changes to the regulatory process *per se.* Invited workshop participants will include public- and private-sector researchers developing small market biotech crops or experienced in the regulatory process, and representatives of growers of small-market crops.
Output: Analysis of the special challenges of small-market crops; existing examples of public support for products lacking commercial drive (e.g., the USDA/state IR-4 project, NIH, FDA orphan drugs program); and research models and researchable issues to facilitate preparation and reduce cost of regulatory dossiers for small-market crops. A report will be published on USDA and NCFAP websites. Anticipated outcome: Developers of small market crops will be able to submit products to regulatory review in a smooth and affordable way. Anticipated impact: i) More small-market crops will complete the regulatory process, especially from public sector and small business research; ii) more products and benefits from biotechnology will be available;

(iii) a wider range of products will enable consumers to form a broader view of biotechnology, which may inform current debates in international trade and development.

Ag Diversity Tours. Two separate farm diversity tours were held in cooperation with 1890 institutions and tribal entities.
2002 Ag Diversity Tour. Introduction and Discovery Tour to meet Minority Farmers served by 1890 Partner Institutions. Organized in cooperation with four partner institutions: Alcorn State University (MS), University of Arkansas/Pine Bluff (AR), Langston University (OK), and Southern University (LA). Designed mainly for CSREES program staff who have little or no previous contact with minority farmers. Goal of the tour: To broaden CSREES staff understanding of the needs of minority farmers, and to strengthen commitment to meeting those needs, through face-to-face conversations and farm visits. A report was shared with CSREES staff and other USDA agencies (Thro, Hoffman, and Hunt: Field Visit to Minority Farmers Served by 1890 Universities in Louisiana, Mississippi, and Arkansas).
2003 Ag Diversity Tour. Tour of minority farmers served by Langston University. July 14-18th , 2003 . Visiting the farmers at their farms not only allowed the participants to see the agricultural production, but to encourage the growers to communicate in a relaxed atmosphere. 2) The opportunity to visit with the extension staff while traveling from farm to farm with county extension agents, scientists, and administrators, especially while seeing things on the road

"Will genomics be useful to plant breeding?" A standing-room only symposium at the annual meetings of the American Society of Crop Science, 13 Nov, 2002, Indianapolis, Indiana. The most frequent answer was a cautious 'yes,' particularly when MAS was considered. Nearly all panelists agreed that the largest potential benefits of plant genomics are still years away--use of today's genomics information in plant breeding is limited. Factors that limit current genomics applications in plant breeding were identified as: It will take time to develop a way to use genomics that is a practical improvement over very successful current methods. --Few researchers or students are conversant at an adequate professional level in both plant genomics and plant breeding. -- Plant genomic research has centered on model species; many critical crop traits are simply not represented in these "models" . -- Plant breeding infrastructure and human resources have been lost, limiting capacity to take advantage of genomics - Plant breeding capacity to use genomics is particularly lacking for crops grown on small acreages. Recommendations will be published (Thro, A. M., W. Parrott, J.A. Udall, and W.D. Beavis (eds). Genomics and Plant Breeding: The experience of the Initiative for Future Agriculture and Food Systems. Crop Science. Accepted 22 Feb 2004)..

A Discussion on the Future of Plant Breeding, held at the ASHS / ISHS meetings, Toronto, Canada, Aug 13, 2002. A well-attended opportunity to learn concerns of breeders of horticultural crops. An interactive plant breeding contact web site was suggested as an alternative to an additional professional association, which would be costly in funds and time. .-- Plant breeders in the 20th century made great progress working phenotypes and environments. With new genomics techniques, students are mostly interested in genotype. Yet skills in working with phenotypes in environments will still be needed. There is a "brain drain" from plant breeding per se to genomics and other sciences having more funding. How can gifted individuals be attracted to training in plant breeding? -- There is a danger that all forms of genetic improvement will get "lost in the biotechnology controversy". -- Public perception is important. Tell people why they should care about plant breeding: Why plant breeding is essential for economic growth, national security. environmental preservation. genetic diversity, rural economics. Need for public ownership of decisions about plant breeding objectives.

The Secretary's Advisory Committee on Agricultural Biotechnology (ACAB). This was a select external advisory committee composed of representatives of every viewpoint on biotechnology in the United States. After two years of deliberations, the ACAB reached agreement on only topic, the importance of public plant breeding. It forwarded that recommendation to the Secretary on August 2, 2001. Their report is: The future of public plant breeding programs: Principles and roles for the 21st Century. It is available at http://www.usda.gov/agencies/biotech/archive/acab/meetings/mtg_8-01/ppbprpt_8-01.html, or from the CSREES NPL for Plant Breeding.

The National Plant Breeding Study. This study consisted of a data collection phase followed by a "think-tank" national expert workshop to identify national priorities based on the data. Four publications presented the data and expert conclusions:

Frey, K. J. (1996). The National Plant Breeding Study. Vol. I. Human and financial resources devoted to plant breeding in the United States, 1994. Special Report 98, Iowa Agriculture and Home Economics Experiment Station.
Frey, K. J., (1997). The National Plant Breeding Study. Vol. II. National Plan for Promoting Breeding Programs for Minor Crops in the U.S. Special Report 100, Iowa Agriculture and Home Economics Experiment Station.
Frey, K. J., (1998). The National Plant Breeding Study. Vol. III. National plan for genepool enrichment of U. S. crops. Special Report 101, Iowa Agriculture and Home Economics Experiment Station.
Frey, K. J. (2000). The National Plant Breeding Study. Vol. IV. Future priorities for plant breeding. Special Report 102, Iowa Agriculture and Home Economics Experiment Station.

An update of the National Plant Breeding Study is in progress:
Thro, A. M., G. Traxler, A. Acquaye and K. J. Frey. 2003. An update on the National Plant Breeding Study. p. 226. In: Abstracts, Arnel R. Hallauer International Symposium on Plant Breeding. 17-22 Aug 2003, Mexico City, Mexico.

National Tree fruit Technology Roadmap: This was a three day workshop in February of 2003. It brought together industry, academia and government agency representatives to discuss short-, intermediate-, and long-term research and extension needs of the tree fruit industry. Although results concentrated on the apple and cherry industry in the Pacific Northwest, representatives from other tree fruit industries, such as the citrus and peach industries, were also present.

Wheat Genome Sequencing: A workshop co-organized and sponsored by CSREES and NSF was held November 10-11, 2003, in Washington DC. The genome workshop on this major food crop, which feeds much of the world, generated international interest: it brought together 63 scientists of diverse research interests and institutions, including 45 from the U.S. and 18 from a dozen foreign countries. The objectives of the workshop were to discuss the status of wheat genomics, obtain feedback from ongoing genome sequencing projects and develop strategies for sequencing the wheat genome. The workshop provided a forum for scientists to share findings and advice on research conducted on wheat, corn, rice, Arabidopsis, and other plants. A report has been submitted for publication to convey the information discussed at the workshop and provide the basis for an ongoing dialogue, bringing forth comments and suggestions from the genetics community that could help in developing a strategy for sequencing the wheat genome. The workshop evolved from an earlier stakeholders' workshop sponsored by CSREES and coordinated by the American Society of Plant Biology that was held November 14, 2002, on plants and pest biology.

National Research Council: OSTP and the federal sponsors of the National Plant Genome Initiative (USDA, NSF, and DOE) approached the National Research Council for help in determining goals for the NPGI in the timeframe 2003-2008. In response to the request, the Research Council established a committee to study the future directions for plant biology and genomics and to recommend priorities for the 2003-2008 phase of the NPGI. The work of the committee was informed by a 2 – day workshop co-sponsored by CSREES and held at the National Academy of Science on June 6-7, 2002. On the basis of discussions at the workshop and additional information, the committee developed a set of recommendations, which were summarized in a report. The need to advance a variety of efforts in plant research and applications as rapidly as possible was balanced with the desire to proceed as economically as possible.

Wheat genomics and breeding: A workshop co-organized and sponsored by CSREES: "Implementation of Molecular Marker Technologies in Public Wheat Breeding Programs", was held in Kansas City, MO February 22, 2004. The workshop was attended by 57 participants including representatives from the four USDA-ARS genotyping centers, the National Wheat Improvement Committee and the national Association of wheat Growers, the American Institute of Baking, the North American Miller's Association, and the milling and baking industry. Wheat breeders from 23 wheat-growing states and numerous wheat researchers also attended the meeting. They were able to prioritize quality and resistance traits for the different wheat market classes and discussed the best structure for a national program for marker assisted selection in wheat that integrates the public breeding programs, University research laboratories, and the USDA-ARS regional molecular genotyping laboratories.

State Plans of Work: The State Plans of Work (POW) covering both research and extension programs receiving CSREES funds require documented input from stakeholders. Therefore, the POW and the associated annual progress report provide a continual flow of information from stakeholders from throughout the U.S. regarding priority and emerging issues.

SECTION EIGHT: PUBLICLY-FUNDED AGRICULTURAL RESEARCH AND THE CRIS SYSTEM

The U.S. system of publicly-funded science and education in the areas of food, agriculture, and natural resources supports a diverse, complex knowledge base that is vital to food and fiber production and to the economic well being of the nation. The scientific expertise available though the federal and state research system constitutes a valuable national resource with the necessary flexibility to respond to changes in demand for food and other commodities, threats to the sustainability of food and fiber production, and concerns about environmental quality. The Cooperative State Research, Education, and Extension Service (CSREES) contributes a unique national perspective to the network of research partnerships maintained by the USDA and cooperating institutions. This vantage point is essential to the Agency's regional and national coordination of resources to address diverse research problems.

In recent years, the research agenda for food, agriculture, and natural resources has expanded in response to a broadening array of issues affecting producers, processors, consumers, and other user clientele. Changes in the research agenda were given impetus by the U.S. Congress when it reauthorized the USDA programs through the Food, Agriculture, Conservation, and Trade Act of 1990. This legislation emphasized food and fiber needs, long term viability and competitiveness, improvement of the quality of rural life, the assurance of supply of safe food, and enhancement of the environment and natural resource base. The growing consumer interest in environmental and social issues, as well as the increased complexity of contemporary research problems, has necessitated and increase in multi-and interdisciplinary scientific investigations. In addition, new collaborative relationships are being formed with departments outside colleges of agriculture in land-grant institutions and with institutions outside the traditional land-grant system, as well as with other groups.

The evolving U.S. system of food, agricultural, and environmental research encompasses the programs of state agricultural experiment stations (SAES); colleges and departments of forestry, home economics, and veterinary medicine; 1890 land-grant institutions and Tuskegee University; other cooperating institutions, including state and private colleges and universities; and USDA intramural research agencies (primarily the Agricultural Research Service, the Economic Research Service, and the Forest Service). These programs are closely linked to and complement the teaching and extension activities of land-grant and other institutions. At the university level, research programs also are integral to graduate education, through which scientists are prepared to confront future research challenges.

The research system operates as a network of cooperating institutions and agencies funded via state, federal, and private sources. Coordination, joint planning, and priority setting are accomplished through various national and regional mechanisms to ensure the efficient use of valuable resources.

The summaries presented are based on federal state research activity as documented in the USDA's Current Research Information System (CRIS) database. Research within the CRIS system in classified according to two major categories: 1) USDA intramural research, and 2) extramural research. Intramural research refers to programs conducted internally by USDA agencies, and is supported by USDA-appropriated funds. Extramural research, in contrast, is conducted by state agricultural experiment stations and other university based research organizations and institutions. This research is funded in part through projects, grants, and contracts, many of which are administered by CSREES.

The dynamics of university-based agricultural research are described in terms of the changing levels of investment decided to broad problem areas in agriculture and to specific researchable issues identified in this report. In addition to this input analysis, however, other important indicators of programmatic change may be relevant to understanding the dynamics of agricultural science. These include changes in the mix of basic and applied research over time, patterns in the number and range of disciplines drawn upon to address research questions, relative shifts in emphasis of commodity-specific and cross-commodity research targets, and the distribution of research efforts and support by areas of science or geographic region. For example, see the table for PA 308, which illustrates how Evans-Allen formula funds have been used by 1890 institutions to respond to areas identified as important by their stakeholders. Dynamism also might be suggested by changing patterns in the interaction between-and complementarities of research programs within the federal-state system. By addressing these questions, future analyses could contribute to a more comprehensive understanding of agricultural research.

CRIS has several characteristics valuable for program analysis. The system includes research in progress, objectives and procedures of the projects, annual financial and management data, and reports for accomplishments. Based on analysis of annual expenditures and scientist years accounted for in CRIS, coverage of the database system is nearly comprehensive for those projects supported or conducted by the USDA and for those conducted under the aegis of the SAES. CRIS documentation of agricultural research supported by sources other than the USDA, and of some university-based work conducted outside the SAES may be more variable. As the definition of agricultural research has expanded over time, and the range of scientists have extended beyond those traditionally associated with the USDA and SAES, agricultural research efforts may be understated by CRIS. This consideration may be especially important in those research areas at the boundaries of agricultural research.

It is being proposed that the CRIS Research Problem Areas (PAs) be revised to encompass the entire CSREES portfolio of funding (i.e., research, extension, and higher education). The current PAs would be referred to as Problem Areas (PAs). However, a process to collect resource data for the PAs to implement the new classification system has not been developed at this time. In this document, the term Problem Area (PA) is used.

Education Component Within Problem Areas

Each PA has an education component in addition to the extension and research component. As with the extension component, though, data are not collected in the CRIS system. Education data from other databases are presented in the Evidence Volume.

SECTION NINE: PORTFOLIO ANALYSIS - PLANT PRODUCTION

Plants through photosynthesis and carbon fixation provide the primary production upon which all higher animals depend. Understanding and managing plant production is essential to the survival and well being of mankind. The Land Grant University system evolved out of this need and is still the central core of agricultural research, extension and education. CSREES provides significant support for these functions through a variety of funding mechanisms described elsewhere in this document. This document will focus primarily on the research efforts where the CRIS data base provides a level of detail not available for extension or teaching.

Plant production, as defined in this portfolio, focuses on some of the key factors that impact output from production and/or management systems. These include: Problem Areas (PAs) 201 “Plant Genome, Genetics and Genetic mechanisms,” 202 “Plant Genetic Research and Biodiversity,” 203 “Plant Biological Efficiency,” 204 “Plant Product Quality and Utility (post harvest),” 205 “Production management Systems,” and 206 “Basic Plant Biology.”

A number of other factors important to plant production/management that will be covered in subsequent portfolio reviews and are not included in this report. Such issues as pests, disease, climate, and soils affect plant production and must be considered in a management system. However, for this review the scope is restricted to the specific issues covered under the six Problem Areas listed above. In many cases there are research and extension efforts supported by one or more of those outside factors. Therefore, the total resource allocation directed to Plant Production is greater than shown here.

The State Agricultural Experiment Stations (SAES) allocated a total of $551.29 million to Plant Production research in FY2002, up from $441.84 million in FY1998—an increase of 24.2%, after adjustment for inflation. Genome, genetics and genetic resources (PAs 201 and 202) combined received 35% of the funds, while biological efficiency, abiotic stress, and basic plant biology combined for 34%. The remaining 30% was used for production management and pre-harvest quality. Therefore, a little over one-third of the resources are going into research aimed at developing a basic understanding of the plant biology, and how plants function under stress. Development and maintenance of plant genetic resources received a little over one-third of the resource allocation, while management systems and pre-harvest quality received the remaining 30%.

The SAES FY 2002 funds for research for Plant Production came from a number of sources indicated in Table 9.1.

Source	$ Millions	%
CSREES	89.46	16.2%
Other USDA	16.51	3.0%
Other Federal	85.43	15.5%
State Appropriations	245.46	44.5%
Self Generated	20.17	3.7%
Other non-Federal	42.67	7.7%
Industry Grants	51.56	9.4%
Total	551.29	100.0%

Table 9.1 – Funding sources for SAES plant science research

CSREES funding for Plant Production research in FY-2002 was $89.46 Million which amounted to 16.2% of the SAES total. The allocation among the PA followed closely that of the SAES total, as shown in table 9.2.

PA	**Title**	**SAES**	**%**	**CSREES**	**%**
201	Plant Genome, Genetics and Genetic Mechanisms	122.38	22	21.54	24
202	Plant Genetic Resources	69.09	13	10.06	11
203	Biological Efficiency & Abiotic Stress	97.64	18	14.16	16
204	Plant Product Quality	53.91	10	6.78	8
205	Plant Management Systems	117.99	21	20.51	23
206	Basic Plant Biology	90.27	16	16.41	18
TOTAL		551.29		89.46	

Table 9.2 – FY 2002 SAES and CSREES plant production funds by PA ($ Millions)

Table 9.3 shows the CSREES funding for plant sciences problem areas by funding line item. Hatch funding made up over 37% of the CSREES Funding for Plant Production research with 30% from NRI, just less than 20% for Special Research Grants, and 6% from Evans Allen. Other funding lines contributed much smaller amounts. However, the distribution of funds across PAs varied greatly between funding lines. NRI funds went primarily to genetics and basic biology at $10.36 million and $11.25 million respectively. Biological efficiency/abiotic stress came in at $3.42 million with the others receiving very small amounts. Hatch funds were much more evenly distributed across all PAs. A large proportion of Special Research Grants went to production management with product quality in that order. The NRI funds, by design, are concentrated on the more fundamental aspects of research related to Plant Production. Special Research Grants, also by design, focus on application and problem solving. Hatch funds provide broad support across the entire research spectrum.

PA	Hatch	Mc-Stn	Evans-Allen	Spcl. Gnts.	NRI	SBIR	Other	Total
201	5,021	316	1,025	3,460	10,363	456	896	21,536
202	6,276	133	675	1,598	442	59	874	10,056
203	6,629	464	1,101	2,196	3,418	0	353	14,163
204	3,359	98	2,110	1,673	481	503	277	6,782
205	7,822	159	151	516	11,247	0	120	16,515
TOTAL	33,328	1,297	5,425	17,260	26,681	1,281	4,187	89,462
%	37.2	1.4	6.1	19.3	30.0	1.4	4.7	---

Table 9.3 – FY 2002 CSREES Funding for PA 201-6 by line item

The major funding lines for this portfolio, formula in the form of Hatch and Evan Allen plus focused and earmarked as Special Research Grants, and competitive basic research, as in NRI programs complement each other in providing broad base coverage for Plant Production research. This arrangement has proved to be very successful in meeting the demanding challenges of providing the science base to support sustainable plant production while meeting the associated social, economic and environmental concerns. This model which has been successful in meeting the challenges of today will be even more important in the future as the world faces the demands of a growing population, fixed or declining natural resources and increasing environmental issues.

CSREES funding for Plant Production research in FY 2002 was $89.46 million, up from $69.01 million (or 29.6%) in FY 1998. This is summarized in Table 9.4 and is shown in comparison to the SAES funding totals in table 9.5.

PA	1998	2002	% Change	2002 *Adjusted	% Change
201	13.13	21.54	64.1	19.30	45.1
202	8.36	10.06	20.3	9.01	7.8
203	17.82	14.16	-20.5	12.74	-28.5
204	7.34	6.78	-7.3	6.07	-17.13
205	10.97	20.51	97.2	18.38	65.6
206	11.40	16.41	43.9	14.70	28.9
TOTAL	69.01	89.46	29.6	80.16	16.16

Table 9.4 – Change in CSREES Plant Production Funding FY 1998-2002

PA	1998	2002	% Change	2002* Adjusted	% Change
201	65.52	122.38	86.8	109.65	67.4
202	60.14	69.0	1.4	61.90	0.3
203	114.60	97.64	-1.4	87.48	-23.4
204	45.10	53.91	19.5	48.30	7.1
205	92.49	117.99	27.6	105.72	14.3
206	64.39	90.27	40.0	80.88	25.61
TOTAL	442.84	551.29	24.5	493.96	11.5

Table 9.5 – Change in SAES Plant Production Funding FY 1998-2002

*Adjusted for inflation to FY1998 $ (10.4%)

Adjusted for inflation, the overall increase was 16.6%. SAES funding for PA 201 "Plant Genome, Genetics, and Genetic Mechanisms" increased by 67% while Biological efficiency declined by 23%. PA 206 "Basic Plant Biology" and PA 205 "Production Management Systems" increased by an adjusted 25% and 14%, respectively. PA 204 "Plant Product Quality and Utility (Preharvest)" increased 7%; there was no change in support for PA 202 "Genetic Resources and Biodiversity." Changes in CSREES tended to track the SAES total except the increase for Plant Genome, Genetics and Genetic Mechanisms was lower (45% vs. 67%) while Biological Efficiency and Basic Plant Biology, were basically the same as (-23% vs. -29%) and (29% vs 26%) respectively, while CSREES funding for Plant Production Management was sharply higher (66% vs. 14%) and Genetic Resources was slightly higher (7% vs 0.3%).

The distribution of 2002 CSREES funds for plant production research by subject of inquiry (SOI) is shown in Table 5. Almost 77% of the total went to 10 subjects of inquiry. Hatch funds, which made up almost 38% of the total was the largest source for all of the major subjects of inquiry except grain crops The NRI contributed the largest amount for grain crops and the non-commodity specific (plants, general) category. This probably reflects the major genomic effort under way with the grain crops and the fact that much of the non-commodity specific research is basic in nature. It interesting to note that over two thirds of the Evans-Allen funding for plant production went to vegetable crops. This is consistent with the emphasis focused on small farms by the 1890s Land Grant Institutions and the importance of vegetable crops in small farm operations. Significant Special Research Grant funds were distributed over four of the largest subjects of inquiry plus the non-commodity specific category. The difference in distribution of funds from the separate funding lines to the major commodity specific and non-commodity specific groups, supports the conclusion that a broad base, multiple source, research portfolio is needed to address the spectrum from basic to the applied aspects of plant production research.

Description of SOI	Hatch	McSten	Evn-Allen	SRG	NRI	SBIR	Oth Grnt	CSREES
GRAIN CROPS	4,640	0	544	2,339	7,059	84	497	15,162
PLANTS, GENERAL	3,933	51	122	2,535	11,705	120	390	18,858
VEGETABLES	5,082	79	2,076	1,353	1,358	19	637	10,603
OILSEED & OIL CROPS	2,378	60	466	1,613	880	0	577	5,971
DECIDUOUS & SMALL FR	3,842	0	735	3,327	164	0	552	8,620
ORNAMENTALS & TURF	3,691	103	204	767	161	16	93	5,035
PASTURE & FORAGE CRO	3,377	0	212	825	873	0	82	5,368
MICROORGANISMS	1,028	44	85	0	2,059	104	9	3,330
FIBER CROPS	870	0	276	391	428	44	236	2,244
TREES, FORESTS & FOR	207	865	0	91	566	0	0	1,729
Top 10 SOI TOTALS RPA 201-6	**29,048**	**1,202**	**4,720**	**13,241**	**25,253**	**387**	**3,073**	**76,920**
Percentage of Top 10 SOI RPA 201-6	37.8%	1.6%	6.1%	17.2%	32.8%	0.5%	4.0%	100.0%
All SOI Totals	33,330	1,295	5,430	17,260	26,684	1,281	4,188	89,462
Percentage	37.3%	1.4%	6.1%	19.3%	29.8%	1.4%	4.7%	100.0%

Table 9.6 – PA 201-2065 CSREES Top 10 Subjects of Investigation (SOI) by Funding Line Items

The following Program Area descriptions were written by different groups of Plant Production National Program Leaders that were assigned to the task..

SECTION TEN: PROBLEM AREA 201 & 202 – PLANT GENOME, GENETICS, AND GENETIC MECHANISMS; AND PLANT GENETIC RESOURCES

The years between 1998 and 2002 have seen a doubling of funds expended for PA 201, plant genomics, genetics and genetic mechanisms research (Figure 1). However, funding for genetic resources and germplasm development (PA 202), and for applied plant breeding (in the "downstream" PAs 203-204 and 211-214), increased little—generally not enough to keep up with costs—and in some cases decreased. A bottleneck in the application of genomics results may be imminent.

This is of concern because plant breeding is a cyclical activity, based on living organisms, and cannot be put "on hold". Disinvestment in plant breeding over time causes loss of plant germplasm needed for getting maximum benefit from genomics, and leads capable young scientists to chose other career paths. Results of the 1994 National Plant Breeding Study, and an on-going update of that study, suggest that the disinvestment may have gone on for considerably longer than the 5 years' duration of this overview. At worst, this could mean that when funding does become available for strategic use of genomics results, there will be a time lag while plant populations are redeveloped and a new generation studies plant breeding.

CSREES is aware of the bottleneck between conducting and using genomics research. To support strategic use of genomics results, with limited funds available, CSREES projects strengthen links between genomicists and plant breeders within a crop R&D community. These "linkage projects" use various CSREES funding vehicles: integrated research projects and conferences may be funded by competitive grants; multistate research projects and coordinating committees use Hatch funds; and even special grants contribute. Within each dimension below--relevance, quality, performance--, after general comments, we use three crops, rice, wheat, and potatoes, to illustrate CSREES linkage activities and what they can accomplish.

The illustrations also show how much more could be accomplished with additional funds to link genomics research to application for strategic goals. Resources are also needed for plant breeding in crops without genomics research, a category that includes many crops, including crops important to small-scale farmers and organic producers.

RELEVANCE

SCOPE

Plant genome, genetics, and genetic mechanism research (PA 201) develops and disseminates genetic and genomic knowledge and tools with the purpose of making plant breeding more efficient. Plant genetic resources research (PA 202) uses knowledge and tools that are developed in PA 201 to develop and disseminate knowledge to identify, preserve, and characterize genetic resources for plant production or protection. Knowledge and materials from PAs 201 and 202 are used in research in PAs 203-204 and 211– 214 to develop improved varieties.

Obligated CSREES funding for PA 201, year 2002:
Competitive Programs $ 11,715,000 (includes integrated programs, SBIR, and other grants)
Formula funds $ 6,364,000
Special grants $ 3, 459,000

Obligated CSREES funding for PA 202, year 2002:
Competitive Programs $ 1,373,000 (includes integrated programs, SBIR, and other grants)
Formula funds $ 7,085,000
Special grants $1,598,000

FOCUS ON CRITICAL NEEDS

The peer review process ensures that competitively-awarded CSREES projects focus on scientifically critical areas. The AREERA process requires that formula-funded projects reflect stakeholder priorities. The competitive review process encourages innovative ideas that are likely to open new research approaches to enhancing US agriculture. A proven mechanism for stimulating new scientific research, the 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 proposal based on scientific merit, investigator qualifications, and relevance of the proposed research to US agriculture.

IDENTIFICATION OF EMERGING ISSUES

Setting priorities is important to facilitate scientific and technological advances to meet the challenges facing US agriculture. Congress sets the budgetary framework by providing funds to CSREES. Members of Congress also make recommendations for the scientific and programmatic administration through appropriation language and through their questions and comments during Congressional hearings. Input into the priority-setting process is sought from a variety of customers and stakeholders. The scientific community provides input through the proposals it submits each year as well as through the proposal evaluation and funding recommendations of individual peer-review panels.

Review panels for competitive programs, Federal interagency working groups, stakeholder workshops, the National Research Council, participation in multistate projects with AES, ARS, and other researchers, including the National Plant Germplasm System, are examples of important mechanisms for CSREES to identify emerging issues for PAs 201 and 202. National Program Leaders attend scientific and professional meetings to stay current on scientific trends that should be reflected in CSREES programs and in the coordination of priority setting with other federal agencies. NPLs also participate in meetings with representatives of key commodity groups and other user groups to discuss these stakeholders' current priorities, learn ways that CSREES can assist in meeting their needs, and solicit comments and suggestions.

INTEGRATION OF CSREES PROGRAMS

Through its "linking" projects, multi-institutional activities that create links across funding sources, CSREES creates a mechanism for integrating its PA 201 and 202 activities in competitive grants, formula funds, and special grants—activities that may otherwise be disjoint.

INTERDISIPLINARY INTEGRATION

CSREES linking projects are multi-institutional and multidisciplinary. Through these projects, CSREES is able to stimulate the integration of current scientific advances with national stakeholder needs for applied research. Both mission-linked research and fundamental research are supported by CSREES. 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. Both mission-linked research and fundamental research are essential to the sustainability of agriculture.

EXAMPLES:

The five criteria: scope, focus on critical needs, identification of emerging issues, integration of CSREES programs, and interdisciplinary integration, are illustrated by three crops with contrasting situations: rice, wheat and potatoes.

EXAMPLE 1 – RICE

In 1999, a CSREES interagency partnership with the NSF and DOE, competitively funded US Laboratories to participate in the International Rice Genome Sequencing Project. In 2002, the International consortium completed a high quality draft sequence of the rice genome and they are on target to complete a fully annotated sequence in 2004. By combining advances in rice genomics with the strong history of US rice breeding presents an excellent opportunity to solve intractable problems in rice production and quality important to the US rice industry. The prospect of a CSREES-funded project (the Applied Plant Genomics – Coordinated Agricultural Project (CAP) has forged a new alliance among US rice breeders and genome scientists to work together in an unprecedented integrated effort to solve problems in rice production that are governed by complex traits.

<u>Scope</u>: Large-scale, multi-million dollar activity that is intended to promote collaboration, open communication and exchange of information, reduce duplication of effort, and coordinate activities among individuals, institutions, states, and regions. .

<u>Critical needs</u>: Two problems identified by the US rice industry that would benefit from a combined genomics and breeding approach are milling quality and resistance to sheath blight disease. Rice milling quality directly impacts profits for nearly the entire US rice industry and is considered one of the most important researchable issues by the US Rice Foundation. The genetic complexity of milling quality makes it difficult for breeders to identify and develop cultivars improved for this trait. Fungicide is needed to control sheath blight. Reducing fungicide use on rice would significantly reduce production costs and would enhance development of environmentally benign rice production systems.

<u>Identification of emerging issues</u>: A portion of requested CAP funds would be made available to accomplish time-critical objectives of national interest that could be determined at a later date. This flexibility in funding is innovative in that it does not obligate all the funds but allows the consortium to respond to unexpected advances and promising leads or unforeseen new national needs related to project goals and objectives. A scientific and stakeholder board would provide input, advice, and oversight for the project with leadership from CSREES NPLs.

Integration of CSREES programs: The CAP is designed to be a multi-disciplinary, multi-state, and multi-institutional research effort integrated entirely with CSREES education, and extension programs. It would also involve coordination and linkages to ARS, NSF, international cooperators, private companies, growers and processors.
Interdisciplinary integration: Through cross-training and workshops, post-doctoral fellows and graduate students would link the molecular biology and breeding disciplines together. A program would be developed for extension personnel educate the public on the merits of applying genome information to improve agricultural crops.

EXAMPLE 2 – WHEAT

The wheat crop research community demonstrates what can be done when a CSREES-funded project stimulates integration of basic and applied research and multiple disciplines, for impact that is close to reaching the fields.

The wheat genomics and breeding community competed successfully for an IFAFS award, "Bringing genomics to the wheat fields", in 2001. IFAFS proposals were required to be multi-institutional and multi-disciplinary. The goal of IFAFS was to deliver the impact of upstream research funded by NRI and similar programs in the form of applied research and its products.

Scope: The four-year project, with a budget of $3,250,000, includes 12 public wheat breeding programs across the U.S.
Critical issues: This project focuses on resistance to diseases that threaten productivity and quality of U.S. wheat, and on quality traits that will allow U.S. wheats to compete in new markets. Through overlapping membership and through the National Wheat Improvement Committee, the project links to the National Wheat Scab Initiative (a presidentially-requested special grant through ARS).
Identification of emerging issues: Close links of the wheat breeding community with wheat growers, millers, and bakers, through the NWIC and NAWG, ensure that emerging issues for wheat production and marketing are identified by CSREES-funded wheat research. Consumer feed-back appears to be mainly through the marketplace experiences of wheat processors.
Integration of CSREES programs: The project has been a focal point for integrating the work of 16 Hatch projects in PAs 201 and 202, five individual-investigator NRI projects in plant genomics, and a special grant (Wheat Genetic Resources, Kansas). The project also supports integration of CSREES programs and AES research with ARS programs through linkages to collaborative work with the ARS regional cereal genotyping labs.
Interdisciplinary integration: Through Hatch projects of the PDs, the IFAFS project links the NRI and Special Research Grant activities to applied work in PAs 203, 204, 211, and 212, as well as PA 502. Directly supported by the IFAFS grant are 11 graduate students and 14 post-docs, and high school summer rotations, which integrate wheat genomics and breeding while attracting and educating plant breeders of the future, part of CSREES's education role.

EXAMPLE 3 – POTATOES

The potato breeding community is well-linked internally but has surprisingly few linkages to basic research and genomics, despite the fact that upstream potato projects are not lacking.

The potato breeding community receives a Special Research Grant administered by CSREES. Congress has specified that this Special Grant is to be awarded competitively. Proposals are reviewed by a scientific peer panel and by a panel of potato growers. In addition, the potato community is served by NRSP-6, the Inter-regional Potato Introduction Project, a multistate project funded by ARS (about 90%) and CSREES (about 10%, through Hatch regional funds).

Scope: Research funded by the CSREES-administered Potato Special Research Grant must involve variety development and have variety release as an objective. Four multi-institutional projects are awarded, one in each region of the U.S. Geographic coverage is extensive; most or all U.S. potato breeding programs are involved. The project had a budget of $1,465,000 in FY 2002. This was reduced by a factor similar to most Special Grants, to $1,316,000 in FY 2004. NRSP-6 is international in scope and collaborates with potato genetic resources work in, for example, South America (mainly CIP and Peru), Poland, and Russia.

Focus on critical needs: Because projects are recommended for funding by a panel of potato growers, they correspond closely to needs that potato farmers consider critical. These critical needs include disease resistance to reduce cost and increase stability of production, processing quality for commodity potatoes, and novel potato types for new markets, such as miniature colored salad potatoes.

Identification of emerging issues: For identification of on-the-ground emerging issues, the potato breeding community is closely linked to potato growers through state and national chapters of the National Potato Council. For identification of emerging issues in upstream scientific research results and new methods the potato breeding community is less well-linked, at least, through CSREES programs. For example, at this time only a few potato breeders have been funded NRI grants in PAs 201 or 202. A second set of potato Special Research Grants, also competitively awarded but through ARS, funds individual investigator projects that apply upstream scientific research results to anticipated medium- and long-term future needs in potato production and marketing. These proposals are also reviewed by both a peer review panel and a grower panel. The farmer review panel looks carefully also at these proposals for likely relevance, and generally considers that special grant funds are not most appropriately used for emerging research issues.

Integration of CSREES programs: PDs on the Potato Special Research Grant are also PDs on 14 Hatch projects, and members of one of four Multistate Research Projects focusing on potatoes. There is potential for integration with NSF plant genomics and molecular biology. NSF funds a potato genome project which is not, at this time, linked to potato breeding. Recent NSF-funded research at the U. Wisconsin/ARS has transformed cultivated potato with a gene from a wild potato species that appears to confer immunity to late blight. One of the PDs on a CSREES – administered Potato Special Grant is also a co-PD on both NSF grants. The NSF potato genome project primary PD has expressed interest in linking the project with potato breeding, if an appropriate funding vehicle exists.

Interdisciplinary integration: Activities funded by the Potato Special Research Grant include collaboration with plant pathology, entomology, and production management research. Hatch projects which link to the Potato Special Research Grant include RFAs 204, 205, 211, 212, and 216.

QUALITY

SIGNIFICANCE OF FINDINGS AND OUTPUTS
Publications, abstracts, theses.

STAKEHOLDER ASSESSMENT
Listening sessions, review panels, workshops, working groups.

ALIGNMENT OF PORTFOLIO WITH CURRENT SCIENCE
Peer review of proposals and projects, NPL expertise.

METHODOLOGICAL RIGOR
Peer review of proposals and projects

EXAMPLES:
The four criteria: significance of findings and outputs, stakeholder assessment, alignment of portfolio with current science and methodological rigor, are illustrated by three crops with contrasting situations: rice, wheat and potatoes.

EXAMPLE 1 – RICE

The US RICE GENOME SEQUENCING PROJECT - *The NSTC Interagency Working Group on Plant Genomes*
In January 1998, the National Science and Technology Council's Interagency Working Group (IWG) on Plant Genomes published a 5-year plan for a National Plant Genome Initiative. The IWG included representation from USDA, NSF, DOE, NIH, OSTP and OMB. One of the goals of the IWG was to participate in an international effort to sequence rice in collaboration with the Rice Genome Program in Japan and other countries. To accomplish that goal, USDA, NSF and DOE joined together in 1999 to coordinate their limited federal resources to support a US RICE GENOME SEQUENCING PROJECT (USRGSP). In addition to the US and Japan, participating countries include Brazil, China, France, India, Korea (South), Taiwan, Thailand and the United Kingdom. Each country is responsible for funding their scientists to participate. For this international collaboration, the 12 chromosomes of the rice genome, totaling approximately 430 million base pairs were divided among participating countries. The US is responsible for sequencing and annotation of all of chromosomes 3 and 10 and part of chromosome 11 which will require sequencing approximately 85 million bases. The US project is based at the Institute for Genomic Research in Maryland, Clemson University in South Carolina, Cold Spring Harbor Laboratory in New York, Washington University in Missouri, University of Arizona and University of Wisconsin. CSREES, NSF and DOE have awarded nearly $16 million since 1999 (approximately 10% of the worldwide funding) for US laboratories to participate and coordinate with the international project. CSREES is the lead agency for the USRGSP.
Significance of findings and outputs: Rice is the most important food crop in the world and feeds half the human population. It is that half of the population that is projected to double over the next half century, so it is of critical importance that we learn as much as possible about rice to be able to improve production and quality on less land and with less water. With access to the rice genome, the agriculture community will have new tools available for exploiting the

capability of plants. Rice is also considered an important reference organism to study plant biology and it shares a common ancestor with many other important cereals like corn, wheat, barley, oats and sorghum. The cereal crops will benefit from the decoding of the rice genome by associating sequence information to increase knowledge of disease resistance, nutrition, response to inhospitable environments, quality, and other agriculturally important traits. Access to genes of this major agricultural crop provides an immediate resource for engineering the quantity and the quality of rice production.

The first major accomplishment of the USRGSP was the establishment of a publicly available sequence ready physical map of the rice genome that was integrated with the rice genetic map (Plant Cell 14: 537-545, 2002). This physical map in addition to tools and resources developed primarily by the Rice Genome Program in Japan, were used as a scaffold for the international project to sequence the rice genome.

The second major accomplishment of the USRGSP was the generation and public release of the highest quality and publicly available draft sequence of the rice genome in December 2002 in collaboration with international partners (paper submitted for publication). This draft provided early access to the majority of genes in rice as well as their position along the 12 rice chromosomes. It also incorporated draft sequence data from two privately held data sets from Monsanto and Syngenta and effectively released all privately held sequence data into the public domain for all to use.

The third major accomplishment of the USRGSP was to generate a finished sequence of rice chromosome 10 in June 2003 and publish the results in the journal Science (Science 300:1566-1569, 2003). Sequence analysis revealed the presence of 3,500 new rice genes, 43 of which represented a potential new source of disease resistance genes for breeders to improve current rice varieties. This work added significantly to the basic knowledge of the genome organization of rice as well as its relationship to the corn and sorghum genomes. The work documented that even partial genome sequence for other crop species can be leveraged using the complete rice genome sequence. Thus, the benefits of sequencing the rice genome are not limited only to rice but will be seen in other crop species of significant economic importance such as corn, wheat, barley, oats and sorghum. The USRGSP has developed new annotation technologies and bioinformatic tools that can be applied to finishing the remainder of the rice genome at an accelerated pace. Rice chromosome 10 now appears to be an ideal model chromosome for rice functional genomics and is expected to yield new insights into the effect of heterochromatin on gene expression. Finally, the USRGSP trained a new generation of talented scientists that will help to lead the future of agriculture toward a safe and secure food supply for generations to come. "Decoding the rice genome is an important scientific achievement that can lead to improved nutrition and aid in efforts to eliminate hunger throughout the world. This scientific partnership between the United States and Japan continues to demonstrate our commitment to advancing research and science," said Secretary of Agriculture Ann Veneman.

Stakeholder assessment: The concept for a USRGSP began in September, 1997 at a workshop held in conjunction with the International Plant Molecular Biology Meeting in Singapore to explore the possibility of a coordinated international effort to sequence the genome. The workshop was attended by about 150 scientists. The meeting resulted in an agreement to collaborate on the project, to share materials and results, and to sequence a common cultivar (*Oryza sativa* cv. Nipponbare). The participants also agreed to construct PAC and BAC libraries which would be fingerprinted and end-sequenced. Five national representatives were nominated to work out the details of the collaboration. In February, 1998, the five national representatives from Japan, China, Korea (South), USA, and Europe met in Tsukuba, Japan to work out the details of the international collaboration. The organization was given its name, The International Rice Genome Sequencing Project (IRGSP), and it was agreed that its goal was the complete map-based sequence of the rice genome. It was estimated that this goal would take ten years to achieve. Sequencing methodology and policies for sequence release and accuracy, based on the Bermuda accords for HUGO, were agreed upon. The governing body of IRGSP is the Working Group made up of one representative from each participating country with the head of the Japanese Rice Genome Research Program (RGP) as the permanent chairman. The resulting Guidelines which are continuously updated were based on HUGO and the Arabidopsis Genome Initiative. In April, 1998, a one day workshop for rice genomic sequencing was held in Washington to promote and coordinate US activities in rice genomic sequencing with the IRGSP. The workshop was funded by a joint grant from the USDA, NSF, and DOE. There were about 75 attendants at the meeting. At this meeting, scientists laid the groundwork by explaining the current stage of rice research and the important syntenic relationship of the rice genome to that of the other cereal grasses. The current state of rice genomics and the background and details of the IRGSP were covered. While the meeting was no doubt useful in giving background and details to scientists interested in rice genomic sequencing, it is likely that its real success was in mobilizing the US funding agencies to plan for US participation in the IRGSP. In September, 1998, at an interim meeting in Miami, Canada, France and Taiwan joined the IRGSP. The RGP reported refinements to its YAC based physical map and the construction of a PAC library using partial Sau3AI digests which comprises 71,000 clones. It was also reported that a BAC library was made and prepared with partial HindIII digests of Nipponbare DNA containing 37,000 clones. In February, 1999, at the annual meeting in Tsukuba, India and Thailand joined the IRGSP. The RGP demonstrated INE, a prototype of the proposed Rice Sequencing Database. In September, 1999, at an interim meeting in Phuket, Thailand, it was announced that as of September 7, 1.26 Mb of Nipponbare contiguous genomic sequence had been submitted to public databases. Additionally there were 49,424 BAC-end sequences with 92,000 expected to be completed by the end of 1999. The IRGSP agreed to a minimum uniform standard for annotation. In April, 2000, The Japanese Ministry of Agriculture, Forestry and Fisheries (MAFF) announced the contribution of a working draft sequence of the rice genome and the associated files and physical mapping data to the IRGSP. The working draft sequence was done by scientists at the University of Washington under contract to the Monsanto Company. It was a BAC-based sequence using the Nipponbare cultivar of *Oryza sativa*. Monsanto expected the IRGSP to put all of this sequence in the public domain after it had been combined with new sequence information generated by the IRGSP. The BACs provided by Monsanto along with the associated draft sequences and map information was especially helpful as these sequences underlie about 25% of the IRGSP sequences in public databases. In January, 2001, at the annual meeting in Tsukuba, the useful incorporation of Monsanto data to fill gaps in tiling paths was demonstrated in three laboratories. The IRGSP proposed a change in strategy that would achieve a 10X coverage of the rice genome by the end of 2002. This interim goal - maintaining the ultimate goal of finished quality sequence for the entire genome - was accepted by the Working Group. In June, 2001, a technical meeting was held in Tsukuba to plan for and discuss the feasibility of obtaining the 10X sequence for the entire genome as an interim goal of the IRGSP. By the interim meeting in September at TIGR it was agreed that the goal was obtainable. In February, 2002, three chromosomes (1, 4, 10) are essentially complete. In March 2002, two physical maps of the rice genome are published. Scientists from the RGP and colleagues described a transcript map with 6591 tags that covers 81% of the genome (Plant Cell 14: 525-535, 2002) and scientists from Clemson University and collaborators described a BAC-based map covering 91% of the genome (Plant Cell 14: 537-545, 2002). Both maps were genetically aligned. In May, 2002, The Japanese National Institute of Agrobiological Sciences (NIAS) and Syngenta announced that they signed an agreement to share the Syngenta rice genome draft sequence data with the IRGSP. The Syngenta draft rice genome sequence, developed by the Torrey Mesa Research Institute (TMRI), was developed using the whole genome shotgun sequencing method and used the Nipponbare cultivar of *Oryza sativa*. In October, 2002, a poll of all active members indicated that they had secured or have been assured of funding to complete finished quality sequence for their assigned chromosomal regions. In December, 2002, the IRGSP announced the completion of the 10X coverage of the genome. On this date, about 36% of the genome was completed with finished quality sequence and the remainder was phase 2 quality. ["Finished" sequence means that every base pair has been determined with an accuracy of 99.99 percent. "Phase 2" sequence means that the orientation and order of all of the pieces are known]. A ceremony was planned for December 18 in Tokyo and Washington DC to announce and celebrate the achievement of an advanced high quality rice genome sequence. The IRGSP is on track to produce a finished quality sequence by the end of 2004.

Alignment of portfolio with current science: The USRGSP is aligned with the IWG 5 year plan to participate in an international effort to sequence the rice genome with Japan and other countries in 1999. The completion of an "advanced draft" sequence in 2002 was aided by data from two private companies, Monsanto and Syngenta. Along with fruitful international collaboration, the partnership between public plant researchers and private researchers will produce a "finished" rice genome sequence by 2004, four years ahead of schedule. In the meantime, the "draft" sequence is providing valuable information for researchers studying rice and other cereals and, through genomics technology and plant breeding will lead to improvements in crop productivity and quality.

Methodological rigor: The USRGSP is the result of competitively peer-reviewed proposals and joint funding by CSREES, NSF and DOE. The agencies provided additional funding for peer-reviewed proposals in 2002 and 2003 to "finish" the sequence. The US laboratories collaborate and coordinate their activities and progress via a Scientific Advisory Committee that provides recommendations to the funding agencies regarding accomplishment of goals and objectives. The USRG consortia publish their research findings in peer-reviewed journals.

EXAMPLE 2 – WHEAT

Significance of findings and outputs: Research in public laboratories over the past decade has resulted in the development of molecular markers, or tags, for many genes of interest which can be used in Marker-Assisted Selection (MAS) strategies for cultivar development in wheat breeding. However there are limited sources of funding to help bridge the gap between basic laboratory discoveries and the development of varieties for farmers. Public sector wheat breeders in the US recognized the need for such a program, and were able to obtain funding for the project from the CSREES IFAFS competitive grants program in 2001. The wheat MAS project includes wheat molecular geneticists and breeders from 12 public programs across the

USA. Molecular markers are available for more than 50 favorable alleles including genes for resistance to fungal pathogens, insects and viruses. In addition, numerous genes and markers are available to manipulate quality parameters. Most of these markers have been developed by US scientists participating in the MAS wheat project. The project activities have resulted in seven scientific publications and 23 presentations in growers meetings, field days and symposium that have contributed to improve the public understanding of the benefits of biotechnology.
Stakeholder assessment: Integration of genomics into practical wheat improvement programs is a high priority for the National Wheat Improvement Committee and the National Association of Wheat Growers. As the MAS wheat project comes to completion, it is timely for stakeholders to analyze the results achieved to date and to discuss future directions and opportunities. To accomplish this goal, CSREES sponsored a workshop that brought together 26 public wheat breeders from 25 different states, 6 representatives from USDA ARS regional genotyping laboratories, nine representatives from the milling and baking industry, and 19 wheat researchers and private wheat breeders. An outcome of the workshop was the exchange of information and ideas among growers, end-users, wheat breeders, geneticists and genome scientists to establish new research and implementation priorities for a MAS wheat project.
Alignment of portfolio with current science: The MAS wheat project complements CSREES goals for a safe, secure and more nutritious food supply and world food security through genomics; the CSREES competitive programs issue area on genomics and future food and fiber production; the 5 year plan of the IWG on Plant Genomes; extends the groundwork established by the research community to implement knowledge and tools generated by genomics research into practical crop improvement programs and; facilitates the implementation and integration of the numerous USDA-ARS and University projects that are currently developing molecular markers for new traits in wheat.
Methodological rigor: The MAS wheat project was competitively peer-reviewed for funding. Results are published in peer reviewed journals.

EXAMPLE 3 – POTATOES

Significance of findings and outputs: A rough average of 100 papers, 30 abstracts, and 2 theses each year report the use of *Solanum* germplasm from NRSP-6. This includes publications from the current NRI potato linkage mapping project, and publications by researchers in other countries who use NRSP-6 germplasm. Significance of the findings and output of potato research from CSREES-administered finding is demonstrated by varieties released—four varieties in 2002 and nine in 2003—and their farm impact. New red skinned potatoes developed by this group are replacing Red LaSoda, the standard U.S. red potato variety for over 40 years. Most potato acreage in the Southwest is planted to varieties from this grant. Texas summer potato yields have doubled. The North Central programs have released 5 of the top 10 potato varieties in the USA. In the Northwest, 100,000 acres are planted to recent regional potato releases; economic research found that varieties from this research have returned thirty-nine dollars for every dollar invested.
Stakeholder assessment: CSREES-administered potato special grant work is reviewed each year by the research subcommittee of the National Potato Council, a farmer organization. A farmer will participate in the five-member panel that will conduct an external review of NRSP-6 in June 2004. Potato farmer stakeholders are concerned about increasingly difficult demands made on them by consumers and processors on the one hand and regulators on the other, but, absent

market acceptance, they cannot currently use potential solutions based on transgenic varieties. They are consequently very keen on productive classical potato breeding programs. Both farmer and researcher stakeholders feel that "the limited funding available in the Special Grants for Potato Research should be focused on applied potato breeding … It should be used to maintain the infrastructure that will benefit growers in the short-term. This infrastructure will be needed to evaluate and develop the products of molecular-based improvement programs." (from a reply to reviewer comments on 2003 proposals).

Alignment of portfolio with current science: With the exception of a few programs such as Cornell, because of the restricted funding mechanisms for integrating genomics with potato breeding (Hatch funds are the only present CSREES funding mechanism that could used; depends on AES allocation decisions), the potato portfolio is not as aligned as it could be with respect to current science. PDs have requested that CSREES expand the funding available to the special grant in order to expand the use of molecular tools for potato breeding, but CREEES does not determine special grants, or their funding levels. "There is tremendous scope for making potato breeding more efficient by identifying the genes that control various traits, and then developing markers to track the genes …" (from a reply to reviewer comments on 2003 proposals).

Methodological rigor: Potato proposals are examined by peer review panels in both NRI and the Potato Special Grant. Genetic resources research in NRSP 6 is reviewed for rigor by both ARS (2003 "OSCAR" review) and CSREES (2004) external review panels.

PERFORMANCE

PORTFOLIO PRODUCTIVITY
Appropriate productivity outputs for PAs 201 and 202 include: genetic and/or physical maps; genomic tools and resources; identified and characterized genes; technologies for mapping, cloning, sequencing, and bioinformatics; databases and bioinformatics implementation methods; techniques for applying genomics resources to plant breeding, and their implementation; **d**iscovered, acquired, preserved, characterized or developed plant germplasm resources; increased efficiency in characterizing and developing plant germplasm resources; enriched gene pools; and introgression of genes into breeding lines. These outputs are assessed through annual reports, publications, and presentations at meetings.

PORTFOLIO COMPLETENESS
NPL assessment of research-education-extension integration, from creating knowledge to using knowledge to benefit U.S. citizens, and maintaining the knowledge/research infrastructure. External strategic plans, such state Plans of Work and the IWG five –year plan.

PORTFOLIO TIMELINESS
Submission of annual and termination reports; completion of project milestones.

AGENCY GUIDANCE RELEVANT TO PORTFOLIO
Forms of agency guidance include Requests for Applications (RFAs), in reviewer comments on proposals received, in grant writing workshops, and in CSREES reviews of programs and departments. Individual NPLs respond to questions about CSREES programs.

PORTFOLIO ACCOUNTABILITY
Accountability is ensured differently in different CSREES-administered programs. NRI and other competitive programs ensure accountability by the competitive process itself: grantees that do not deliver are less likely to receive future grants. Hatch project accountability is monitored at the AES level, and through state annual reports and AREERA plans of work. Special grant accountability mechanisms are highly variable.

EXAMPLES:
The five criteria: portfolio productivity, portfolio completeness, portfolio timeliness, agency guidance relevant to portfolio, and portfolio accountability, are illustrated by three crops with contrasting situations: rice, wheat and potatoes.

EXAMPLE 1 – RICE

<u>Portfolio productivity</u>: The draft sequence of rice provided early access to the genes in rice as well as their position along the 12 rice chromosomes. It also incorporated sequence data from two privately held data sets from Monsanto and Syngenta and therefore represents the highest quality sequence of rice to date. Cereals such as wheat, barley, oats, corn, and sorghum will benefit from the decoding of the rice genome, by associating sequence information to increase our knowledge of disease resistance, nutrition, response to inhospitable environments, quality,

and other agriculturally important traits. The rice sequence is publicly accessible through Genbank for anyone to use. The funding agencies have provided support for a comparative cereal genome database to translate knowledge in rice into practical solutions for cereal crops. The USRGSP report their results to the broader community at the annual Plant and Animal genome meetings, stakeholder workshops, IRGSP technical meetings, and peer reviewed journals.

Portfolio completeness: The USRGSP are focused in 2004 on generating "finished" quality sequence by filling gaps in the genomic sequence, increasing accuracy of the sequence data to no more than one error per 10,000 bases and, annotation. All sequence data are deposited in a central repository and available for public use. Access to genes of this major agricultural crop provides an immediate resource for engineering the quantity and quality of rice production. By completing the decoding of the rice genome sequence, it is expected that elucidating rice gene functions will be facilitated, and contribute greatly to secure a sustainable worldwide food production.

Portfolio timeliness: The USRGSP was originally expected to finish by 2008 but with international cooperation and funding the project is on track to be completed this year, 4 years ahead of schedule. With access to the rice genome, scientists now have new tools available for exploiting the capability of plants. Also of great importance is that rice is a major food source for most of the world's population and its genomic sequence could be used to improve nutritional quality and to maximize productivity in a cost effective and efficient manner.

Agency guidance relevant to portfolio: CSREES is a member of the IWG on plant genomes. The IWG is co-chaired by the Undersecretary for REE and the Assistant Director of NSF. The IWG published a 5 year plan (1998-2003) in 1998 that recommended increased Federal investment on plant genome research. The IWG currently consists of representatives from USDA, NSF, NIH, DOE, USAID, OSTP and OMB. The IWG published a new 5 year plan (2003-2008) in 2003 that included a goal to finish the rice genome. The IWG solicited and received input from many sources in the development of its 5 year plans that included recommendations from the National Academy of Sciences and a variety of stakeholder workshops including scientists, growers, producers and the public to identify future scientific opportunities and challenges for the National Plant Genome Initiative (NPGI). The plan is used by each of the participating agencies to establish priorities and initiate new activities consistent with the mission of each agency and with the overall goals of the NPGI. CSREES provides key leadership to accomplish NPGI goals through coordinated interagency funding opportunities and workshops.

Portfolio accountability: The IWG publishes annual reports documenting continued progress in plant genomics research from competitively funded projects and examples of new projects that promise to advance the field in the coming years. In regards to the rice genome project, a scientific advisory committee reviews progress with project directors annually and makes recommendations to CSREES regarding project goals and objectives.

EXAMPLE 2 – WHEAT

Portfolio productivity: The public sector plays a critical role in wheat breeding in the US. More than 60% of the current US wheat varieties were developed by the public sector. During the last 2 years the consortium has introduced valuable alleles using MAS into the best 100 lines from the different growing regions and all market classes. These parental lines can now be used to

deploy these valuable alleles into a wider section of the germplasm using a high-throughput MAS approach. The project has empowered breeders to accelerate the transfer of valuable genes into public cultivars using modern molecular technologies, thus transferring the value of genomics research to the field.
Portfolio completeness: Additional markers are still required for complex traits and for durable resistance to pathogens and pests. Expanding the wheat genotyping database to include information about the molecular markers currently used in the different breeding programs as well as pedigree information, polymorphism information, map positions, common alleles, and a photograph of a representative gel for commonly used markers.
Portfolio timeliness: The molecular marker information is publicly available and therefore, competitiveness is not determined by access to the information but by the speed and efficiency of the implementation of the technology in the breeding program. Implementing MAS in US public wheat breeding programs and improving the throughput capacity of genotyping laboratories are high priorities. The portfolio is consistent with CSREES goals and the IWG 5 year plan for translational genomics.
Agency guidance relevant to portfolio: There is a general consensus that implementing MAS in the public wheat breeding programs will have a positive impact on wheat improvement in the US. The continuation of the MAS wheat consortium will enable US public breeders to accelerate the development of improved varieties that are essential to maintain the competitiveness of US wheat, and the vitality of rural areas.
Portfolio accountability: The MAS wheat consortium has provided proof of concept of the immediate benefits obtained by dedicating a significant proportion of resources to the implementation of available markers. The project has completed the incorporation of valuable alleles in 53 lines that are currently under field testing for potential variety releases. A synergistic collaboration between the USDA ARS genotyping laboratories, the MAS wheat consortium, and additional public wheat breeders is essential to develop a successful innovation system for the use of genomic tools in wheat breeding. The MAS project could benefit from stakeholder advisory committee.

EXAMPLE 3 – POTATOES

Portfolio productivity: The NRI project has produced a linkage map of loci associated with late blight resistance and identified two strong QTLs. NRSP 6, the multistate Hatch project, has added 13 to 145 new accessions each year (1998-2002) to the national potato germplasm collection, mostly from collecting in South and Central America and the southwestern USA, also by exchange, especially with Russia and Poland. NRSP 6 distributes between 3000 and 8000 accessions per year to users. It conducts research for efficient genebank management including taxonomic studies for accurate classification, methods of retaining vulnerable (rare) alleles; and propagation of difficult wild species. The project annually screens germplasm for important traits including late blight resistance (at sites in the USA, Canada, and Mexico), frost hardiness, tuber calcium, antioxidant content, glycoalkaloid content, and apomixis. It has developed the Intergenebank Potato Database with Peruvian, Argentine, and European potato genebanks. The Potato Special Research Grant has developed information on the genetics and stability of antioxidant and Vitamin C content in potatoes, the affect of genotype vs. environment on acrylamide formation, and inheritance and physiology of resistance to cold sweetening and internal heat necrosis. It has identified new sources of resistance to golden nematode, insect, late blight, early blight, early-dying syndrome, verticillium wilt, virus, and scab, and durable multigenic resistance to all three regionally-present strains of potato virus Y; and new flesh color, skin color, and processing traits--such as two wild potato species with good chipping quality from cold storage. *Solanum etuberosum, S. tuberosum sbp. andigena, S. phureja, S. bulbocastanum, S. hougasii,* and *S. hjertingii* are being used in crosses. The special grant has also developed planting methods for growers to provide desired tuber sizes for specialty small, new, baby and salad potatoes.

Portfolio completeness: The potato portfolio is incomplete. There is a gap between what could be done with results of research such as NSF and NRI funded projects in PAs 206 and 201; and applied capacity in PAs 202, 203-204, and 211-214. Presently, Hatch funds are the only CSREES-administered funds that can be used to bridge this gap. Some state administrators do use Hatch funds for this purpose: there are 20 Hatch projects in PA 201, e.g. "Molecular Mapping Tools for Potato"; Lorenzen, J. H. (Univ of Idaho); "Golden Nematode Resistant Chipping and Tablestock Varieties to Meet the Evolving Needs of the NY Potato Industry" (includes marker-assisted selection) Halseth, D. E. , Brodie, B. B. , DeJong, W. S. , and Perry, K. L. (Cornell University). However, it is not clear how much funding is actually reaching potato breeding through these projects. Moreover, since 1980 , Hatch funds have not kept up with cost increases. Consequently, these performance indicators are lagging:

- Implementation of genome technologies for plant breeding.
- Increase in genomic tools and resources developed.

Portfolio timeliness: Hatch projects and NRSP6 annual reports are up to date. The NRI project has a final-year extension to prepare publications.

Agency guidance relevant to portfolio: The agency has been increasingly active in providing guidance to potato special grant applicants. The RFA has been refined to foster participation of additional states, enhanced regional cooperation, and demonstration of stakeholder involvement. The review process has been made more rigorous, with input from peers and leaders in genetics and breeding of potatoes (when there is no disqualifying conflict of interest) and other crops. Comments from the review panels have impacted both research planning and proposal drafting. For example, state by state accountability is more explicit; more researchers are exploring early generation selection methods; and researchers are becoming more explicit about how genetic progress toward important breeding goals is monitored and how diversity is maintained in advanced selections.

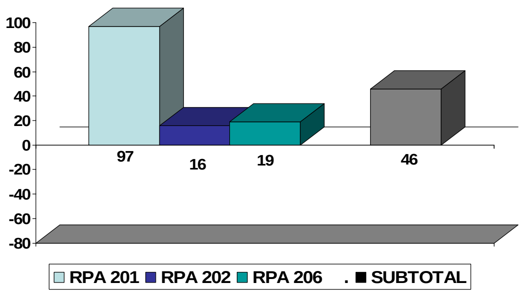
Portfolio accountability: CSREES-administered potato special grant projects are reviewed by two panels each year, a scientific peer panel and a producer panel. Funds are released only to projects that satisfy both panels as to relevance, quality and performance. NRSP 6 is reviewed by ARS (2003 "OSCAR" review) and CSREES (2004) external review panels.

Plant Science Funding Trends

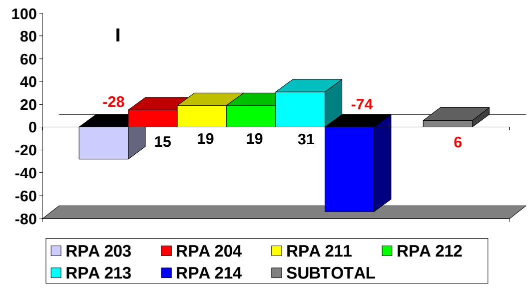
Expenditures of CSREES-administered funds

Changes from 1998 to 2002

Increases in basic research



Decreases in applied research



- Total funding increase, all plant science areas: 21%
- Scientist salary increase 14% in same interval
- Increase in applied research of 6% does not keep up with salary increases needed to perform the work
- **Applied research bottleneck imminent**

Figure 10.1 – Selected funding trends from FY 1998-2002

SECTION ELEVEN: PROBLEM AREA 203 – BIOLOGICAL EFFICIENCY AND ABIOTIC STRESSES AFFECTING PLANTS

Plant-based agriculture faces short-term challenges such as flooding and long-term challenges such as global climate change and loss of arable land. The need for hardy, stress-tolerant and high-yielding crops grows as the earth's population increases. Thus, research is needed to develop agriculturally-important plants with optimized biological yield and increased tolerance to environmental stresses. This need is broadly recognized by the agricultural and scientific communities. The "National Academies of Science on Transgenic Plants and World Agriculture" report noted that "Achieving the minimum necessary growth in total production of global staple crops…without further increasing land under cultivation will require substantial increases in yields per acre." In a 1982 Science article Dr. John S. Boyer stated "An analysis of major U.S. crops shows that there is a large genetic potential for yield that is unrealized because of the need for better adaptation of the plants to the environments in which they are grown. Evidence from native populations suggests that high productivity can occur in these environments and that opportunities for improving production in unfavorable environments are substantial. Genotypic selection for adaptation to such environments has already played an important role in agriculture, but the fundamental mechanisms are poorly understood." The Council for Agricultural Science and Technology has stated that "through genetic alteration of crops and animals, it now is possible, and will become ever more commonplace, to increase food and fiber production and improve food nutritional properties while limiting environmental stress."

The Problem Area (PA) 203 addresses basic and applied research on plant biological efficiency and abiotic stresses affecting plant productivity and growth. The goal of research in this area is a better understanding, targeted towards improvement, of plant productivity, quality, and response to reduced inputs, such as water or fertilizer, or to abiotic stresses such as drought, temperature extremes, and nutrient availability. The findings and outcomes of CSREES-supported research can lead to crops with improved drought, salinity, and flooding tolerance, with increased productivity in nutrient-poor soils, and with improved yield under broader temperature ranges or under temperature stress. Drought and salinity stress are increasing agronomical problems in the arid midwest and western growing areas. Although irrigated land tends to be significantly more productive than rain-fed land, long-term irrigation inevitably increases salinity. Plants with increased salinity tolerance will maintain productivity on irrigated land while plants with increased drought tolerance can reduce the need for irrigation. Plants with increased biological efficiency will minimize fertilizer input and allow sufficient quantities of food, feed, and fiber to be grown on less land. Thus, land is available for other purposes, and forests and wilderness are not converted to cropland. CSREES-supported research is also leading to improved propagation and cultivation techniques for applied projects and serving as the basis for small businesses. These outcomes will allow agricultural sustainability and environmental protection not only for the U.S. but also for the world.

An example of the timeliness and impact of CSREES support and funding is the sponsoring of a major symposium on plant proteomics at the 2002 Plant Biology meeting, the annual meeting of the American Society of Plant Biologists. The symposium, entitled "High Throughput Plant Biology in the Post-Genomics Era," was funded through a CSREES Innovation grant and brought together scientists developing and using cutting-edge, powerful technologies in proteomics and metabolomics. The symposium gave meeting attendees a broad view of the uses and challenges of this technology for determining the function of genes and for improving our understanding of fundamental biological processes."

Current Directions and Emerging Issues

Research on plant biological efficiency and abiotic stresses affecting plants utilizes contemporary, cutting-edge approaches as well as more conventional technology. These approaches and disciplines include genomics, bioinformatics, proteomics, plant genetics, molecular biology, metabolic engineering, physiology, biochemistry, plant breeding, ecophysiology, cell biology, and developmental biology. The combination of disciplines and techniques in many CSREES-funded projects allows researchers to develop a complete picture of how plants respond to abiotic stress and how biological efficiency is controlled and affected by stress. This knowledge is then used to engineer new pathways or to guide plant breeding programs for improved abiotic stress tolerance or increased biological efficiency in crop plants. The studies are also leading to improvements in plant yields in natural and controlled environment cultivation systems. The goal is to move the plant research from the fundamental biochemical and cellular levels to the applied, whole-plant, and population levels.

An emerging issue for PA 203 is the use and application of genomics and genetic engineering for improvement of agricultural plant varieties. When compared to conventional genetic breeding, genomic approaches typically can lead to more directed, precise, and rapid development of plant varieties with improved abiotic stress tolerance and optimized yield (conversion of input to output) under both hospitable and inhospitable environmental conditions. More and more, CSREES-supported projects are making use of biotechnology to improve environmental stress tolerance and productivity of agronomic and horticultural crops, moving knowledge gained from basic research to the producer and consumer.

Another issue is transfer of scientific knowledge from studies of model species to studies and improvement of agriculturally important species. The completely-sequenced genomes of the model plant *Arabidopsis thaliana* and the model cereal rice can serve as a guide for research in other agricultural plants (crop plants, horticultural plants, trees, etc). The challenge is to use powerful genomic approaches, and the resulting knowledge, to create opportunities for plant improvement in both the laboratory and the field, benefiting increased sustainability of both agriculture and the environment.

Two areas in tracking of project results need consideration: (1) the education component of the projects (number of graduate students and postdoctoral researchers trained) and (2) the long-term tracking of the effects and impacts of the research. In the first instance, the database does not record the number of students or postdoctoral researchers involved in a project. The future of agricultural research and productivity requires continued training and support of tomorrow's scientists. Regarding long-term tracking of research results, currently once a project is terminated, publications and impacts are no longer tracked in the database. As many of the projects provide fundamental knowledge, the use and impacts of the research may not be felt for many years. Thus, a method needs to be developed for long term tracking of the impacts of CSREES-supported research.

Funding

In FY 1998, CSREES awarded approximately $17.8 million for PA 203, research on plant biological efficiency and abiotic stresses affecting plants. The majority of CSREES funding was administered through Formula funds (Hatch $9.762 million, 54.8%), competitive grants (NRI $4.54 million, 25.5%), and special research grants ($1.89 million, 10.6%). The projects funded through these various mechanisms are complementary and allow a broad approach to specific research areas. The funding equates to approximately 15.5 % of the total public investment (federal, state, and other) and approximately 25.8% of the total CSREES investment in the Plant Production Problem Area (PA 201-206). The majority of the CSREES funding in PA 203 supported grain crop research (2.796 million, 15.6%) and unspecified, general plant research ($2.809 million, 15.7%). Smaller amounts of funding supported research on vegetables ($2.289 million, 12.8%), pasture and forage crops ($1.632 million, 9.2%), deciduous and small fruits ($1.623 million, 9.1%), ornamentals and turf plants ($1.492 million, 8.4%), and oilseed and oil crops (1.199 million, 6.7%).

In FY 2002, CSREES awarded approximately $14.1 million for PA 203. This amount equates to approximately 14.5 % of the total public investment (federal, state, and other) and approximately 16% of the total CSREES investment in Plant Production. As in 1998, he largest part of FY 2002 CSREES funding in PA 203 was administered through Formula funds (Hatch $6.628 million, 46.8%), competitive grants (NRI $3.419 million, 24.1%), and special research grants ($2.195 million, 15.5%). The majority of the CSREES funding in PA 203 supported deciduous and small fruits (2.362 million, 16.7%) research and unspecified, general plant research ($3.083 million, 21.7%). Lesser amounts supported research on vegetables ($1.436 million, 10.1%), pasture and forage crops ($0.855 million, 6%), grain crops (1.7 million, 11.9%), ornamentals and turf plants (0.910 million, 6.4%), and oilseed and oil crops (0.848 million, 6%).

Overall funding in the Plant Production area increased from $69.011 million in 1998 to $89.462 million in 2002. This change equates to an increase of 29.6% (or 17.4% when inflation is considered). Funding in PA 203, however, decreased from $17.8 million in 1998 to $14.16 million in 2002. This decrease in FY 2002 may reflect the increased emphasis on plant genomics. Funding in PA 203 through Hatch and the NRI dropped from $9.762 and $4.54 respectively in FY 1998 to $6.628 and $3.419 in FY 2002. Funding through special research grants, however, increased from $1.89 million in FY 1998 to $2.195 million in FY 2002. The seven major research subjects were the same from 1998 to 2002 although the order in terms of funding changed. General plant research received the largest amount of funding in PA 203 in both FY 1998 and 2002. Deciduous and small fruits research received the second largest amount of funding in 2002 but was the fifth largest in 1998. Grain crops received the second largest amount of funding in 1998 but dropped to the third largest in 2002. Oilseed and oil crop research ranked seventh in terms of funding in PA 203 in both FY 1998 and FY 2002.

Performance Criteria and Indicators

The objective of CSREES leadership and funding is to acquire knowledge and to increase understanding of plant productivity, quality, and response to reduced inputs (water, fertilizer) or abiotic stresses (such as water, temperature, salinity or nutrient availability). The long-term impact of this leadership and funding will be optimized plant productivity and quality under different environmental conditions.

The three performance indicators for PA 203 range from obtaining fundamental scientific knowledge to using that knowledge to improve agricultural sustainability. The specific indicators are:

(1) Identify and characterize biological mechanisms that affect plant growth, survival, and yield (actual or potential) and response to environmental conditions or stresses including water availability and water stress (drought, flooding, salinity), nutrient availability or stress, and temperature stress (heat, cold).

(2) Develop new and optimized breeding technology (including genetic engineering) for producing biologically efficient or stress tolerant crop plants.

(3) Develop new and optimize existing cultural practices to improve plant biological efficiency or stress tolerance.

Accomplishments

Research projects supported in PA 203 are wide-spread geographically as illustrated below. The projects focus primarily on PA 203 although some reseach overlaps with PA 206, etc. The projects describe below show that CSREES supported efforts are leading to a better understanding of:

DROUGHT/SALINITY STRESS:

1. A CSREES-funded project in New York addressed the effects of water deficit on early kernel development in maize. In maize, water deficits during pollination and grain (kernel) formation cause severe losses in crop productivity. Research focused on the cellular and physiological bases for changes in cell division in plants subjected to water stress during reproductive development. The outcomes of the research included microarray analysis of gene expression and characterization of the roles of abscissic acid and sugars in kernel set and response to water stress. The project increased our understanding of the biological and

molecular mechanisms underlying kernel abortion under drought conditions and produced at least 6 publications in the 1998-2002 period. The results can be applied through genetic engineering and/or breeding to improve the performance of grain crops during water deficit. The long term impact would be increased stability of plant productivity and yield with respect to water stress and different environmental conditions. (CRIS accession numbers 0168512 and 0185731, NRI)

2. A project in Kansas addressed water requirements and drought tolerance of various turfgrass species under field conditions. Research focused on characterization of physiological and metabolic mechanisms associated with tolerance to drought and water stress. At least 17 publications resulted from this project from 1998-2002. The long term impact of this study is more effective water use through proper selection of turfgrass species. The knowledge from this study also could be combined with molecular and genetic information to direct breeding studies for more drought-tolerant turfgrass varieties. (CRIS accession 0174913, Hatch)

3. CSREES-funded research in Florida led to identification and characterization of genes and enzymes involved in glycine betaine synthesis. Some plants synthesize and accumulate the osmoprotectant glycine betaine which helps protect the plant from damage due to drought or salinity. Many crop plants, however, lack glycine betaine. The goal is to genetically-engineer the ability to produce glycine betaine into crop and horticultural plants that lack the pathway. This research identified components needed for engineering the pathway and developed methods to overcome metabolic constraints. Funding for this project from 1998 to 2002 produced at least 5 scientific publications and 1 patent application. The long term impact of the research can be production of crop and horticultural crop plants with increased drought and salinity tolerance. (CRIS accession numbers 0188742 0179015, 0168586, NRI and 0168151 Hatch)

NUTRIENT STRESS AND UPTAKE:

1. A CSREES-supported study in Michigan characterized enzymes and physiology involved in plant nitrogen metabolism, focusing on the enzyme urease. Enzymes in the soil such as urease help break down the nitrogen-containing compound urea so that the nitrogen can be used by the plant. Urea is often used in fertilizers; however, urease inhibitors are necessary to control urease activity and reduce the problems associated with fertilizer use (alkaline soils and elevated ammonia). The outcomes of this CSREES-funded research include improved understanding of the molecular and cellular mechanisms of urease activity and inhibition, and the results were the basis for at least 6 publications. The long term impact can be the development of new, more effective urease inhibitors for optimized fertilizer efficiency and increased rate of nitrogen uptake by plants. (CRIS accession number 0179467; NRI Highlight 1999)

2. A research project in Minnesota examined phosphorus stress in plants. Phosphorus is an important nutrient required for plant growth and development, but it is frequently deficient in the soil. Genes involved in adaptation of plants to phosphorus deficiency were identified and characterized in white lupin, a grain legume. The project resulted in at least 6 publications and several abstracts from 1998-2002. The outcome of the research was a better understanding of genes important for phosphorus stress tolerance. The long term impact of the study can be development of ways to improve how plants absorb and use phosphorus, reducing need for phosphorus fertilizer. (CRIS accession number 0179058, NRI)

3. A project in North Carolina examined the nitrogen uptake in phosphorus stressed plants and provided an increased understanding of how phosphorus stress inhibits nitrate transport and

assimilation. This project also analyzed the physiological mechanisms of aluminum tolerance and toxicity in soybean. Results were presented in over 20 publications from 1998-2002. A better understanding of the physiological processes involved in nitrogen uptake and in aluminum tolerance can be used to guide molecular and genetic research in this area. The long term impact can be development of plants with improved tolerance to phosphorus and aluminum stress. (CRIS accession number 0172692, Hatch)

TEMPERATURE STRESS:

1. A CSREES-supported multistate research project (W-130) provided insights on mechanisms used by horticultural plants to acclimate to cold and to tolerate freezing injury. Freezing of water in plant tissues affects survival, productivity, and growing range of plants. Losses due to freezing are a common problem in the horticulture industry. The goals of this multistate project are: (1) to understand how freezing injures plants, (2) to determine modifications to cultural practices that reduce susceptibility to freezing, and (3) to identify ways to select and develop horticultural plants with improved tolerance to freezing. The outcomes of this research are characterization of (1) gene expression associated with freeze tolerance and winter survival, (2) factors, such as physical barriers, influencing ice nucleation and ice propagation, (3) factors, such as genotypes and soluble sugar content, influencing cold acclimation and winter survival. Results from this project are presented in numerous publications. The long term impact can be application of new methods and technologies for low temperature acclimation and freezing protection and development of freeze-tolerant/cold hardy horticultural plants through genetic engineering and/or conventional breeding. (Multistate project no. W130; CRIS accession numbers 0181484, 0181358, 0181080, Hatch)
2. A CSREES-supported project in California examined the effects of chilling and heat tolerance on flowering. Warm season crop plants, such as cowpea and cotton, can be damaged by cold temperatures during emergence and high temperatures during reproductive development. The study characterized a gene involved in tolerance to chilling and heat and developed more efficient methods for breeding warm-season annual crops. At least 6 publications resulted from this research. The long term impact is development of crops with optimized, more stable productivity in subtropical zones. (CRIS accession number 0179750. NRI)
3. A project in Florida addressed the function of heat shock proteins under stressful and non-stressful environmental conditions. Heat shock proteins are known to protect and repair the plant cell from heat damage. This study suggested that heat shock proteins play roles not only in response to heat but also to cold shock, in seed maturation, and in response to pathogens. Most crop growing regions are subject to temperature extremes causing heat or cold stress to the crop plant and resulting in significant economic losses in productivity. The data from the project have resulted in 6 scientific publications as of September 2003. Thus, the long term impact may be development of crop varieties with improved tolerance to temperature extremes and pathogen attack. (CRIS accession number 0185423, NRI)

BIOLOGICAL EFFICIENCY (PHOTOSYNTHESIS):

1. Photosynthesis, the conversion of sunlight into biomass, is a major determinant in plant productivity. Environmental factors influence plant photosynthesis and thus affect yields of food and fiber products. The rate of increase of agricultural productivity is declining, and new approaches are needed to increase productivity for both future global needs and enhanced

competitiveness of U.S. agriculture. A CSREES-supported multistate project (NC-142) is a cooperative, integrated research program to acquire fundamental knowledge of the regulation of photosynthetic enzymes and the effects of environmental (nitrogen, temperature, salt, drought, CO_2) and developmental signals on photosynthesis. Data from this project are presented in numerous publications. The outcomes of this research include detailed characterization of the genes, enzymes, and molecular regulatory mechanisms involved in photosynthetic efficiency. This knowledge can then be used to improve crop plants through molecular genetics and classical breeding. Thus, the long term impact will be development of crop plants with increased photosynthetic capacity and corresponding increased productivity. (Multistate project number NC-142, new number NC-1142, CRIS accession numbers 0176997, 0176844, 0167474, Hatch)

MULTIPLE STRESSES FOR COMMERCIAL APPLICATIONS:

1. A project in Washington explored the effects of environmental conditions for accelerating wheat breeding. The goals of the study were the development of an efficient artificial culture system for wheat breeding and an increased understanding of mechanisms that trigger microspore embryogenesis. Environmental factors of nutrient stress, temperature shock, and chemical exposure were tested for ability to induce androgenesis in wheat microspores. The technologies developed in this study resulted in at least 1 patent application and in licensing of marketing rights. (CRIS accession number 0176235, SBIR)

Focus	CRIS accession number	%PA 203	Other PA	Subject
Drought/salinity	0168512 0185731	50% 100%	206 (50%)	Corn Corn
Drought/salinity	0174913	100%		Turf
Drought/salinity	0188742 0179015 0168586 0168151	100%	 206* 206* 206*	Greens, leafy vegetables (10%), fungi (10%), tobacco (80%) Plant research, general Plant research, general Citrus (50%), plant research general (50%)
Nutrient	0179467	50%	102 (50%)	Bacteria
Nutrient	0172692	50%	206 (50%)	Cross commodity - multiple crops
Nutrient	0179058	100%		Plant research, general
Temperature**	0181484 0181358 0181080	50% 100% 40%	205 (50%) 132 (60%)	Cherry (20%), grapes (40%), peach (20%), miscellaneous/new crops (20%) Grapes (70%), apple (20%), raspberry (10%) Citrus
Temperature	0179750	100%		Beans (dry)
Temperature	0185423	100%		Noncrop plant research
Biological efficiency**	0176997 0176844 0167474	100% 100% 60%	102 (50%)	Cross-commodity – multiple crops Corn Tropical forests (40%), tropical/subtropical fruits (60%)
Multiple stresses	0176235	100%		Wheat, general

Table 11.1 – Additional Information for PA 203 Examples

* Projects appear to be misclassified and should be a 50/50 effort towards 203 and 206 because they clearly address plant stress tolerance as mentioned in their titles. These earlier grants also provide the basic knowledge needed for completion of the project.

SECTION TWELVE: PROBLEM AREA 204 – PLANT PRODUCT QUALITY AND UTILITY (PRE-HARVEST)

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

Relevance

SCOPE

In 1998, CSREES invested a total of $7,336,000 in PA 204. Of this total, 47 % came from Hatch funds, 7 % from Evans-Allen funds and 21 % from Special Research Grants (SRG). Together, these three non-competitive sources of funding accounted for 75 % of all funds allocated to PA 204. The National Research Initiative (NRI) invested $1,477,000 in programs dedicated to PA 204, which equates to 20 % of the total. These four funding sources therefore accounted for 95 % of the CSREES funding invested in PA 204. The CSREES investment in PA 204 in 1998 represented 12 % of the total funds invested in PA 204 and 2 % of the total investment in all of plant production. The breakdown of funding by commodity area is presented in table PA204-1.

Description of SOI	Hatch	%	Evn-Allen	%	SRG	%	NRI	%	SBIR	%	Oth Grnt	%	CSREES TOTAL
VEGETABLES	181	14.6%	21	1.7%	473	38.3%	561	45.4%	0	0.0%	0	0.0%	1,236
GRAIN CROPS	498	44.3%	0	0.0%	321	28.5%	306	27.2%	0	0.0%	0	0.0%	1,125
ORNAMENTALS & TURF	777	74.8%	77	7.4%	89	8.6%	0	0.0%	65	6.3%	31	3.0%	1,039
DECID. & SMALL FRUIT	593	66.0%	133	14.8%	172	19.1%	0	0.0%	0	0.0%	0	0.0%	899
OILSEED & OIL CROPS	346	44.7%	175	22.6%	51	6.6%	0	0.0%	65	8.4%	137	17.7%	774
PASTURE & FORAGE	382	62.6%	0	0.0%	58	9.5%	170	27.9%	0	0.0%	0	0.0%	610
POTATO	146	26.7%	0	0.0%	336	61.5%	0	0.0%	64	11.7%	0	0.0%	546
PLANTS, GENERAL	61	16.5%	0	0.0%	0	0.0%	310	83.8%	0	0.0%	0	0.0%	370
FIBER CROPS	88	40.4%	0	0.0%	0	0.0%	130	59.6%	0	0.0%	0	0.0%	218
Top 9 SOI	3,072	45.1%	406	6.0%	1,500	22.0%	1,477	21.7%	194	2.8%	168	2.5%	6,817
13 Other SOI	368	70.9%	78	15.0%	33	6.4%	0	0.0%	0	0.0%	40	7.7%	519
204 Total	**3,440**	**46.9%**	**484**	**6.6%**	**1,533**	**20.9%**	**1,477**	**20.1%**	**194**	**2.6%**	**208**	**2.8%**	**7,336**

Table 12.1 – Distribution of CSREES Investment in PA 204

In 2002, CSREES investment in PA 204 had been reduced to $6,782,000. Hatch funds accounted for 50 % of the total and together, non-competitive sources of funding for PA 204 accounted for 80 % of the total. NRI funding in this PA had dropped to 7 % of the total while Small Business Innovation Research (SBIR) program funding had increased to 7 %. The continued maturation of the CSREES Integrated Research, Education and Extension grant programs, such as the Initiative for Future Agricultural and Food Systems (IFAFS) and the Organic Transitions Program, also provided some funding for programs in PA 204. The CSREES investment in PA 204 in 2002 represented 13 % of the total funds invested in PA 204 and 1 % of the total investment in all of plant production. The breakdown of funding by commodity area is presented in table PA204-2.

Description of SOI	Hatch	%	McSten	%	Evn-Allen	%	SRG	%	NRI	%	SBIR	%	Oth Grnt	%	CSREES TOTAL
DECIDUOUS & SMALL FR	886	59.3%	0	0.0%	88	5.9%	504	33.7%	16	1.1%	0	0.0%	0	0.0%	1,494
GRAIN CROPS	431	40.8%	0	0.0%	0	0.0%	207	19.6%	281	26.6%	44	4.2%	94	8.9%	1,057
ORNAMENTALS & TURF	578	63.1%	0	0.0%	28	3.1%	217	23.7%	0	0.0%	0	0.0%	93	10.2%	916
PASTURE & FORAGE CRO	450	62.5%	0	0.0%	0	0.0%	171	23.8%	99	13.8%	0	0.0%	0	0.0%	720
VEGETABLES	355	53.1%	0	0.0%	123	18.4%	189	28.3%	2	0.3%	0	0.0%	0	0.0%	669
OILSEED & OIL CROPS	211	45.1%	60	12.8%	17	3.6%	27	5.8%	63	13.5%	0	0.0%	90	19.2%	468
TROPICAL/SUBTROPICAL	58	20.5%	0	0.0%	0	0.0%	225	79.5%	0	0.0%	0	0.0%	0	0.0%	283
MISC & NEW CROPS	29	10.4%	0	0.0%	44	15.7%	0	0.0%	0	0.0%	207	73.9%	0	0.0%	280
POTATO	169	64.0%	0	0.0%	0	0.0%	95	36.0%	0	0.0%	0	0.0%	0	0.0%	264
RES EQUIPMENT & METH	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	207	100.0%	0	0.0%	207
Top 10 SOI	2,911	54.7%	60	1.1%	256	4.8%	1,315	24.7%	461	8.7%	44	0.8%	277	5.2%	5,324
17 Other	449	30.8%	67	4.6%	106	7.3%	357	24.5%	22	1.5%	458	31.4%	0	0.0%	1,458
204 Total	**3,360**	49.5%	**127**	1.9%	**362**	5.3%	**1,672**	24.7%	**483**	7.1%	**502**	7.4%	**277**	4.1%	**6,782**

Table 12.2 – Distribution of CSREES Investment in PA 204

There was an 8 % reduction in CSREES funding for PA 204 between 1998 and 2002, which was actually equivalent to 21 % when adjusted for inflation. However, there was an 87 % increase in CSREES funding for the related area of Plant production Management Systems (69 % when adjusted for inflation).

FOCUS ON CRITICAL NEEDS

The globalization of trade has put pressure on the agricultural sector of the U.S. economy as U.S. markets are opened for the importation of foreign agricultural products. In order to remain competitive in this global market place, where foreign producers generally have access to a greatly less expensive labor force, U.S. producers must maintain the production of high quality plant products at the same time they reduce costs. Programs dedicated to PA 204 are a major means that CSREES has to assist growers in this effort. Over the years from 1998 to 2002, the overall budget of CSREES remained relatively stable. At the same time, the CSREES investment in PA 204 declined only slightly. The Agricultural Research, Education and Economics Reform Act of 1998 (AREERA), shifted previously formula based funds to competitively awarded funds. At the same time, funding for PA 204 shifted from 25 % of funding coming from competitive sources to 18 % of funding coming from competitive sources. This demonstrates the ability of the CSREES-land grant university partnership to respond to critical needs in the grower community by shifting the allocation of resources to areas of critical need. Although there was a decline in funding for PA 204 over the five years covered in this review, there was a larger increase in the related PA of Plant Management Systems (PA 205). This is reflective of the shift in strategy among CSREES and its partners to move away from studying single factors in trying to improve plant production and quality to a systems approach in addressing these issues.

IDENTIFICATION OF EMERGING ISSUES

CSREES is engaged in a continuous process of obtaining input from stakeholders and partners on new and emerging issues facing the agricultural community. As an example, National Program Leaders from CSREES have worked closely with the deciduous tree fruit industry to help develop a technology roadmap that identifies short-, intermediate- and long-term research and extension needs for this vital industry. The goal of this roadmap is to reduce the cost of producing the highest quality fruit by 50 % by the year 2010. National Program Leaders are currently using this model to work with the citrus industry and the grape industry to develop similar roadmaps. The long term strategy is to work individually with the various commodities that comprise horticultural crop production. Once the individual roadmaps are defined, a national workshop will be convened where the various plans can be compared and contrasted. The result of this effort will be a national strategic plan for research and Extension needs in Horticulture. This systematic approach to identifying and prioritizing research and extension needs is illustrative of the philosophy employed by CSREES to insure that its programs are answering the needs of U.S. citizens.

INTEGRATION OF CSREES PROGRAMS
It is evident from the data on funding sources that CSREES programs are being used in a comprehensive manner to address the needs identified in PA 204. The various programs are coordinated so that continuous attention is given to the research and extension needs of the agricultural community in regards to the pre-harvest quality of crop plants. This coordination assures that critical levels of funding are available from appropriate sources to meet these challenges. In addition, the shift of empasis, as reflected in the change in investment between the two, from PA 204 to PA 205 also demonstrates the way that CSREES programs are integrated to address challenges facing agriculture in an integrated coordinated fashion.

INTERDISCIPLINARY INTEGRATION
It is the very nature of PA 204 that research and extension efforts to increase pre-harvest quality and utility of crops is interdisciplinary. Whole plant physiologists, geneticists, plant breeders, soil and water scientists and others, must work jointly to increase crop quality at the organismal level. It is unlikely that this will change in the future.

Quality

PERFORMANCE CRITERIA AND INDICATORS
The objective of CSREES leadership and funding is to acquire and disseminate knowledge leading to the improvement of the pre-harvest quality of crops. This can result from an increased understanding of biological processes, from plant breeding efforts, from the development of cultural practices and from improving handling of plant propagules to insure rapid, uniform growth that results in the ability to harvest plants at the optimum growth stage.

ACCOMPLISHMENTS
Research and Extension on pre-harvest product quality and utility tends to be commodity specific. Recognizing this, the strategy chosen to identify and document impacts from CSREES investment in PA 204 is also commodity specific. A search of the CRIS system was done that

identified projects that were terminated in 2002. From these projects, representatives were chosen to illustrate the types of activities funded under this PA.

DECIDUOUS AND SMALL FRUITS:

Concord Grape Production for Optimum Yield with Minimum Cost of Production
Funding Source: Hatch
Performing Institution: Washington State Univ.
Investigator(s): Keller, M.; Spayd, S.E.

Statement of Problem: Manual pruning of concord grapes is labor intensive, expensive and can lead to high fruit production years followed by low fruit production years (alternate bearing). Wide variations in crop production from year to year is a problem for growers, juice processors and financial institutions. For growers, one of the main problems with crop yield variation is the ability to achieve desired fruit quality standards in seasons with high crop production. In addition, alternate bearing can contribute to a loss of cold hardiness and general decline in the health of the vineyard.

Approach: Evaluate the combined effects of pruning techniques and crop thinning techniques on yield and quality parameters. Use GPS to map crop removal and yield on an individual plant basis.

Results: Cumulative yields over five years indicated that mechanically pruned vines outperformed manually balanced pruning by over 45 t/ha. Fruit quality and cold hardiness were satisfactory even in relatively cold seasons. Mechanical pruning followed by crop thinning produced 23 t/ha more fruit than manual pruning with comparable fruit quality and plant cold hardiness.

Impact: Adoption of mechanical pruning, with or without crop thinning, will result in increased yield of fruit with satisfactory processing quality. This should result in lower costs of production. Since equipment operators make 3 to 4 times the wages of manual laborers, on average, mechanization should also result in a more stable workforce that will contribute to the rural prosperity of the concord grape growing area of Washington state.

GRAIN CROPS:

The Improved Marketability for Wheat Grown in the Pacific Northwest
Funding Source: Other grants
Performing Institution: University of Idaho
Investigator(s) Souza, E.J.; Stark, J.; Talbert, L.; Bruckner, P,

Statement of problem: When wheat grain is milled into flour, the protein content and quality of the grain affect the baking quality of the flour. Conditions during the growth of the crop affect the protein content and quality of the grain. Growers are faced with many management decisions that can adversely affect the protein profile of the harvested grain. Poor flour quality can adversely affect growers ability to capture foreign markets.

Approach: Farming practices used by growers were monitored for two cultivars of wheat. Samples were evaluated for end-use quality. Those practices that led to best flour quality were determined. Practices that led to highest quality were used in replicated trials with other cultivars of wheat to determine the general applicability of the management practices. The cost of the inputs were compared to the actual pricing of the wheats in the marketplace during the time of the study.

Results: It was determined that it was possible to grow wheat with both good bread quality and good Asian noodle quality. Grain with higher protein levels tended to produce noodles with poor color. Higher protein levels were a result of the cultivar selected rather than other management decisions. On farm research was used to develop enterprise budgets for hard white wheat.

Impact: As a result of this research, two hard white spring wheats, two hard white winter wheats and one soft white spring wheats have been released. All releases produce flour that is suitable for both bread and Asian noodle production. Additional releases are anticipated. These new cultivars give growers the option of selling their grain for either the domestic or export market, allowing them to maximize revenue based on market conditions. Growers can also use the enterprise budgets developed to help make management decisions.

ORNAMENTALS AND TURF:

Turfgrass Fertility Management and Environmental Impact
Funding Source: Hatch
Performing Institution University of Florida
Investigator(s) Cisar, J.L.

Statement of Problem: Improper application of fertilizers has been implicated as a as a potential sourc of nitrogen pollution in hydrologically linked watersheds. Since nutrient applications are necessary to maintain healthy turf, techniques that minimize nutrient runoff from home lawns, golf courses and sports fields are needed.

Approach: The "Florida Yard" concept has been developed to encourage the use of native plants and those well-adapted to Florida growing conditions in landscapes. A sloped (10 %) run-off facility was developed and planted to turfgrass and a Florida yard to measure both surface nitrogen and phosphorus run-off and leaching following fertilization. Lysimeters and ceramic soil cup soil-water samplers were installed on golf courses to evaluate the effect of nitrogen and phosphorus rate, application frequncy, fertilizer type and methods of application on leaching of these nutrients below the root zone of the turf. Cultural managemnet techniques, including fertilization, will be studied on athletic fields to determine practices that result in a superior playing surface.

Results: Nitrogen leaching was higher from turf grown on soil with a higher organic matter content. Nitrogen leaching increased with rate of application and was greater during the rainy season when turf was irrigated on a fixed schedule. Nitrogen leaching was greater from the "Florida Yard" landscape than from a mature St. Augustinegrass turf despite the fact that the

"Florida Yard" received no supplemental fertilization. This was probably caused by the fact that the "Florida Yard" required longer irrigation to recover from visible signs of water deficit.

Impact: Best Management Practices for turf and landscape fertilization and irrigation were developed. When followed, the guidelines will reduce nutrient run-off and leaching into fragile Florida ecosystems. This will aid in maintaining these unique ecosystems for future Floridians to enjoy.

PASTURE AND FORAGE CROPS:

Forage Protein Characterization and Utilization for Cattle

Funding Source:	Hatch (Multi-state Project NC-189)
Performing Institution:	Iowa State University
Investigator(s):	Moore, K.J.; Russell, J.R.

Statement of Problem: Protein in stored forage degrades over time, necessitating the use of protein supplements in cattle rations. This increases the cost of producing livestock and reduces profit. Livestock producers need to know which forages produce the least undegradable intake protein (UIP) and what factors lead to the formation of UIP.

Approach: A set of standard forage samples were developed for evaluation of procedures for quantifying protein fractions. Procedures evaluated included *in situ, in vitro* and enzyme assays. A comprehensive database of forage protein characteristics was developed based on samples collected throughout the North Central Region. NIRS calibrations for predicting protein fractions were developed and evaluated using samples included in the regional database. Experiments were conducted to evaluate environmental and genetic factors affecting forage protein characteristics.

Results: Five legumes were sampled at four dates over two growing seasons. There was little difference in UIP between years suggesting that the proteins comprising this fraction are relatively stable and less responsive to environment and maturity than soluble proteins. In a greenhouse study, UIP concentration spiked following freezing for red clover and crimson clover and decreased for white clover and berseem clover. UIP than decreased over time following freezing in all species. Of the legumes evaluated in these studies, red clover, birdsfoot trefoil and alfalfa produced forage with higher UIP concentration and would be preferred for use in forage-livestock systems where UIP is limiting. Stockpiling forage for autum grazing is an effective menas of extending the grazing season beyond the forage growing season. With the exception of sweetclover, all of the legumes evaluated retained their leaves during the 28 day period following a killing frost and would be suitable for grazing during this period. The legume of choice for use as a protein source for stockpiled forage will depend on the nutritional needs of the livestock and nutritional characteristics of other forages available to them.

Impact: The results of these experiments will enable producers to develop improved strategies for providing adequate protein nutrition to ruminant livestock. Growing legumes that maintain higher UIP concentrations under stockpiling conditions will reduce the need for protein supplementation and extend the grazing season. This will result in lower costs to the producer and greater profit.

VEGETABLES:

Physiological Regulation of Health-related Phytochemicals in Food and Non-food Crops

Funding Source: Hatch

Performing Institution: Texas A & M University

Investigator(s): Dunlap, J.R.

Statement of Problem: Crops contain chemicals that are beneficial for human health. Developing crops with elevated levels of these chemicals would be beneficial for human health. Understanding the crop management strategies that lead to optimum production of these health-promoting chemicals is also beneficial.

Approach: New phytochemicals with activity in humans and new commercial interests were examined to determine tissue-specific origins, hormonal signals up-regulating the biosynthetic pathway and environmental/management conditions that optimize phytochemical production while maintaining product safety. Phytochemicals responsible for consumer acceptnace and their respective biosynthetic pathways were characterized in food and non-food crops to develop genetic and physiological markers for chemical-specific breeding strategies to improve quality and safety. Both objectives relied on cDNA technology and gas-chromatography/mass spectrometry to alter specific biosynthetic steps and measure the resulting levels of “high value” phytochemicals.

SECTION THIRTEEN: PROBLEM AREA 205 – PLANT PRODUCTION MANAGEMENT SYSTEMS

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

Relevance

SCOPE
In 1998, CSREES invested a total of $10,965,000 in PA 205. Of this total, 62 % came from Hatch funds, 12 % from Evans-Allen funds and 18 % from Special Research Grants (SRG). Together, these three non-competitive sources of funding accounted for 92 % of all funds allocated by CSREES to PA 205. The CSREES investment in PA 205 in 1998 represented 12% of the total funds invested in PA 205 and 2% of the total investment in all of plant production. The breakdown of funding by commodity area is presented in table PA205-1.

Description of SOI	Hatch	%	Evn-Allen	%	SRG	%	NRI	%	Oth Grnt	%	CSREES TOTAL
VEGETABLES	939	49.5%	703	37.1%	154	8.1%	16	0.8%	84	4.4%	1,896
GRAIN CROPS	1,111	72.4%	10	0.7%	245	16.0%	130	8.5%	37	2.4%	1,534
ORNAMENTALS & TURF	1,251	84.8%	73	4.9%	98	6.6%	0	0.0%	54	3.7%	1,476
DECIDUOUS & SMALL FR	651	46.8%	241	17.3%	499	35.9%	0	0.0%	0	0.0%	1,391
PASTURE & FORAGE CRO	827	93.3%	0	0.0%	59	6.7%	0	0.0%	0	0.0%	886
PLANTS, GENERAL	307	36.4%	0	0.0%	507	60.1%	30	3.6%	0	0.0%	844
OILSEED & OIL CROPS	430	53.8%	77	9.6%	28	3.5%	0	0.0%	264	33.0%	799
FIBER CROPS	350	73.2%	44	9.2%	83	17.4%	0	0.0%	0	0.0%	478
Top 8 SOI	5,866	63.0%	1,148	12.3%	1,673	18.0%	176	1.9%	439	4.7%	9,304
Other 24 SOI	878	52.9%	195	11.7%	340	20.5%	48	2.9%	200	12.0%	1,661
Total	**6,744**	**61.5%**	**1,343**	**12.2%**	**2,013**	**18.4%**	**224**	**2.0%**	**639**	**5.8%**	**10,965**

Table 13.1 – Distribution of CSREES investment in PA 205

In 2002, CSREES investment in PA 205 had increased to $20,511,000. Hatch funds accounted for 38 % of the total and together with non-competitive sources of funding for PA 204 accounted for 86 % of the total. The continued maturation of the CSREES Integrated Research, Education and Extension grant programs, such as the Initiative for Future Agricultural and Food Systems

(IFAFS) and the Organic Transitions Program, accounted for some funds invested in PA 205. The CSREES investment in PA 205 in 2002 represented 17 % of the total funds invested in PA 205 and 4 % of the total investment in all of plant production. The breakdown of funding by commodity area is presented in table PA 205-2.

Description of SOI	Hatch	%	Evn-Allen	%	SRG	%	NRI	%	SBIR	%	Oth Grnt	%	CSREES TOTAL
VEGETABLES	1,342	42.9%	1,028	32.8%	711	22.7%	50	1.6%	0	0.0%	0	0.0%	3,131
GRAIN CROPS	752	27.8%	162	6.0%	1,303	48.1%	90	3.3%	0	0.0%	403	14.9%	2,709
DECIDUOUS & SMALL FR	833	31.1%	191	7.1%	1,514	56.5%	16	0.6%	0	0.0%	127	4.7%	2,681
PASTURE & FORAGE CRO	1,119	57.6%	212	10.9%	531	27.3%	0	0.0%	0	0.0%	82	4.2%	1,943
ORNAMENTALS & TURF	1,381	81.9%	0	0.0%	289	17.1%	0	0.0%	16	0.9%	0	0.0%	1,686
PLANTS, GENERAL	368	24.8%	0	0.0%	977	66.0%	40	2.7%	40	2.7%	56	3.8%	1,481
OILSEED & OIL CROPS	481	35.1%	85	6.2%	533	38.9%	45	3.3%	0	0.0%	226	16.5%	1,369
FIBER CROPS	362	36.0%	205	20.4%	204	20.3%	0	0.0%	0	0.0%	236	23.5%	1,006
Top 8 SOI	6,638	41.5%	1,883	11.8%	6,062	37.9%	241	1.5%	56	0.3%	1,130	7.1%	16,006
29 Other	1,186	26.3%	230	5.1%	1,757	39.0%	489	10.9%	208	4.6%	637	14.1%	4,505
205 Total	**7,824**	38.1%	**2,113**	10.3%	**7,819**	38.1%	**730**	3.6%	**264**	1.3%	**1,767**	8.6%	**20,511**

Table 13.2– Distribution of CSREES investment in PA 205

IDENTIFICATION OF EMERGING ISSUES

In addition to feedback mechanisms listed under the "Relevance" section of the Plant Production Portfolio, CSREES National Program Leaders obtain information from a number of sources that relate specifically to PA-205 emerging issues. The State Plans of Work (POW) covering both research and extension programs that CSREES funds require documented input from stakeholders. Therefore the POW and the associated annual progress report provide a continual flow of information from stake holders from throughout the US regarding priority and emerging issues. In addition CSREES National Program Leaders work closely with research and extension faculty on focused program such as Precision Agriculture, Integrated Pest Management, SARE, Organic and Alternative Crops, and others. They also serve on Multi-State Technical Committees for both research and extension, and lead comprehensive reviews of programs and departments at the Land Grant Universities. Interaction with commodity associations, industry organizations, and professional societies provide additional insight into issues that are of concern to stakeholders. This information provides the bases for priority setting and program planning.

INTEGRATION OF CSREES PROGRAMS

PA-205 Plant Production Management Systems by the very nature of the activity is an integrative process, which seeks to optimize the various inputs and other controllable factors to achieve sustainable, profitable, and environmentally friendly plant production. Cultivar selection, fertility, water, and pest management as well as cultural operations interact to determine plant production. None of these factors operate independently of the system in which they occur. Therefore an integrated systems approach is needed to understand how the component factors interact and their ultimate impact on plant production.

INTERDISCIPLINARY INTEGRATION

CSREES identifies focus areas to which specialists are assigned, but they also function across the agency as well as cooperatively with state scientists to deliver program service. Therefore PA-205 is both integrative and interdisciplinary. Plant breeders, ecologists, soil and water scientists, engineers, and pest managers contribute to decision support tools used by plant production managers.

Quality

PERFORMANCE CRITERIA AND INDICATORS
The goal of CSREE is to facilitate the improvement of management practices and decision support tools for plant production through resource allocation and program leadership. Efforts are toward directing resources to address emerging as well as existing high priority issues to assure that limited resources are going to the greatest needs. Success is measured by the research and extension out put from those projects supported by CSREES funds.

ACCOMPLISHMENTS
Research and Extension programs for plant production management systems are generally commodity specific. Therefore representative examples from each of the major commodity groups are listed to illustrate the impact of CSREES investment in PA-205. A search of the CRIS data base for projects terminated as of FY-2002. The following examples were selected from each of the groups.

GRAIN CROPS:

"Decision Support Systems for Site-Specific Crop Management"
Funding Source: Hatch and State
Performing Institution: North Carolina State University
Investigator: Wilkerson, G. C.

Statement of Problem: A need exist for development of interactive editors for crop models to facilitate their use in computerized decision support tools for crop production management.

Approach: Several existing computer programs for herbicide application, weed mapping, and crop simulation were merged using a special editing tool. Models were revised as necessary to integration and subjected to validation with field experiments.

Results: New versions of weed management aids for corn, cotton, soybean, and peanut were released for grower use. Weed scientists in 10 Southern states, Canada and Brazil have used to techniques developed in this study to create weed management tools customized to their specific conditions.

Impact; Field trials of variable rate herbicide applications have shown that this decision aid can improve weed management for both economic and environmental effects. The technique developed in the study enables manipulation of large data sets to improve crop simulation models.

VEGETABLE CROPS:

"Cultural Practices to Minimize Environmental Stress on Vegetable Crop Production and Physiology"
Funding Source: Hatch and State
Performing Institution: University of Nebraska
Investigators: Hodges, L and Brandle, J. R.

Statement of Problem: Strong wind is a common occurrence in Nebraska and other states in the Great Plains especially in the spring. There is a need to identify and quantify the effect on seedling vegetable plants and develop techniques to reduce its negative impact.

Approach: Plants were grown in a greenhouse with wind channels designed to produce variable wind stress to growing plants. Field studies were conducted on several vegetable crops for the direct comparison of wind protected and exposed plants.

Results: Yield ranged over 300% where wind stress and wind transported pathogen were both present to as little as 15% for other crops without the pathogen issue. Wind protected plants produced more flower buds, flowers, and higher fruit set. Total yield and marketable fruit were higher from wind protected plants.

Impact: Poor plant development and low yield that was formerly attributed to nutrient status is now recognized to be wind stress. Incorporating windbreaks into vegetable production has resulted in improved yield, quality, and economic returns for Nebraska agrowers.

PASTURE AND FORAGE CROPS:

"Forage Protein Characterization and Utilization for Cattle"

Funding Source: Multi-State/Hatch
Performing Institution: Iowa State University
Investigators: Moore, K. J. And Russell, J. R.

Statement of Problem: There is a need to refine and validate methodology for quantifying forage protein for cattle, and to characterize genetic, environmental andmanagement effecto on forage protein fractions.

Approach: Studies for the Iowa part of this Multi-State project was to conduct field and laboratory studies to evaluate seasonal and environmental effect on forage protein quality for several legume species and to characterize genetic, environmental and management effecto no protein fractions. Additional studies were designed to measure the effect of freezing on the protein quality of standing forage.

Results: Field experiments showed that legume species could be left standing for late season grazing can retain much of their protein quality. All but sweet clover retained their leaves after frost and were suitable for grazing.

Impact: Livestock producers are now able to use grazing strategies to provide adequate protein nutrition for ruminants. Growing legumes that maintain their protein quality after being frosted allow stockpiling has reduced the need for protein supplementation and therefore feed costs for cattle.

DECIDUOUS AND SMALL FRUITS:

"Intensive Production System for Strawberies"

Funding Source: Hatch
Performing Institution: University of New Hampshire
Investigators: Lord, W. G. and Loy, J. B.

Statement of Problem: The need exists for production systems that will expand the summer sales window for strawberries in the northern temperate climate of New England. The focus is on earlier harvest to take advantage higher returns at the beginning of the season.

Approach: Planting dates, dormant crowns, plug plants, black plastic row covers and raised beds were compared for plant growth, berry size, total harvest, harvest dates, and pest management.
Results: Late summer plug planting using raised beds with black plastic covers produced higher yields compared to spring planted dormant crowns. Plants wintered under floating row covers grew better than those wintered under traditional organic mulch.

Impact: More than 30 New England growers including 12 from New Hampshire have adopted the new system and are experiencing higher yields and expanded market window.

ORNAMENTAL AND TURF:

"Physiological and Environmental Factors Influencing Growth and Development of Flower Crops"

Funding Source: Hatch
Performing Institution: Michigan State University
Investigators. Heins, R. And Carlson, W.

Statement of Problem: Successful production of commercial flowers under greenhouse conditions requires precise control of temperature and light with the opportunity to change them as needed to achieve flower initiation and development. Therefore a need exist for an integrated decision support tool for environmental management of flower crops grown under greenhouse conditions.

Approach: Candidate plant species were grown under a range of environmental conditions that evaluated photo period, cold requirement and growth regulators as well as growth conditions. This information was used simulation model development for various plant groups. Separate greenhouse experiments were conducted for model validation. A grower management tool for manual of computerized greenhouse control was developed.

Results: Specific photo period and or cold requirements were evaluated for over 400 species. Over 90 species were tested for response to growth retardants. The effects of temperature on flower initiation as determined. Management strategies were defined using model species.

Impact: The project has determined flowering and cultural requirement of a wide range of herbaceous perennials. The results have been implemented by the floriculture industry and they have contributed to growth in sales of perennials valued at $488 million which is an increase of 12% over 2001 returns.

SECTION FOURTEEN: PROBLEM AREA 206 – BASIC PLANT BIOLOGY

Relevance

SCOPE
Basic plant biology uses functional genomics and other molecular, cellular, and whole organism approaches to elucidate fundamental processes and mechanisms in plants important to agriculture. CSREES awarded approximately $16.4 million in basic plant biology research in FY 2002 which comprises about 18 percent of the total public investment in basic plant biology research.

FOCUS ON CRITICAL NEEDS
Basic plant biology is a critical application area for exploiting the rapidly growing amount of genomic data on plants and plant-associated microorganisms. Without a vigorous basic plant biology research program, newly discovered plant genomic data will go underutilized thus foregoing future agricultural advances in the U.S. In addition, basic plant biology has always played an important role in breeding efforts to improve crop productivity and adaptability by providing the fundamental knowledge needed for these endeavors.

IDENTIFICATION OF EMERGING ISSUES
Emerging issues for basic plant biology include deciphering the biological function of the multitude of genes that have been mapped in plants and plant-incorporated microorganisms, and using the newly discovered gene functions to elucidate plant mechanisms of energy transduction/conversion, nutrient uptake/transport, plant reproduction, and response to abiotic factors. Examples include
Characterization of an Arabidopsis thaliana Gene Involved in Root and Shoot Morphogenesis, a Hatch project at the University of Wisconsin (0183864) and *Defining the Function of Auxin-Regulated Gene Expression During Plant Growth and Development,* an NRI competitive award to Macalester College, St. Paul, MN (0196064).

INTEGRATION OF CSREES PROGRAMS
Basic plant biology research constitutes about 18 percent of the CSREES total expenditure on plant science research (~$89.5 million in FY 2002. The National Research Initiative, Hatch projects, and special research grants account for the vast majority of these awards in plant science research. CSREES also participates in interagency activities in basic plant biology by providing funding toward interagency programs such as the Interagency Metabolic Engineering Program. Examples of such awards include *Metabolic Engineering of Plant Vitamin C Biosynthesis for Improved Nutrition* at Virginia Polytechnic Institute (0190345) and *Metabolic Engineering of Plants for Enhanced Productivity* at Washington State University (0186933).

INTERDISCIPLINARY INTEGRATION
Basic plant biology stands at the nexus between molecular biology and genomic discovery on one hand and the provision of annotated genes of know function in plant systems to plant breeding programs on the other. Basic plant biology studies can and often do integrate two or more of the following scientific disciplines: plant physiology, biochemistry, genetics, cell biology, developmental biology, reproductive biology, and evolutionary biology. An example of an interdisciplinary project is *Molecular, Genetic, and Genomic Analyses and Improvement of Plant Growth and Development* at Cornell University (0193857).

Quality

SIGNIFICANCE OF FINDINGS AND OUTPUTS
In the post-genomic world, basic plant biology is key to discovering and annotating the functions of newly mapped genes in plants and plant-associated microorganisms, integrating these functions into cellular and higher level systems, and providing this new information to plant breeders for the development of improved agricultural crops. An example is *Functional Genomics of Fiber Development in Cotton and Arabidopsis*, a Hatch project at Texas A&M University.

STAKEHOLDER ASSESSMENT
The Council for Agricultural Science and Technology has said that "through genetic alteration of crops and animals, it now is possible, and will become ever more commonplace, to increase food and fiber production and improve food nutritional properties while limiting environmental stress. Increased agricultural production will be accomplished primarily through increased yields of plants and animal efficiencies, and through decreased losses due to pests and postharvest spoilage." An example is *Cellular Genetics and Direct Gene Transfer Techniques for Crop Improvement in Semiarid Agriculture*, a Hatch project at New Mexico State University (0180165).

ALIGNMENT OF PORTFOLIO WITH CURRENT SCIENCE
For decades basic plant biology proceeded with traditional scientific methods such as changing one variable at a time and observing the effects with special instruments, statistical analysis, etc. The advent of high throughput genome mapping and microarray analysis of gene/protein expression has provided a veritable scientific breakthrough in the potential understanding of structure and function in plant systems. Another powerful tool in basic biology that takes advantage of recent advances in molecular genetics is the creation of gain-of-function or loss-of-function mutants by a variety of techniques to directly determine the function of particular genes. An example is *Biochemical and Biophysical Characterization of Site-Directed Mutants of Photosystem II*, an NRI grant to E.I. du Pont de Nemours & Co. (0196388). Large collections of valuable mutants are openly accessible by researchers because these efforts have been supported by public funds. Basic plant biology, as supported by CSREES, stands poised to utilize the new knowledge provided by structural and functional genomics in the improvement of agricultural crops.

METHODOLOGICAL RIGOR

Research in basic plant biology increasingly utilizes quantitative methods of high-throughput sequencing, bioinformatics, and functional genomics supplemented with appropriate statistical methods when needed. An example is *Functional Genomic Analysis of the MEKK-Like Group of Arabidopsis MAP Kinase Genes,* an NRI grant to the University of Wisconsin (0195881).

Analysis of CRIS Data

In FY 2002, the total CSREES funding for Basic Plant Biology (PA 206) was $16.4 million. About $11.3 million (68%) was NRI and about $4.2 million (26%) was Hatch funding. Other smaller amounts were funded through special research grants, McEntire-Stennis, Evans-Allen, and other programs.

The following table shows the distribution of 2002 funding of basic plant biology (PA 206) by CRIS subject of investigation and primary funding sources.

Description of SOI	Hatch	%	McSten	%	Evn-Allen	%	SRG	%	NRI	%	Oth Grnt	%	CSREES TOTAL
PLANTS, GENERAL	1,561	19.1%	29	0.4%	0	0.0%	110	1.3%	6,485	79.2%	0	0.0%	8,185
VEGETABLES	501	30.5%	0	0.0%	0	0.0%	141	8.6%	1,000	60.9%	0	0.0%	1,642
GRAIN CROPS	325	19.8%	0	0.0%	69	4.2%	0	0.0%	1,247	75.9%	0	0.0%	1,642
MICROORGANISMS	527	34.9%	30	2.0%	0	0.0%	0	0.0%	953	63.1%	0	0.0%	1,511
OILSEED & OIL CROPS	196	34.1%	0	0.0%	42	7.3%	0	0.0%	337	58.6%	0	0.0%	575
PASTURE & FORAGE CRO	139	24.8%	0	0.0%	0	0.0%	0	0.0%	422	75.2%	0	0.0%	561
MISC & NEW CROPS	64	14.3%	0	0.0%	0	0.0%	75	16.8%	187	41.9%	120	26.9%	446
DECIDUOUS & SMALL FR	214	51.6%	0	0.0%	40	9.6%	161	38.8%	0	0.0%	0	0.0%	415
BIOLOGICAL CELL SYST	179	51.4%	0	0.0%	0	0.0%	0	0.0%	169	48.6%	0	0.0%	348
Top 9 SOI	3,706	24.2%	59	0.4%	151	1.0%	487	3.2%	10,800	70.5%	120	0.8%	15,325
2 Small Focus Areas	640	29.1%	0	0.0%	0	0.0%	141	6.4%	1,422	64.5%	0	0.0%	2,203
23 Other	513	47.1%	100	9.2%	0	0.0%	30	2.8%	448	41.1%	0	0.0%	1,090
206 Total	**4,219**	**25.7%**	**159**	**1.0%**	**151**	**0.9%**	**517**	**3.1%**	**11,248**	**68.5%**	**120**	**0.7%**	**16,415**

Table 14.1 – Distribution of CSREES investment in PA 204

Examples of Research Accomplishments

SEQUENCING METHODOLOGY

A methodological advance that could prove to be a breakthrough for plant genomics was developed with CSREES funding (*Testing Novel Methods for Sequence Analysis of the Maize Genome,* NRI competitive grant, 0176679). Researchers at Cold Spring Harbor Laboratory in New York developed a method that captures gene-rich regions and excludes the vast majority of repetitive, gene-poor stretches of DNA, yielding a shortcut to sequencing genes of agricultural crops such as maize. The method, called methylation filtration, relies on the observation that the DNA of repetitive, gene-poor regions of plant genomes can be preferentially modified by a chemical process called methylation. This enables researchers to skip over 93 percent of repetitive, gene-poor regions of DNA and focus their efforts on the sequencing and analysis of the gene-rich regions of plant genomes. (P.D. Rabinowicz, et al., Differential Methylation of Genes and Retrotransposons Facilitates Shotgun Sequencing of the Maize Genome, *Nature Genetics*, 23, 305-308, 1999).

The multiplier effect of this advance could be significant. The developers of the method have already applied it to the maize genome (L.E. Palmer, et al., Maize Genome Sequencing by Methylation Filtration, *Science,* 302, 2115-17, 2003) and the method has been featured in a monthly publication of agbiotechnology research and business news (*Ag Biotech Reporter,* 21, 7-8, March, 2004). The method could provide a significant boost to the sequencing and comparative analysis of other genomes in a wide variety of biological, biomedical, and biotechnological settings. CRIS entries related to this project are in the Evidence Volume.

WHEAT VERNALIZATION

CSREES funding has enabled researchers at the University of California, Davis to identify a gene involved in vernalization in wheat. Wheat is one of the most important grains consumed by humans and it grows in a wide variety of different environments. Winter wheats require a long exposure to low temperatures in order to flower, a process called vernalization, while spring wheats, which are planted in the spring or fall, do not require vernalization. The vernalization process prevents flower development during the winter months, providing protection for the cold-sensitive floral organs. The researchers have cloned one of the wheat vernalization genes *VRN2* and 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. This work confirms the function of this gene as a repressor of flowering that is regulated by the vernalization process. 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.

PLANT FERTILITY CONTROL

Working with a decorative plant, the petunia, scientists at Cornell University who have been supported by CSREES funding have identified a gene that restores pollen production to sterile plants. The fertility restorer gene is located in the plant cell nuclei of certain petunia varieties and somehow prevents an abnormal gene in the cells' mitochondria from disrupting pollen production. The finding points the way to probable locations of similar restorer genes in about 150 other plant species with the so-called cytoplasmic male-sterility (CMS) defect (including such food plants as oilseed rape, cauliflower, sunflower and rice) and could facilitate crop-plant hybridization for increased yields. Identification of a crop plant's own restorer gene will help plant breeders transfer the gene more quickly to advanced breeding lines, either by traditional sexual crosses or by using genetic engineering techniques. Once the restorer gene is incorporated into a breeding line, the plants can be used in hybrid seed production.

Performance

Performance indicators for basic plant biology include but are not limited to:

Performance indicator 1: Determine biological functions of genes from sequenced plant genomes.

Evidence:

Number of genes annotated
Gene database entries
Number of publications
Bibliometric analysis

Performance indicator 2: Characterize structure-function relationships in molecular components of metabolic pathways and in cellular components of plants.

Evidence:

Number of molecular and cellular functions illuminated
Number of publications
Number of CRIS reports
Bibliometric analysis

Performance indicator 3: Elucidate plant mechanisms of energy transduction/conversion, nutrient uptake/transport, plant reproduction, and response to abiotic factors.

Evidence:

Knowledge gaps filled
Paradigms developed
Number of publications
CRIS reports
Bibliometric analysis

CONCLUSION

Working under strict constraints, the Plant Production NPLs strived to provide the Panel with broad descriptions of the Problem Areas under their leadership and management. In spite of the effort that went into its development, the report remains incomplete, with issues unaddressed and questions unanswered.

The Plant Production Unit hopes that the Panel will review the report, note questions to ask for clarifications, and examine evidentiary materials and other documents available to them at meetings in Washington, DC. The report, along with presentations by the NPLs at the meeting and other materials, are the only evidence on which the Panel will assess the Plant Production Portfolio.

The scores that the Panel assigns to the Portfolio will serve as a basis for CSREES' report to OMB to fulfill the requirements of program assessment using the new Program Assessment Rating Tool (PART). This will partly fulfill OMB requirements of the Agency to have all portfolios of programs covered under CSREES Goal 1 to be assessed this Fiscal Year. The recommendations that the Panel makes to CSREES will assist the Agency and the NPLs to improve the ways program portfolios are managed.

The Plant Production Unit thanks the Panel for the time and dedication with which it assesses the portfolio and recommends ways to better manage the programs in the portfolio.