Portfolio Annual Report 2008: Processing, Engineering and Technology for Food and Bio Products

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Portfolio Annual Review

Section I: Portfolio Overview

Portfolio Planning

Portfolio Mission
Support world-class research, education, and extension programs to commercialize new processes and new or improved food and bioproducts for a sustainable agriculture through engineering, new technology and biological science.

Portfolio Vision
Food and bioproducts through sustainable agriculture production and processing systems using new and improved technology.

Portfolio Introduction
In the U.S. during the past several decades the research, education and extension focus has been on improving the efficiency of agricultural production systems. Over the years, the CSREES and its partners have made use of cutting edge technologies to make steady progress in this area. Significant research has been undertaken to develop biosensor technologies and rapid identification systems assure food supply chain security, quality and safety. While it is important that this effort must continue, it is equally important that other areas such as finding new uses for agricultural products must be explored because it has the potential to increase agricultural profitability and sustainability by creating new markets for U.S. agricultural products. Past studies have shown that many industrial, pharmaceutical, nutraceutical and other products can be produced from agricultural commodities. Studies have also concluded that industrial products from biological materials have the potential to replace industrial products derived from petroleum.

Processing, Engineering and Technology for Food and Bio Products (PETFB) is designed particularly to encourage research, education and extension (outreach) programs to develop engineering and technology for agricultural production and food and bioproducts processing that results in commercialization of new processes and new or improved food and bio-based products. More specifically, this portfolio addresses issues dealing with the engineering aspects of agricultural production, processing and storage of foods, food services, new and improved food products, and new nonfood products and storage. An analysis of the PETFB is provided in this section of the report.

Specific details pertaining to different knowledge areas within the portfolio are included in the following sections describing the individual knowledge areas.

Food Science and Technology component of Food and Non-Food Processing and Production (F&NFPP) provides national leadership in consultation with the partners and stakeholders; and administers grants in a fair and efficient manner in the area food

science and technology. Leadership roles include identification, development and implementation of priority areas of research, education and extension; reviewing programs and providing direction; and active participation in multi-state research and extension activities. Administration of grants encompasses several mechanisms (National Research Initiative, Small Business Innovation Research, Formula funds, Presidential Initiatives and special Congressional appropriations). The goal of this program is to improve the quality of foods for improving human health and well-being, increase the markets for the producer of foods and prepare future work force. CSREES has been maintaining a data base of funded research through its Current Research Information System (CRIS). Recently, we have started maintaining data base on extension and education also. Knowledge Areas (KAs) 501, 502, 503 and 504 include the food science and technology portfolio. Food Safety Portfolio which is reviewed separately has different KAs.

Linkage to CSREES Strategic Plan

Supported CSREES Strategic Goal: This portfolio supports strategic goal "Enhance the Competitiveness and Sustainability of Rural and Farm Economies." CSREES supports numerous research and extension activities to enhance the competitiveness and sustainability of rural and farm economies, ranging from the development of new products to improvements in productivity and financial management. Education programs strengthen the foundation for this goal by building capacity in the agricultural research and extension system and training the next generation of scientists and educators.

Supported CSREES Objective: This portfolio supports objective, "Provide Research, Education, and Extension to Expand Domestic Market Opportunities." CSREES sponsors vital research and development contributions for new food and non-food products and technologies, quality improvements, new uses, and value-added processes that enhance market opportunities for agricultural and forest products. Through extension, CSREES and its partners effectively demonstrate and transfer this knowledge to users.

CSREES Strategic Plan Performance Measures Progress Table The following key long-term outcomes and performance measures coordinate with the strategic goal and objective that are both supported by this portfolio and its areas of focus. This portfolio's primary areas of focus are processes, engineering, technology, foods and bio products. The key long-term outcome and performance measure presented in the following table only cover bio products, yet performance criteria and actionable strategies supported by this portfolio cover all areas of this portfolio's focus.

Key Long-Term Outcome: Expanded science-based knowledge and technologies to generate high-quality products and processes by: 1. increasing knowledge of bioenergy and biomass conversion and 2. creating new commercially viable and marketable alternative markets for non-food products from existing crops
Performance Measure: Cumulative number of expanded commercially adaptable processes that convert biomass to fuels through the development of cost effective biochemical or thermochemical technologies, and used commercially
Performance Criteria *Performance Criterion for Bio Products:* • Develop new and improved non-food products and processing technologies (KA 511) • Improve quality maintenance in storing and marketing non-food products (KA 512) *Performance Criterion for Engineering and Systems:* • Improve the design, construction, and cost effectiveness of facilities for animals, agricultural products, agricultural inputs, equipment and other material products (KA 401) • Improve mechanization, including nanotechnology, to increase efficiency and decrease labor requirements in agricultural and forestry production (KA 402) • Develop and improve instrumentation and information systems and sensors for improved control of the production and processing of biological materials and biohazards (KA 404) *Performance Criteria for Food Products:* • Develop new and improved food products and processing technologies (KA 501) • Develop new and improved food products (KA 502) • Improve quality maintenance in storing and marketing food products (KA 503) • Improve home and commercial food service (KA 504)

Actionable Strategies:

- Expand research to assess the effectiveness of developing profitable alternative crops and on – or near – farm processing that add value to agricultural products and enhance the economic viability of rural communities and families, particularly socially disadvantaged farm operators
- Focus existing research, and education programs to encourage new, innovative, and alternative uses for agricultural products, including increasing the use of biomass, biofuels, and bioproducts
- Provide research, education, and extension to enable an increase in the amount of ethanol produced through cellulosic conversion technology
- Expand research, education, and extension to help producers, processors, and distributors address changing consumer needs, tastes, and preferences
- Support research to understand the relationships between chemical composition, molecular and physical structure, and end-use quality and function of bioproducts
- Sponsor development of food products with improved nutritional and health-related characteristics
- Strengthen working relationships with other Federal agencies and departments, including the Department of Energy, the Environmental Protection Agency, the Department of the Interior, the Department of Defense and the Office of Federal Procurement Policy, to coordinate programs related to development of new markets for agricultural products and activities
- Use grant programs to provide research, education, and extension that enables an increase energy production from the Nation's farms, ranches, and forests

Portfolio Performance Measures

This portfolio has 3 performance measures that indicate the portfolio's progress toward its mission. These performance measures were carefully developed by portfolio team members. These performance measures were not developed for the purpose of aligning with the strategic plan, but these measures along with those identified in the strategic plan broadly support the mission of the Agency and the portfolio. The first two performance measures are reported to the Office of Management and Budget annually, as well as other portfolio performance measures, to indicate the Agency's progress to its mission.

Performance Measure Description: Cumulative number of expanded commercially adaptable processes that convert biomass to fuels through the development of cost effective biochemical or thermochemical technologies, and used commercially.

Explanation of Measure: Commercially adaptable processes to convert cellulose to sugars, fermentation of cellulosic sugars to Ethanol, chemical transesterification of oils from oilseed crops, and the thermal pyrolysis and gasification of biomass will have been increased by 2009. These will increase the biofuel conversion and utilization for the US consumers. This measure captures the goal to increase the use of biomass-based transportation fuels 8 fold over the next 5 years. Data from the Renewable Fuel Association shows the use of fuel ethanol increasing from 174M gallons in 1980 to 2.8B gallons in 2003, 6.5B gallons in 2007. Current data show that 3.4B gallons were produced in 2004 and the Association reported that there is capacity to produce 4.4B gallons in 2005. The National Biodiesel Board estimates biodiesel usage has increased from 500,000 gallons in 1999 to 75M gallons in 2005, to approximately 500M gallons in 2007.

Baseline (FY 2005): 2	**Target**	**Actual**
Fiscal Year 2006	3	3
Fiscal Year 2007	3	3
Fiscal Year 2008	4	
Fiscal Year 2009	4	
Fiscal Year 2010	5	
Fiscal Year 2011	5	
Fiscal Year 2012	6	

Performance Measure Description: Cumulative number of new crops that have been developed and used commercially.

Explanation of Measure: New crops provide agricultural diversity, new sources of revenue and can be grown sustainably with reduced inputs.

Baseline (FY 2005): 6	**Target**	**Actual**
Fiscal Year 2006	6	6
Fiscal Year 2007	6	6
Fiscal Year 2008	6	
Fiscal Year 2009	7	
Fiscal Year 2010	7	
Fiscal Year 2011	7	
Fiscal Year 2012	8	

Performance Measure Description: Expand the number of biobased industrial products that have been developed to the precommercialization stage or have been commercialized. Biobased products fall under a variety of broad categories		
Explanation of Measure: Products are biodegradable, as appropriate and utilize oils, proteins, starches, or environmentally preferable products for US consumers.		
Baseline (FY 2005): 45	**Target**	**Actual**
Fiscal Year 2006	1	1
Fiscal Year 2007	1	2
Fiscal Year 2008	1	

Processing, Engineering, and Technology for Food and Bioproducts Logic Model

Situation	Inputs	Activities	Outputs	Outcomes		
				Knowledge	Actions	Conditions
There are a number of needs that should be addressed concerning food processing and preservation, as well as farm structures, facilities and supplies. The following issues are addressed by this portfolio: - New products, new uses and value added processes must have consumer acceptance to create effective demand. - Need for advanced design, construction, and cost effectiveness of physical facilities for agriculture - Need for technological advance of mechanization including nanotechnology to increase efficiency and decrease labor in agricultural and forestry production	**Funding Sources:** - Federal - State - Others provide funding that contributes to research, extension and education. **Human Capital:** - CSREES NPLs - Researchers - Faculty - Extension Practitioners - Teachers - Para-professionals - Stakeholders - Volunteers	- Develop new cooking methods, understand factors that promote lipid oxidation - Develop & improve measurement techniques during thermal processing of foods - Develop market acceptance of U.S. grown ag-based industrial lubricants & greases - Design and evaluate utility and efficiency of physical structures - Develop and evaluate agricultural mechanical tools - Develop biomass crops for energy and products.	- New fundamental or applied knowledge - Scientific publications - Patents - New methods & technology - New food and non-food products and processes - Practical knowledge for policy and decision-makers - Information, skills & technology for individuals, communities and programs - Participants reached - Students graduated in agricultural sciences	Better Understanding of… - Flow and heat transfer in foods - Effective models to simulate air impingement freezing & study the effect of external thermal boundaries & time dependence - Design time temperature indicators for use in food distribution and retail - Design of efficient facilities - Beneficial use of agricultural mechanical tools - Useful farm management practices - Sustainable biomass production and conversion technologies	- Improved process efficiency and heat transfer in foods - Model widely used by frozen food operators - Developed a desktop version - Improved production efficiency - Reduced labor costs - Improved control of production - Changes the way producers managed their operations - Environmental, economic and social impacts are incorporated into project implementation	- Energy efficiency in processing - More nutritious processed foods - Improved economic opportunities for producers - Increased production and labor efficiency - Increased net value added by agriculture - Sustainable practices become economically viable

ASSUMPTIONS - These practices will improve the overall quality of food and ensure food safety, these practices will be accepted by consumers and are environmentally safe

EXTERNAL FACTORS - Variable funding; scientific advancements; changing priorities; producers' and consumers' attitudes; natural disasters; economic conditions; coordination and cooperation with other government entities; public policy

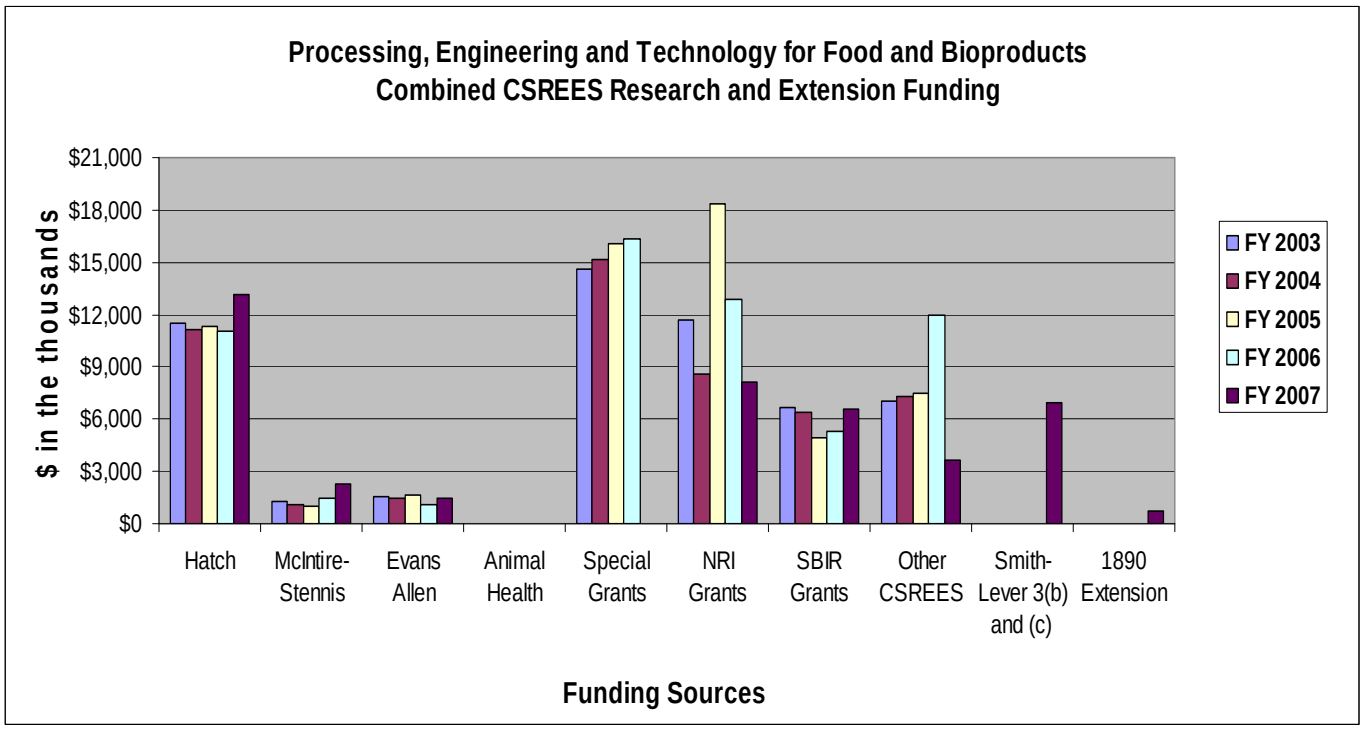
Portfolio Inputs

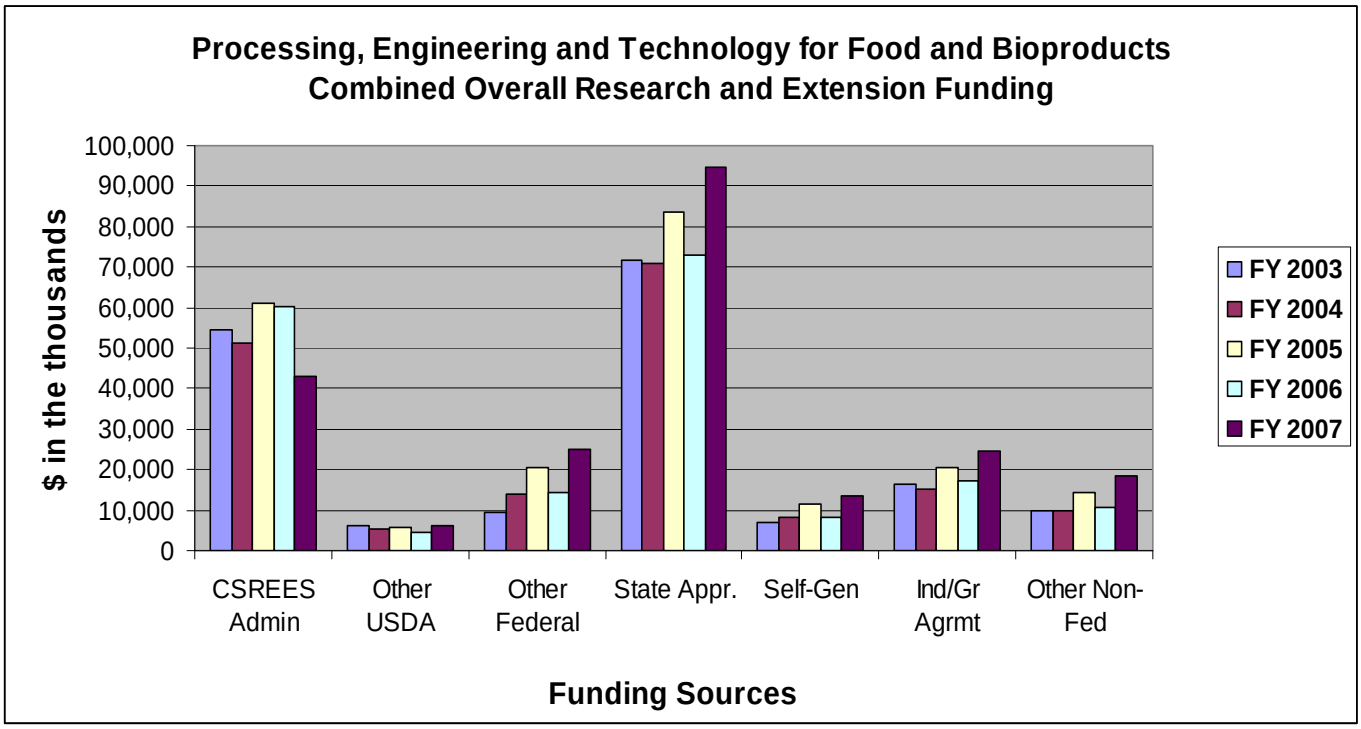
Portfolio Level Funding Table and Bar Chart

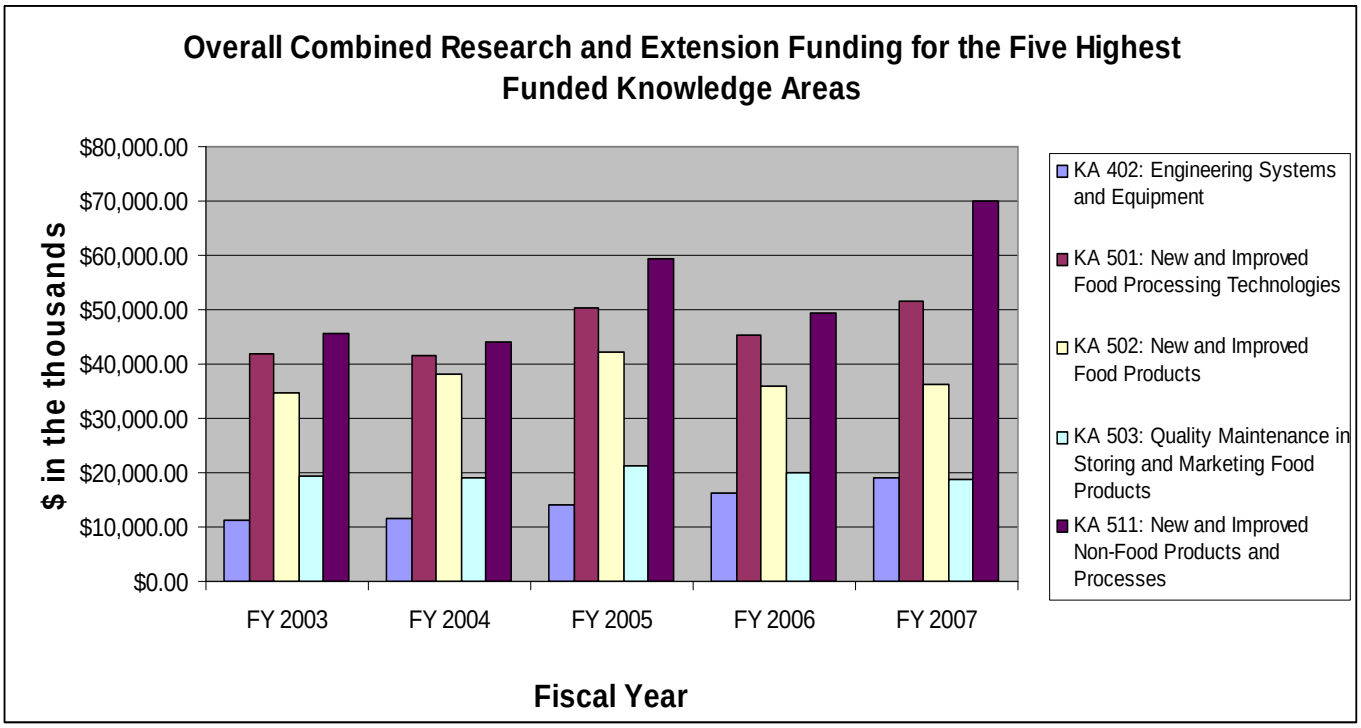
Agency funding data for fiscal year 2007 were collected from the Current Research Information System (CRIS) and the Plan of Work (POW) annual report. Fiscal year 2007 funding data includes Smith-Lever 3(b) and (c) and 1890 extension funding, which were not otherwise accounted for in FY 2003 – 2006. Agency funding data for fiscal years 2003 through 2006 were collected from CRIS only.

Table 1: Processing, Engineering, and Technology for Food and Bioproducts Portfolio Summary Funding Table
Combined Research and Extension Funding

	($ in the Thousands)					
Funding Sources	**FY 2003**	**FY 2004**	**FY 2005**	**FY 2006**	**FY 2007**	**Grand Total**
All CSREES Funding	$54,377.00	$51,065.00	$60,883.00	$60,056.00	$42,942.00	**$269,323.00**
All non-CSREES Funding	$120,839.00	$123,483.00	$155,772.00	$127,815.00	$182,750.00	**$710,659.00**
Total Funding	$175,216.00	$174,548.00	$216,655.00	$187,871.00	$225,692.00	$979,982.00
Percentage of CSREES Funding	45%	41%	39%	47%	19%	27%







FY 2007 CSREES funding reflected in this portfolio has several major changes.

- All CSREES funding was nearly $43 millions, a reduction of more than 28% (Table 1). It is mainly due to Congress' action to suspend earmarked special grants amounts for about $16 M.

- All non CSREES funding has a significant increase of $55 M resulted from a combined increase in investment by state appropriation, other federal agency grants, industry and private sector supports, and other non-federal sources. Such a surge represents an increase interests in supporting research and extension in the areas of this portfolio from all stakeholders.
- It is noted that with a combined decrease in CSREES funding and increase from non-CSREES funding, the ratio between them has reached the lowest of 19% over last five year period, and about only a half of the previous four years' average.
- Particularly noteworthy is a significant increase in KA 511 area for new and improved biobased products and biofuels.
- NRI portion of CSREES funding in this portfolio is the lowest among last five years, and experienced a rapid decline from $18 M in FY05 to $8 M of FY07. It is not clear the reason for such a trend.
- Smith-Lever 3(b) and (c) are the program supporting the Extension services. It was reported for the first time in this portfolio in FY 2007. The total funding was about $7 M across all the KAs in this portfolio with 501, 502 and 503 being three largest.

Portfolio Results

Portfolio Outcomes

Sensing Technology and Decision Support Systems for Precision Agriculture. Researchers were able to develop remote sensing technology and sensor networks for detection of soil and plant parameters including, soil moisture, plant population and density. The research has resulted in the deployment of simulator that aids rapid prototyping of field automation equipment for precision control of agricultural machinery systems. The modeling and water quality aspects of this work have helped international research and education projects in South East Asia and Eastern Europe (Accession #: 0198449)

Applied Biotechnology Institute: *Cellulases for Biomass conversion from the Transgenic Maize System.* This Small Business Innovation Research (SBIR) project was designed to demonstrate the feasibility of cost-effective conversion of lignocellulosic biomass to sugars. A model for using maize-produced cellulase for ethanol conversion was developed to illustrate the advantages and requirements that this may have over other systems. In addition, chemical and biological assays were conducted to evaluate activity on insoluble cellulase. These assays confirmed activity of maize-produced cellulase on insoluble cellulose. Five generations of cellulase-expressing plants were grown and selected based on expression levels in the seed. The expression levels were increased up to five-fold in bulk inbred seed. These results demonstrated the potential for these seeds to reach the expression target assumed in the production model. Based on the results discussions are underway with industrial partners to commercialize a maize-produced cellulase.

National Program Leaders leading CSREES' competitively funded grants work with their CSREES colleagues to find and recommend faculty from the LGU that have knowledge and expertise in specific areas to serve on review panels. This provides a more accurate review of proposals and provides professional development for the faculty members at the LGU.

NPL's lead departmental reviews of engineering, food science and related department as part of the post award management and review of integrated research education and extension functions.

Portfolio Considerations

Portfolio Leadership and Management

The Processing Engineering and Technology (PET) Section provides leadership for annual performance reviews for this portfolio. The majority of funded programs that comprise the majority of this portfolio are led by National Program Leaders (NPL's) in the PET Section of the Plant and Animal Systems Unit and NPL's in the Competitive Programs Unit.

NPLs throughout CSREES lead in a number of ways within the system:

- NPLs develop and participate in a wide variety of professional opportunities for partners to dialogue about current and emerging issues related to the portfolio in a variety of settings.
- Since the inception of the NPL Liaison Program, NPLs are in continuous contact with their assigned state land-grant universities, dialoguing with administrators, faculty and staff to assess climate and gauge stakeholder challenges and opportunities.
- At the programmatic level, NPLs continuously interact with partnership colleagues, external partners, professional organizations, and each other to assess and integrate stakeholder input into their programs. NPL's met with multi-state committees to identify and coordinate priority research and extension projects.

CSREES also recognizes its role as a conduit of current research information. CSREES works closely with other agencies, organizations and land-grant universities and provides a mechanism to distribute information to stakeholders and partners. Outlets include multiple CSREES listservs, dedicated web pages, newsletters, teleconferences, trainings and conferences, all facilitated, monitored and moderated by NPLs managing them.

National Program Leaders leading CSREES' competitively funded grants work with their CSREES colleagues to find and recommend faculty from the LGU that have knowledge and expertise in specific areas to serve on review panels. This provides a more accurate review of proposals and provides professional development for the faculty members at the LGU.

NPL's lead departmental reviews of engineering, food science and related department as part of the post award management and review of integrated research education and extension functions.

Programmatic or Management Shortcomings
The major shortcoming of this portfolio is the outdated knowledge area classification system used to frame the priorities in processing engineering and technology for food and bio products. This is not unique to this portfolio but may be the most notable in this portfolio given the knowledge areas cut across many other portfolios. For example, engineering as a science contributes to multiple issues and priorities from production through processing, storage, distribution, preservation, consumption and by product utilization and disposal. Instrumentation and controls are needed in all of these stages. Science and technology needs have evolved with new sciences such as nanotechnology that have yet to be classified in this system. These shortcomings are endemic to the continued difficulties researchers, extension professionals and National Program Leaders have in accurately and appropriately classifying their research and extension programs often resulting in inefficient and incomplete analysis and impact assessment for portfolio reviews.

Knowledge area descriptors such as "general farm supplies" have little relevance to CSREES research and extension priorities. There are nine primary KA's in this portfolio. In the current portfolio reporting and accountability framework they are all treated at the same level regardless of funding or priority. This distracts and distorts from both the agency and our stakeholder research/extension priorities; that are otherwise well articulated in the examples of relevant work and impacts in this document.

The knowledge area classification system was designed prior to implementation of the current federal budget and performance mandates. If it is to be used as the primary framework for portfolio reviews, significant revisions will be needed to bring it up to date with the new sciences and research/extension priorities. CSREES' sister agencies and university partners have a vested interest in this classification system. This could be a monumental task given the hegemony that may resist change with so many competing priorities.

Key Future Activities and Changes in Direction

Specialty Crop Research Initiative
Specialty crops are defined in the Specialty Crops Competitiveness Act of 2004 (Public Law 108-465, and modified in the Food, Conservation, and Energy Act of 2008, Pub. L. 110-246) as "fruits and vegetables, tree nuts, dried fruits, horticulture, and nursery crops (including floriculture)." One of the findings of the Act is "a secure domestic food supply is a national security imperative for the United States." Furthermore, three out of five components of USDA's food pyramid included specialty crop foods, so they represent a critical portion of the recommended nutritional program for U.S. citizens. Without a strong and viable specialty crop industry in the United States, a significant portion of our nation's nutritional based would be reliant exclusively on foreign markets. This puts readily available and affordable health-conscious foods at risk for U.S. citizenry. Specialty crops are also a significant and important part of the U.S. agricultural economy. As a percentage of total agricultural production, specialty crops represent a substantial

revenue stream for many states and counties. Recognizing the importance of specialty crops, the 2004 act established a permanent specialty crop committee on the National Agricultural Research, Extension, Education, and Economic Advisory Board (NAREEEAB) and charged the committee to prepare an annual report to counsel USDA on research, extension, and economics programs related to specialty crops. Two reports have been published to date (http://NAREEEAB.ree.usda.gov). The Specialty Crop Research Initiative (SCRI) is authorized by Section 7311 of the Food, Conservation, and Energy Act of 2008, which added section 412 of AREERA establishes a specialty crop research and extension initiative to address the critical needs of the specialty crop industry by developing and disseminating science-based tools to address needs of specific crops and their regions. This legislation calls for mandatory expenditures of $230 million over fiscal years 2008-2012 across the following five focus areas:

1. Research in plant breeding, genetics, and genomics to improve crop characteristics;
2. Efforts to identify and address threats from pests and diseases, including threats to specialty crop pollinators;
3. Efforts to improve production efficiency, productivity, and profitability over the long term (including specialty crop policy and marketing);
4. New innovations and technology, including improved mechanization and technologies that delay or inhibit ripening; and
5. Methods to prevent, detect, monitor, control, and respond to potential food safety hazards in the production and processing of specialty crops, including fresh produce.

Specialty crop industry problems (and their solutions) must be viewed, and treated, as systems of interrelated processes, participants, institutions, collaboration, and technologies in a comprehensive manner. This vision of a systems-based approach consists of a hierarchical taxonomy of systems, which, in total, define a "producer-to-consumer" system. The primary specialty crop systems – crop production, processing and distribution, and consumers and markets – appear at the highest level, with specific subsystems found within each. Emphases would be placed on efforts that focus on an entire primary system of where two or more of the primary systems overlap/intersect. At the most specific level of the hierarchy, one finds traditional, disciplinary research, development, and application efforts (more narrowly focused investigation), which would also be envisioned as part of this initiative. With sustainability as an umbrella goal for the industry, the principles of systems thinking, trans-disciplinary scientific approaches (bridging biological, physical, and socio-economic disciplines), and effective outreach are essential for meeting stakeholder needs.

Role of Food Science and Technology in Obesity Prevention

Previously, the consumer behavior change of food consumption was considered a critical issue in addressing obesity in the effluent countries. However, the effectiveness of this approach is less conclusive to date. Food technology may provide a new angle other than modification of consumer behaviors. According to the latest data from Economic Research service (ERS, 2002), 46% of the food dollars are spent on eating away from

home. This segment of food systems not only adds close to a trillion dollars to the raw agricultural products, but also has a strong history of responding to prevention of diseases. Notable examples are prevention of pellagra, rickets and neural tube defects, notwithstanding successful introduction of several lines of cholesterol reducing and low glycemic index products. Thus, the discipline of food science and technology is well poised to contributing to the prevention of obesity. But many entities have to collaborate to bring synergy within the discipline.

One of the issues within food science discipline is to identify variables that are outside the domain of consumer, and therefore do not influence their behavior. The identification of these variables is clearly a researchable item. Some examples include 1). proper balance of macro and micronutrients, especially in convenience foods (ex: type of carbohydrate, ratio of carbohydrates to proteins, role of soluble and insoluble dietary fibers, calcium, and levels bioactive components such as CLA (CDC, MMWR Feb 6, 2004 for increasing trends in energy and macronutrient intake); 2). proper balance between dietary guidelines and foods prepared; 3). clarity in food labeling; 4). serving size; 5). prepared foods for home and institutional use (restaurants, schools etc); 6) food prices, poverty and obesity. (See Drewnosky, AJCN, January 2004). The other issue is balancing the already low profit margins in food processing against the consumer demands. The food industry has to come up with innovations that will benefit consumers while keeping the competitive edge.

The above few examples point out the need for collaborations among government, food processing industry, food service industry, land-grant and other universities, FDA and other federal agencies.

New Program in Food Engineering and Processing Technologies

Value Addition to the harvest was one of the seven key challenges identified by NASULGC in 2001 document entitled "A Science Roadmap for Agriculture." Adding value to various food commodities is an integral part of overall agriculture strategy to sustain the global competitiveness of US. Value addition to the harvest not only expands the nation's agricultural economy, but also it is critical to improve human health and safety, and to support rural community resilience issues (CSREES White Papers). Novel processing technologies and their engineering designs are crucial to process foods with added economic, esthetic, nutritional and health-promoting values. Public funding for R&D in food engineering and processing technologies is scanty (e.g. Food irradiation supported by DOD, Aseptic Processing Center supported by NSF and some basic research supported by NRI). Food Technologies are receiving greater emphasis internationally, particularly in Europe, Pacific Rim Countries and Japan**,** eroding our global competitive edge in food technology.

An expanded program represents a unique opportunity for USDA to enhance the value of the harvest by significant proportions. This program could be coordinated with the Rural Development, USDA Value Added Program and also DOD Army Natick Solider Sustainability Research Program, as well as NSF and NASA programs. A few examples

of innovative technologies that potentially have enormous economic and social implications are hydrostatic high pressure processing, pulsed electric field processing, Ohmic heating, nonthermal plasma, electrolyzed water and ultrasonic treatments, better membrane materials for separation process, advanced computational techniques for process simulation and product design, new packaging materials and system design, rapid and noninvasive detection of pathogenic microorganisms and physical property characterization methods. It is obvious that food engineering and processing is a cross-cutting issue encompassing global competitiveness, food safety, consumer issues and rural development. It is proposed that basic and mission-oriented components of this new program be included in the AFRI and an applied aspect be included in the Integrated Programs.

Bioactive Components in Foods

It is well documented in medical archives that mankind has always looked up to foods in preventing, mitigating and treating diseases. With the advent of modern medical and surgical advances, the role of foods in health has remained folklore. However, in the past couple of decades, foods have been shown to contain many bioactive and possibly health promoting components. Meanwhile, consumer demand for the 'health foods' surged ahead of the science and became a significant market of the food chain. The estimated sales of the bioactive components (Nutraceuticals) and health foods (functional foods) in the U.S. in year 2002 is $ 21 billion (Nutrition Business J. 2003. Functional Foods Overview, March/April: 1-11) and is growing at the double digit rate.

Several Federal Agencies (CSREES/ARS, ODS/NIH, NCI/NIH, FDA, and DOD) have been supporting research to provide scientific basis for the efficacy and safety of the bioactive components in botanicals and to some extent in foods. CSREES has supported in a large way a program entitled "functional foods" in fiscal years 2001 and 2002 under the Initiative for Future for Agriculture and Food Systems (IFAFS) which was authorized by specific legislation. Most of the work supported was in the area of nutrition and Metabolism. However, the monies were not appropriated for the following fiscal years and IFAFS is non existent. Thus, CSREES does not have a defined portfolio in this important area as it relates to agricultural products. We are participating in an interagency initiative being coordinated by the National Institute of Health.

New Emphasis on Sustainability for the Production of Biomass Crops and Bioproducts: Environmental, economic and social impacts, i.e. sustainability of new technologies are becoming a key issue. CSREES has programs and partnerships to address sustainable feedstock production, harvest/transport/storage/, and conversion technologies.

NRI budget request in FY 2007 and 2008, included $19.1 M to support a new competitive program to fund research, education, and extension projects on bioenergy. Efforts supported by the new program would utilize a systems approach to bioenergy, including the environmental and social implications of bioenergy production.

SBIR FY 2008 Biofuels and Biobased Products topic included economic and environmentally sustainable production and conversion of agricultural biomass into biofuels.

Other programs in the agency include projects focused on sustainable bioenergy and biobased products, for example Ag in the Classroom, Higher Education Challenge Grants Program, National Needs Fellowship Program, Water Quality Program, SARE program, NRI Ecosystems Services topic, new multistate committees that address economics and community impacts, and eXtension.

What are Others Doing:

- Joint effort between DOE Office of Science and CSREES to support the Joint Energy Feedstock Genomics Program
- NPL participation on Biomass R&D Board interagency working groups including: feedstock development, biomass handling and logistics, conversion technologies, environment/health/safety, sustainable biofuels production.
- USDA Office of Administration is implementing the Biopreferred Program, which creates a pull for research, education and extension projects focused on biobased industrial products.

- USDA Agricultural Research Service (ARS) -- Food Processing and Sensory Quality Unit

  http://www.ars.usda.gov/main/site_main.htm?modecode=64-35-56-00

  The mission of the Food Processing and Sensory Quality Unit is to invent, design, and develop cost-effective, environmentally acceptable processing systems that yield value-added products of enhanced quality from food crops. A multi-disciplined team of scientists is meeting these challenges by (1) obtaining a basic biochemical understanding of the interactions of food components attributing to flavor (development and deterioration) and functionality of the food and its individual components; (2) scientifically defining and measuring sensory quality in foods before and after processing (3) designing cost-effective, environmentally-acceptable processes for converting foods and their separated components into value-added products; and (4) developing technologies for predicting and assessing the nutritional, sensory and processing quality attributes of foods.

Section II: Primary Knowledge Areas

Knowledge Area 401: Structures, Facilities, and General Purpose Farm Supplies

KA 401: Structures, Facilities, and General Purpose Farm Supplies' Introduction:
This KA is focused on extension and research for the design, construction, and cost of facilities for animals, agricultural products, agricultural inputs, equipment, and other materials. The properties and behavior of the animals, products, equipment, and materials while in various facilities and during transport or processing is a part of this KA. This KA is the only one that addresses the above topics in this portfolio. The applicability of this KA to the portfolio objectives is to supporting the research and extension needs for specialized facilities for preconditioning or preservation of biomass and food crops prior to processing.

This KA is applicable to other portfolios, especially those that deal with on-farm production of animal and crops. The structures and facilities for each farm require major investments but these investments are necessary to protect the products (crops, equipment, feed, animals, fuel, chemicals, etc.). New designs and technologies for structures and facilities continue to be developed as older on-farm structures and facilities become outdated and need to be replaced.

KA 401: Structures, Facilities, and General Purpose Farm Supplies' Logic Model

Situation	Inputs	Activities	Outputs	Outcomes		
				Knowledge	Actions	Conditions
The large farms, whether they are large greenhouse operations or large livestock and poultry operations will require specialized structures that provide consistent high quality products that are efficiently produced. The overall effort for extension and research towards these structural related activities has declined over the past decades. The design and construction of new facilities such as: confinement livestock and poultry structures, greenhouses, milking parlors, grain storage, and machinery storage are carried out by commercial engineering design companies with little input from the Land Grant system.	**Financial Resources:** - Federal - State - Some provide funding that contributes to research, extension and education. **Human Capital:** - CSREES NPLs - Researchers - Faculty - Extension Practitioners - Teachers - Para-professionals - Stakeholders - Volunteers	- Developed a Hydroponic Vegetable Program in 1999, to foster hydroponic greenhouse vegetable businesses in Ohio by providing horticultural, marketing, business, planning and greenhouse design support - Extended the service life of forest products, particularly hardwood species through preservations, reuse of treated wood, recycling of wood removed from service and the application of biotechnological means for the production of high decay resistant wood	- New fundamental or applied knowledge - Scientific publications - Patents - New methods & technology - Practical knowledge for policy and decision-makers - Information, skills & technology for individuals, communities and programs - Participants reached - Students graduated in agricultural sciences	- Increased the knowledge of hydroponic vegetable and flower growers about marketing strategies, business planning, and greenhouse design - Increased small farmers' knowledge about alternatives to commodity crop production - Increased small farmers' knowledge about new economic ventures in high tech agriculture - Increased knowledge concerning wood preservation	- Six new commercial hydroponic lettuce production enterprises were started in Ohio - A major Toledo grower began growing and marketing hydroponic orchids in cooperation with a Taiwanese orchid company - Increased the number of activities involved in maintaining the vitality of hardwood-based industries throughout the US	- Enhanced horticulture production - Utilization efficiency increases as high as 22% - Less wood is being harvested and the US is moving closer to sustainable forest utilization patterns

ASSUMPTIONS - The U.S. agricultural sector must be able to quickly respond to changing political, economic, technological, environmental, and consumer-driven market forces.

EXTERNAL FACTORS - Agricultural production and marketing are constantly affected by external factors such as weather and growing conditions, diseases and pests, financial conditions, cultural practices, and consumer demand. New and emerging risks associated with domestic and international policy, genetic technology, exotic invasive species, and complex agricultural diseases that can affect humans defy conventional means of identification, quantification, and management.

KA 401: Structures, Facilities, and General Purpose Farm Supplies' Key Activities:

Key Activities in 2008
Some of the key activities include: energy efficiency, energy conservation, energy reduction, greenhouse facilities and use, air quality in livestock buildings, and components of typical farm structures (trusses, framing, materials, post-framing, and fasteners). Energy costs continue to rise and the farmer/producer continues to seek ways to reduce this cost by managing ventilation systems, use of alternative lighting systems, and using more efficient heating and cooling systems. Greenhouse structures can provide an excellent environment for high value crops but the operational costs for greenhouses are very high. Providing the proper conditions (light, temperature, water, fertilizer and possibly pesticides) requires excellent management and the proper facilities within the greenhouse to meet the required growing environment. Confinement animal buildings need proper ventilation and temperature control for efficient growing conditions for the livestock and poultry and for the workers inside these buildings. Most modern buildings on farms are of the post-frame construction type and are built by modest sized construction companies which specialize in wood frame buildings. Research continues to be needed to improve on the durability and utility of these farm buildings. These buildings can include: machinery storage, equipment storage, feed and fiber storage, chemical storage, and livestock and poultry production.

Many outstanding extension publications or other types of outcomes have been produced at various Land Grant universities where there still is an active agricultural structures program. An example of extension outputs are the 24 fact sheets from Penn State Agricultural and Biological Engineering Department related to livestock structures. These are available via their web site. http://www.abe.psu.edu/extension/factsheets/g/index.html There are other states which provide a similar service of fact sheets or construction plans. Extension information from Missouri and be accessed with the following web site http://extension.missouri.edu/xplor/agguides/agengin/

KA 401: Structures, Facilities, and General Purpose Farm Supplies' Key Outputs and Outcomes:

2008 Key Outputs and Outcomes:

At the University of Wisconsin they are developing a sustainable post-frame building system. On today's modern farmsteads, virtually every animal housing facility, commodity storage building, and machinery storage and repair facility is a post-frame building. Investment in farm buildings is one of the largest capital intensive decisions that farmers make. The purpose of this project is to develop a new framing system for post-frame buildings that will substantially reduce use of preservative-treated lumber and will enable quick and easy transformation of the structure once its original functional life has passed. Lumber becomes increasingly expensive (on a board foot basis) in longer lengths. Additionally, dimension lumber is not readily available in lengths longer than 20 feet. When concrete piers are used, the overall length of the wood post is generally shortened by four to seven feet. This means engineers are using shorter, less expensive

lumber to obtain the same building heights, and can also build structures with 20 foot eave heights using unspliced sidewall posts.

At South Dakota State University they are developing mechanical and biological methods for removing dust and odors from the air in swine production units. This will improve the environment for the swine and reduce health problems and improve animal performance. These research efforts were conducted with an emphasis on the design of a commercially produced biofilter that integrates seamlessly into swine production facilities. The performance of the biofilters indicated that this device is an effective means of reducing odor emissions from mechanically ventilated livestock barns. There were no structure problems on the biofilter after 9 months of operation. Static pressure drop across the wood chip biofilter media increased by 18% after six months of settling.

At the University of Alaska research is underway on greenhouse production, often called Controlled Environment Agriculture (CEA) which is a high cost system for high-value crop production. This system allows production of plants out of season, provides for more efficient use of water and energy resources, and increases yields per unit area compared to field crop production. The goal of this project is to make significant advances in greenhouse production by improving the utilization of water and nutrients with related reduction in negative environmental impact, developing a control strategy for natural ventilation of greenhouses, and improving the integration of automation, plant culture and environment into a cost effective, sustainable production system for vegetables, specialty and floricultural crops. Maintaining suitable greenhouse air temperatures can be difficult during periods of hot summer weather. Instead of cooling the air, lowering the temperature of the nutrient solution is an effective approach for continuous high rate of hydroponic lettuce production. Therefore to sustain growth in hydroponic systems during heat waves, a cooler nutrient solution is an effective local greenhouse strategy.

2007 Key Outputs and Outcomes:
Two examples of special grants are Ohio State University and the project, “Hydroponic Tomato Production” and Michigan State University and the project “Advanced Technology Application to Eastern Hardwood Utilization”.

A Hydroponic Vegetable Program began in the spring of 1999 to foster hydroponic greenhouse vegetable businesses in Ohio by providing horticultural, marketing, business planning, and greenhouse design support. The support was provided by direct contact with individuals, seminars, tours, interactive Internet websites and a demonstration greenhouse at the Toledo Botanical Garden. This work greatly increased the chance of success for new hydroponic vegetable and flower growers.

The main goal of this Michigan State University project is to extend the service life of forest products particularly hardwood species through preservatives, reuse of treated wood, recycling of wood removed from service and the application of biotechnological means for the production of high decay resistant wood. This project is providing basic

and applied information to maintaining the vitality of hardwood-based industries throughout the US. Moreover, its focus on increasing utilization efficiency and product life have yielded utilization efficiency increases as high a 22 percent, which translate into less wood harvested and moves the US toward truly sustainable forest utilization patterns. They have successfully enhanced the durability of eastern hardwood by using environmentally acceptable wood preservatives with good performance and little to no impact on the surrounding environment. Wood-plastic composites (WPCs) have been developed and are being used to recycle used plastics and reduce the need for valuable wood resources.

Knowledge Area 402: Engineering Systems and Equipment

KA 402: Engineering Systems and Equipment' Introduction:
Knowledge Area 402, *Engineering Systems and Equipment*, concentrates on increasing production efficiency while decreasing dependence on labor through mechanization of agricultural and forestry production and processing tasks. New processes, machines, devices, and other technology are crucial to systems that produce and process bioproducts. By merging biological sciences with engineering design principles, this KA provides necessary biological engineering research capacity and helps train the next generation of professionals. The scope of this problem area, though broad, does have important limitations. KA 402 includes:

- Tillage, planting, nutrient and chemical application, and harvesting systems including geographical information systems, sensors, and robotics but not including irrigation and drainage systems; and,
- Handling means for animals, plants, animal products and plant products, but not food and non-food product processing, storage, and marketing.

The manual of classification in use between 1998 and 2002 does not clearly differentiate between this knowledge area and knowledge areas 205, 207, 307, 404, 501, and 511. It should not include: Food and non-food processing; crop, herd, and forestry management; or irrigating systems. As a result, about 35 percent of the projects that cite 402 focus primarily on systems and equipment as defined above while 9 percent focus on structures and facilities (KA 401), 19 percent on instrumentation and control systems (KA 404) and 42 percent on other areas (including KA's 205, 207, 307, 501, and 511).

According to data collected by the National Agricultural Statistics Service (NASS), in 2002 United States farms spent at least $48.3 billion (25.4percent of all farm expenditures) on labor related expenses. This sum does not include the equivalent of the principal operator or his families' hourly wage, i.e. profit. In sharp comparison, NASS estimates that U.S. farms spent $26.2 billion (13.6percent) on farm machinery and equipment including maintenance and fuel. This figure also includes farm building renovations and repairs, so the actual amount spent on machinery and equipment is somewhat lower. Given that the average farm spends at least twice as much on labor as it does on machinery and equipment, agriculture's research and outreach community has a responsibility to develop novel and improved systems to reduce labor costs and increase farm production efficiencies.

The above data also does not account for lost time due to farm work related injuries, illnesses, and fatalities. Even conservative estimates of the cost of farm-related fatalities, injuries, and disease suggests that the agricultural safety and health problem is a $4.5 billion annual issue (National Safety Council, 2001) with substantial potential for large returns on investments made to reduce or eliminate the losses.

New engineering systems, especially equipment and machinery designed to reduce labor demands while preserving product and environmental quality, hold great potential to

reduce labor costs while increasing machinery related costs less than a commensurate amount which would hopefully result in increased profits (or at least reduced debts) for producers.

KA 402: Engineering Systems and Equipment's Logic Model

Situation	Inputs	Activities	Outputs	Outcomes		
				Knowledge	Actions	Conditions
According to a National Agricultural Statistical Service (NASS) report, United States farms spent at least $48.3 billion on labor related expenses and only $26.2 billion on farm machinery and equipment including maintenance and fuel. There is a growing need to develop novel and improved systems to reduce labor costs and increase farm production efficiencies. New engineering systems designed to reduce labor demands while preserving product and environmental quality, hold great potential to reduce labor costs while increasing machinery related costs less than a commensurate amount which would hopefully result in increased profits for producers.	**Financial Resources:** - Federal - State - Some provide funding that contributes to research, extension and education. **Human Capital:** - CSREES NPLs - Researchers - Faculty - Extension Practitioners - Teachers - Para-professionals - Stakeholders - Volunteers	- Integrate new soil sensor technologies with farm input application actuation components while developing an automatic guidance system for vehicles - Create and supply producers with tools that both contribute to agricultural productivity and address environmental quality and regulatory requirements - Developed equipment modification and evaluated equipment effectiveness by measuring crop yield, quality, and production efficiencies following implementation of experimental modifications - Developed automated growing systems that are adaptable with advanced life support systems that are capable of supporting human life for long-duration space missions - Developed farm dosing systems that are responsive to field needs	- New fundamental or applied knowledge - Scientific publications - Patents - New methods & technology - Practical knowledge for policy and decision-makers - Information, skills & technology for individuals, communities and programs - Participants reached - Students graduated in agricultural sciences	- Increased knowledge regarding the benefits of using GPS systems in farming and other agriculture related work - Increased producers knowledge about selecting equipment for purchase, maintenance activities, farm task assignments, and later sale - Increased producers' knowledge about the benefits of equipment modifications - Increased knowledge regarding the use of automated growing systems for human life support for long-duration space missions - Increased producers' knowledge about the efficient application of fertilizers, pesticides, and other chemicals	- Reduced minimum skills required to successfully navigate a tractor - Reduced time required to prepare fields - Assisted producers to adopt a rational basis for selecting equipment for purchase, maintenance activities, farm task assignments, and later sale or salvage - Provided a common framework for factoring equipment and machinery business decisions into the farm's greater economic outlook - Adapted commercially produced equipment systems to minor use crops and specialized applications to make such ventures more profitable	- Increased agricultural profits - Increased crop yields - Helped crop producers minimize soil erosion in some fields and improve crop performance when using no-till and other high-residue planting methods - Reduce labor costs - Encouraged broader user participation and effective information integration within the scientific and engineering communities - Protects natural resources through the introduction of less nutrients, hormones, and pesticides

ASSUMPTIONS - The U.S. agricultural sector must be able to quickly respond to changing political, economic, technological, environmental, and consumer-driven market forces.

EXTERNAL FACTORS - Agricultural production and marketing are constantly affected by external factors such as weather and growing conditions, diseases and pests, financial conditions, cultural practices, and consumer demand. New and emerging risks associated with domestic and international policy, genetic technology, exotic invasive species, and complex agricultural diseases that can affect humans defy conventional means of identification, quantification, and management.

KA 402: Engineering Systems and Equipment's Key Activities:

Specialty crop industry stakeholders, university and federal researchers, educators, and federal program managers met in early 2007 for a workshop entitled, "Engineering Solutions for Specialty Crop Challenges." The workshop provided a forum for special crop industries to engage the science and technology community. Industry representatives voiced their concerns with regard to productivity, production efficiency, post-harvest processing, and environmental quality. In response, the research community offered some engineering science and technology capabilities that could form key components of eventual solutions. A workshop report details the dialog and will be used as guidance for future federal science and engineering investments to assist this important segment of U.S. agriculture. (2007)

Following passage of the Food, Conservation, and Energy Act of 2008, the agency issued a Request for Applications (RFA) to implement the Specialty Crop Research Initiative that was authorized with mandatory funding in the above-mentioned Act. That solicitation called for proposals covering five legislatively mandated focus areas. One of those focus areas includes new innovations and technologies, which was further defined to include robotics, precision agriculture, and sensors. (2008)

KA 402: Engineering Systems and Equipment's Key Outputs and Outcomes:

Key Outputs and Outcomes Identified in 2008

Performance of Innovative Native Seed Harvester: Every year natural and man-caused disturbances (wildfire, construction of highways and facilities, mining, noxious weeds infestation, and overgrazing) damage and destroy millions of hectares of native vegetation. These disturbances require restoration, and federal entities emphasize the use of native plant materials. Long term treatment plans call for reseeding native species, but seeds are unavailable in the required quantities. Arbuckle Ranch Inc. developed and tested a machine, Seedster, incorporating Arbuckle's patented technology to: 1) improve the percent of seed recovery from desirable yet difficult to harvest native plant species, and 2) harvest seed from species that cannot be satisfactorily harvested by other means. The Seedster revolutionizes the seed harvest of native grass species that are difficult-to-harvest, increasing supply and expanding the species available for reclamation uses. The patented seed dislodgement technology in the Seedster is most beneficial for difficult-to-harvest species with panicle inflorescence. A study done by the Arbuckle team with funding from the Montana Board of Research and Commercialization Technology found that panicle inflorescence species comprise about 80% of native perennial species in the 17 western states. This will help correct the historical imbalance in favor of spike inflorescence species in reclamation and reseeding of grasslands. (2008)

Development of a Small, Semi-Autonomous Vehicle for Reducing Fuels in Forests: Fires, which are now suppressed in the Western U.S., historically thinned uncharacteristically dense forests, reducing stand densities by removing weak and suppressed trees.

Furthermore, the present forests occupying the inland West are prone to epidemic insect and disease outbreaks as well as catastrophic stand replacing fires. Mechanical means of reducing the forest density before fire is applied appears to have the greatest likelihood of success and may be the safest and cheapest way to improve these "unhealthy" forest conditions. Unfortunately, the large equipment presently used for timber harvesting is expensive, causes environmental degradation, and is usually not cost effective when used with small diameter trees. Low impact, efficient, safe equipment that could be used to remove and/or redistribute these materials before applying prescribed fire would not only benefit the resource but would also help support local economies. The purpose of this project is to develop a small, semi-autonomous vehicle for reducing fuels in forests.

The technology under development will allow an operator to monitor and control a number of small, unmanned vehicles that can operate autonomously. These vehicles will reduce the cost of removing small diameter trees and provide an effective tool for economically reducing fire hazards in our National Forests and at the rural-urban interface. These small, semi-autonomous vehicles will eventually result in a commercial product. (2008)

Knowledge Area 404: Instrumentation and Control Systems

KA 404: Instrumentation and Control Systems' Introduction:
The knowledge area, Instrumentation and Control Systems (404), aims to create the scientific and technological knowledge base that will enable producers, processors, and land managers to collect, analyze, and apply precise and timely information. Throughout production and processing of food and non-food products, new devices and instruments are needed to help end users understand and respond to constantly changing production and processing environments.

Technological advances will enable agricultural production, processing, and distribution to be more efficient, use fewer resources, and improve economic viability. Agency-wide programmatic direction supports three, sequentially dependent activity areas: (1) data collection, (2) analysis and interpretation, and (3) decision support for application to management or policy making. This includes sensing devices, information and decision support systems, simulation models, controllers and actuators, communications, and new agricultural practices and infrastructures that are compatible with increasingly data-rich environments. Because these systems create entirely new agricultural and natural resource capabilities, training new professionals and outreach to end-users are essential companion objectives.

Instrumentation and information systems are important elements in all aspects of pre- and post-production agriculture. Sensors for detecting and monitoring and processing of the collected data can provide improved control of the production and processing of biological and non-biological materials.
Areas of research include but are not limited to:

- Development of instruments, research technologies, and procedures that enhance agricultural efforts.
- Determining accurate and precise standards of measurement.
- Development of sensors, image processing techniques, automation, decision support systems, controls, and models.

Exclude research on:

- Experimental design and statistics (Use KA 901)

Because of the broad applicability of instrumentation and control systems, inputs, outputs, and outcomes are diffused throughout the agency efforts on many national issues The following logical organization of Knowledge Area 404 depicts three broad emphases along with several subordinate topics.

Biophysical sciences and chemistry

- Basic research
- Materials & processes
- Proof of concept

Engineering and technology development, testing, and validation

- New devices and/or systems
- Laboratory, and in situ, testing
- Application development

Adoption, economics, and decision support
- Aides & barriers for adoption
- Applications & economics
- Information management & decision support

Nearly all other programmatic areas within the agency benefit from the research and application capabilities afforded by developments in this problem area. These include, but are not limited to, agricultural & food safety/security, air, soil & water quality, inspection & monitoring, nutrient management, carbon management, agricultural & forest production, water management, pest management, invasive species, forest management, ecosystem studies, wildlife management, and animal & plant health. Because of the broad applicability of instrumentation and control systems, inputs, outputs, and outcomes are diffused throughout the agency efforts on many national issues

Direct, human observations can provide only general and unreliable qualitative information about crop development and health, food safety, and environmental quality. Furthermore, such observations are extremely limited in time and location. We often need more exact quantitative measurements with greater frequency and at many locations. Measurement needs cover a broad range of spatial scales (from landscape-level assessments to bacteria counts on individual food products) and vastly different time frames (from decadal climate change to continuous air monitoring near livestock operations). Sensor systems can make these needed measurements at high spatial and temporal frequencies. Engineered sensors and companion instrumentation and software extend human observational capabilities to help ensure that our crops are healthy and productive, our food is safe and nutritious, and our indoor and outdoor environments remain uncontaminated. Advances in biometrology and information technologies are required to address our need for timely and reliable information that has temporal and spatial relevance.

Collecting data from one instrument, or many instruments, is only the first step in the overall decision-making process, which might be inspection, monitoring, tracking, etc. Often, many other components, e.g., data bases, simulation models, mathematical optimization, must be combined to form a fully developed decision support system (DSS). The final output of a DSS is a recommendation, interpretation, or prediction regarding the situation of interest, such as crop treatment, food safety, or water quality. DSSs may also incorporate economic models or calculations to determine which courses of action are reasonable. Other exogenous factors that might need to be considered include operational cultures within the organization or the industry or current financial markets.

KA 404: Instrumentation and Control Systems' Logic Model:

Situation	Inputs	Activities	Outputs	Outcomes		
				Knowledge	Actions	Conditions
Direct human observation can provide only general, unreliable qualitative information about crop development and health, food safety, and environmental quality. We often need more exact quantitative measurement with greater frequency at more locations. Advances in biometrology (including chemical, biological, electrical, and materials engineering: and information technology are required to address our need for timely and reliable information that has temporal and spatial relevance.	**Financial Resources:** - Federal - State - Some provide funding that contributes to research, extension and education. **Human Capital:** - CSREES NPLs CSREES administrative support - Researchers - Faculty - Extension Practitioners - Engineers - Teachers - Para-professionals - Stakeholders - Volunteers	- Fundamental investigations in the biological, physical, and chemical sciences lead to new or improved sensors - Develop new materials with sensing characteristics - Engineer new devices and systems and support commercialization of technologies - Sponsor academic and public outreach programs to deliver new production methods and technologies to agricultural producers and land managers - Integrate new science-based knowledge and technologies to optimize efficient, economically and environmentally sustainable agriculture production systems that are appropriate in size and scale - Curricula are designed to provided students with the scientific and technical bases to develop and implement better production technologies and methods and to better manage natural resources	- New fundamental or applied knowledge - Scientific publications - Patents - New methods & technology - Practical knowledge for policy and decision-makers - Information, skills & technology for individuals, communities and programs - Participants reached - Students graduated in agricultural sciences	- Training in geospatial technologies leads to greater adoption and effective application by farmers, communities, and land managers - Scientific development lead to new sensor prototypes with improved sensitivity and specificity - Academic programs expand their instrumentation and sensor curricula - Developed an understanding of the integration of these technologies into existing economic, social, and production systems	- New sensors, and companion information systems, are commercially available - A new cadre of agricultural and natural resource professionals is skilled in sensors and information technologies. - Smaller, faster, smarter sensors greatly expand the range of applications that can readily benefit from the technology - Adoption rates of advanced sensing systems increase	- Adoption of new technologies creates significant economic and environmental benefits for producers and land managers - New technology sales and support and development of companion industries, infuses rural communities with high-paying jobs and a strong economic base - Food products are safer, ag production and processing systems are more efficient and controllable, and environmental quality improves - The increasingly high-technology aspect of food production attracts more youth with greater technical skills

ASSUMPTIONS – Engineered sensors and companion instruments and software will extend human observational capabilities to help ensure our crops are healthy and productive, our food is safe and nutritious and our outdoor environments remain uncontaminated

EXTERNAL FACTORS - Demand for instruments and sensors will depend on the need for increased date quantity and quality by agricultural producers and land managers. Decision support and information systems must satisfy the complexities of biophysical and socioeconomic environments and must support policy making

KA 404: Instrumentation and Control Systems' Key Activities:

Because this engineering and technology problem area is broadly applicable across many of the agency's emphases, it appears almost everywhere. Many Agriculture and Food Systems, the Small Business Innovative Research Program, the Section 406 Programs, Hatch, Smith-Lever, and McIntire-Stennis projects, and Integrated Pest Management support work in Problem Area 404. Work is supported that includes technology development, as well as, information systems and decision support. Both areas are covered by the Problem Area description. However, when funded projects are classified for recording in the Current Research Information System, the assigned problem-area classification usually focuses solely on the problem being address, e.g., food safety; soil quality, post-harvest inspection, but fails to account for the engineering component of each project. This results in a serious under-reporting of 404 activities. While similar under-reporting problems are not uncommon in other problem areas, they are most pronounced in 404 due to its sole emphasis on enabling technologies. (2004)

The agency issued a Request for Applications (RFA) to implement the Specialty Crop Research Initiative in 2008. That solicitation called for proposals covering five legislatively mandated focus areas. One of those focus areas includes new innovations and technologies, which was further defined to include robotics, precision agriculture, and sensors, which are within the scope of this KA as well as KA 402. (2008)

KA 404: Instrumentation and Control Systems' Key Outputs and Outcomes:

While numbers of scientific publications are not a good absolute measure of program performance (owing to a large percentage of publications appearing after project termination), they represent one of the few metrics of program outputs that are regularly collected. Data from 1998-2002 suggest that approximately 3.2 publications were generated in every project-year. By applying this approximation to all project-years for 404 activities (1868 project-years), we estimate a total of 5977 publications for the 1998-2002 reporting period. (2004)

Training graduate students is often viewed as more beneficial in the long run than large numbers of publications. Our estimates indicate that approximately 125 FTEs were allocated annually to graduate students. This translates into 250 half-time graduate students receiving training each year. (2004)

*Radio Frequency Energy for Control of Walnut Pests: an Alternative to Methyl Bromide***,** Washington State University; USDA-ARS-SJVASC, Parlier, CA; University of California, Davis (Methyl Bromide Transitions). Radio frequency (RF) treatments effectively control insect pests at life stages present in in-shell walnuts without negatively affecting walnut quality or storability. This process is technically feasible for large-scale commercial application. The RF treatments can potentially serve as a non-chemical alternative to chemical fumigants for post-harvest pest control in similar commodities, such as almonds, pecans, pistachios, lentils, peas, and soybeans, reducing the long-term impact on the environment, human health, and competitiveness of agricultural industries

in an increasingly competitive global economy. A book on heat treatments for postharvest pest control in theory and practice was also produced for CABI Publishing Company in UK. It should serve as an important resource for readers who are interested in knowing the methods and strategies that were used in the development of this environmentally-friendly pest control processes based on thermal energy. (2007)

An Automated Tool for Deriving FARSITE Canopy Fuel from Airborne Lidar Data (SBIR). The USDA is the managing agency for 192.5 million acres, much of which is national forest. Uncontrolled wild land fires are a major threat to goods and services provided by national forests, including natural resources (timber), forage for livestock and wildlife, outdoor recreation, and a vector to sequester carbon. Healthy forests provide habitats for various plant and animal species and protect soil quality, prevent soil erosion, and improve water quality. This project will allow the USDA and other federal and commercial agencies to calculate forest biomass and potential fuels. Customization services will be sold to end-users in the fire management, timber, and insurance industries in conjunction with a web-based visualization application FIRESCAPET. Our browser-based mapping application fuses and displays data from real-time sensor networks for active fires with numerous remote-sensing imagery and weather forecast products. The services developed under this project will directly fill a significant deficiency in the firefighting community. (2008)

Advanced Development of a Low-Cost, Handheld Electrochemical Ethylene Monitor (SBIR). Ethylene is a plant hormone that is involved in regulating various aspects of plant growth and development such as seed dormancy, seedling growth, root and stem thickening, promotion of flowering, and promotion of fruit ripening and spoilage. Measurement of ethylene is important for developing a basic understanding of these processes, as well as for utilization in advanced agricultural practices. Ethylene plays a key role in the production and storage of agricultural products. The current standard analytical technique (gas chromatography) requires expensive instrumentation (>$15,000) that is not readily portable and requires highly trained personnel for operation. The overall purpose of the project is to contribute to higher agricultural yields, to improve quality and cost of food and other plant products, and to enhance U.S. commercial competitiveness in global import and export of agricultural products.

Giner, Inc. is developing a small, cost-effective, rugged instrument with high sensitivity, low detection limit and rapid response. This device could contribute to a safe, nutritious and affordable food supply first by enhancing apple production (price and quality) and then other produce. Apple production economically benefits rural America with the 2004 U.S. cash receipts from apples exceeding 1.7 billion dollars (ERS, USDA 2005). In addition, improvements in produce storage and shipping conditions, which this technology may facilitate, could increase U.S. companies' import and export of agricultural products which is important for being competitive in a global marketplace. (2008)

Map@Syst is an eXtension community of practice (supported by eXtension.org) devoted to the outreach and education for geospatial technologies and their application to today's

world. The Map@Syst community provides information on using geospatial technologies and how geospatial technologies are making a difference in peoples' lives. (2008)

Knowledge Area 501: New and Improved Food Processing Technologies

KA 501: New and Improved Food Processing Technologies' Introduction

The long term goal of this knowledge area is to establish a world class research and extension programs to continuously advance scientific frontiers, including nanoscale sciences, and develop processes and technologies for improving food quality and safety for human consumption and increasing product value that makes substantial contribution to the national economy. Work in this knowledge area focuses on development or improvement of methods, techniques, processes, and materials for improving food nutritional and sensory qualities. At the same time, some of the processes can also benefit food safety against biological hazards exited or developed during long food distribution chains. Short term goals are to seek new and improved food processing technologies to maintain or improve quality and functionality, stabilize or preserve foods, or prepare foods for further processing.

This KA is an important and integral part of the portfolio. It encompasses all the elements in science, engineering and technology relevant to research, development and outreach of novel and improved food processing technologies. It supports the portfolio mission and vision in ensuring a sustainable food supply for the nation and beyond.

This KA does not included subjects such as : utilization of food processing wastes (use KA 403), economics of food processing (use KA 603), nutrient composition of foods (use KA 701), and nutrient requirements and bioavailability (use KA 702).

Agriculture and food system is the second largest national economy after energy sector. Postharvest activities contribute up to 80% of it. Knowledge in science, engineering and technology is the critical foundation of value added processes throughout every step after farm gate. This KA has been an essential contributor to effectively address important challenges with a good balance among research, extension and education. It can make even great contributions if more resources can be allocated to it.

KA 501: New and Improved Food Processing Technologies' Logic Model:

Knowledge Area 501: New and Improved Food Processing Technologies

Situation	Inputs	Activities	Outputs	Outcomes		
				Knowledge	Actions	Conditions
Description of challenge or opportunity - Farmers face increasing challenges from globalization - Opportunity to improve animal health through genetic engineering - Insufficient # of trained & diverse professionals entering agricultural fields - Youth at risk - Invasive species is becoming an increasing problem - Bioterrorism - Obesity crisis - Impaired water quality	**Financial Resources:** - Federal - State - Some provide funding that contributes to research, extension and education. **Human Capital:** - CSREES NPLs - Researchers - Faculty - Extension Practitioners - Teachers - Para-professionals - Stakeholders - Volunteers	**Research:** - Develop and verify the model to stimulate air impingement -Develop & improve measurement techniques during thermal processing of foods -Develop new cooking methods to improve quality & safety of hamburger patties **Education:** - Curriculum development - Sabbaticals - Equipment Grants - Capacity and Facility Building - Distance Education - Undergraduate and Graduate Student Training **Extension:** - Develop outreach programs and partnerships	- New fundamental or applied knowledge - Scientific publications - Patents - New methods & technology - Practical knowledge for policy and decision-makers - Information, skills & technology for individuals, communities and programs - Participants reached - Students graduated in agricultural sciences	Better Understanding of… - Flow & heat transfer in foods - Models to simulate air impingement freezing & increased understanding of the effect of external thermal boundaries & its time dependence - Time temperature indicators for use in food distribution and retail	- Improved process efficiency and heat transfer in foods - Model widely used by frozen food operators - Developed a desktop version - Developed Outreach Centers for Entrepreneurs - Developed partnerships with the food producers and application of the results for end use	- Energy efficiency in processing - More nutritious processed foods

ASSUMPTIONS - Changes in food preparation are feasible and cost efficient and will be accepted by consumers, restaurateurs, and food processing personnel.

EXTERNAL FACTORS - Variable funding; scientific advancements; changing priorities; producers' and consumers' attitudes; natural disasters; economic conditions; coordination and cooperation with other government entities; public policy

KA 501: New and Improved Food Processing Technologies' Key Activities:

The NRI program continues supporting research in new and improved food processing technologies. This competitive research program funds projects in advanced and innovative processing, engineering, and technologies that enhance food quality attributes and development and application of analytical characterization techniques of physical, chemical, biological, and sensory natures. Applications addressing combined and inseparable quality and safety objectives are supported in this program.

For example:

High Pressure Dependence of Compressibility, Density, and Viscosity of Model Food Systems: High pressure processing technology has been investigated in this study to produce high quality, and fresh flavor while assuring their safety. This "non-thermal" pasteurization method can increase the American food industry competitiveness and consumer appeal of food products. This project aimed to develop methods and instruments to measure a key property of foods, compressibility, under high pressure. The data obtained at different food compositions, temperatures, and pressures allow thermodynamic modeling, and therefore prediction of compressibility under commercial processing conditions.

Mathematical Modeling and Experimental Validation of Continuous Flow Microwave Heating of Liquid Foods: The purpose of this project was to develop a validated model that can be used to design a continuous flow microwave processing operation for traditionally hard-to-heat fluid foods with enhanced quality and safety controls.

The NRI program has added integrated projects in this knowledge area.

For example:

An Integrated Approach to Enhance the Teaching, Research and Extension of Modern Food Processing and Preservation Technologies: This integrated project was to enhance the integration of education, research and outreach of modern food processing and preservation technologies; and examines whether the major new and emerging food processing technologies are effective in inactivation peanut allergens.

Nanoscale engineering and technology represents the new frontiers of research discoveries and process developments. The agency supports this area through a variety of funding mechanisms including NRI and Formula funds.

Two examples funded through Hatch fund are as follows:

Improved Food Flavorings through Controlled Release: Food flavor release control is a critical quality attribute. This project intended to determine some of

the basic factors influencing the "release" of encapsulated aroma compounds. The results of this study shed light on release during process and storage as well as during eating; and thus provide useful information to food processors in the optimal delivery of flavorings to the final consumer.

Effect of Surfactants on Hydrophobic Solute Delivery in Biocompatible Systems: This project addressed the need to predict and control the rate at which flavors, nutrients and nutraceuticals are released from foods, by identifying and studying the controlling mechanisms for solute transport. A novel microemulsion-based system was also developed, to provide a transparent, stable vehicle for delivering flavors and hydrophobic nutrients. Microemulsions can deliver solutes in foods, drugs, and cosmetics.

CSREES continues to provide leadership and administers Congressional earmarked grants to conduct research in new and improved food processing technologies. Two examples are provided below:

Modified Atmosphere Packing and Postharvest Quality of Pigeon Pea: Puerto Ricans prefer fresh vegetable pigeon pea to canned, frozen or dried pigeon peas, and due to the preferred flavor of fresh pigeon pea, they command a higher market premium, selling for more than twice the price of the dried product. Nevertheless, the season for fresh pigeon pea in Puerto Rico is much narrower than desired. Modified atmosphere packaging is one possible way to extend the postharvest life of fresh pigeon pea, thereby, adding value to the crop and increasing the return for the growers. The work in this proposal continued to build upon the baseline physiological data and MAP work collected previously, by examining the food safety aspects and marketing opportunities of MAP for pigeon pea.

Improving Safety of Complex Food Items Using Electron Beam Technology: With almost 25% of food production after harvest in the United States lost due to damage caused by bacteria, mold, and contamination with spoilage microorganisms, it is imperative to investigate the applicability of promising alternative technologies that can be used to improve the safety of ready-to-eat and fresh agricultural products. The recent progress in the development of electron beam accelerators together with the increased number of illness associated with produce-associated food borne disease outbreaks in the last years, provide the incentive for the development of an efficient technique to ensure hygienic quality of food products, especially those to be consumed raw or undercooked, to protect consumer health. Yet, despite the advances in irradiation methods available, satisfactory irradiation of fresh produce requires strict process control to ensure that the dose delivered to all parts of the treated product falls within some specified range. Hence it is necessary to assess the ability of a given irradiation system to deliver the required dose to the products intended for treatment This project was aimed at the engineering, design, education, and dissemination of an alternative technology that may help ensure that the U.S. will have a safe and

plentiful supply of fresh fruits and vegetables. This directly addresses one of the priority research areas established under this KA.

SBIR program supports applied food technology development. For example:

Applied Food Technologies received a SBIR Phase I grant in FY 2007 that developed a cost-effective DNA-based diagnostic tool to distinguish Red Snapper, *Lutjanus campechanus* from other snapper species. In the United States there are many species of snapper marketed worldwide and *L. campechanus* is known as the true red snapper and the only species that can legally be labeled "Red Snapper". A Phase I research was funded to develop a species-specific primer that discriminates red snapper from the competitor. A follow-up Phase II was funded in FY 2008.

<u>KA 501: New and Improved Food Processing Technologies' Key Outcomes:</u>

Key Outcomes:

High Pressure Food Processing Systems Resulted in Super Fresh and Safe Products: Researchers developed and instrumented a novel ultrasonic high-pressure measurement device which offers a new capability to measure an array of important food physical properties under a wide range of processing pressure and temperature conditions, and predict each property as a function of temperature, pressure and composition. The advance in understanding of thermodynamic relationships of foods subject to high pressure process will lead to better process and equipment designs for significant improvement of food freshness and safety. The success of this project will ensure move processed fresh fruits and vegetable products available to consumers, hence support the USDA new food nutrition pyramid guidelines. [NRI]

Mathematical Modeling of Continuous Flow Microwave Heating of Liquid Foods: The mathematical model developed will serve as a tool to hone in on the appropriate system and process parameters that will result in the production of a high quality and safe viscous food product aseptically produced. It will eliminate the need for expensive and time-consuming experimental runs. [NRI]

Integrated Approach to Enhance the Teaching, Research and Extension of Modern Food Processing and Preservation Technologies: The project has shown a great potential to enhance the science and education of modern food processing and preservation technologies. This project produced a model, once implemented at other higher educational institutes that can offer shared resources among the institutions worldwide that offer food science and technology programs. It contributes to effectively building future workforce for the food processing industry. [NRI Integrated]

Improving Food Flavorings through Controlled Release: Researchers successfully developed an advanced process that meets the critical challenges in the food industry i.e. controlled release flavoring systems. Many food processes could benefit from a flavor

that is thermally released so it is protected from reaction or volatilization prior to the process. This represents a paradigm shift in technology for the food industry. [Hatch]

Nanotechnology Leading to Novel Functional Foods for Improving Health: New knowledge was developed in understanding the effect of the milk protein alpha-lactalbumin on the nanostructures formed by phospholipid-based biocompatible surfactants. A new approaches, based on fractionated, nearly monodisperse emulsions, for measuring the rate at which oil and other hydrophobic materials are released from droplets during emulsion breakdown and solute release has been developed. Nanometer self-assembled surfactant structures, including microemulsions and lamellar vesicles, could fundamentally change the food processing means to deliver solutes such as therapeutics, micronutrients and flavors in foods, drugs, and cosmetics with unprecedented product stability and easy control of release on demand or biomarker triggers. [Hatch]

Modified Atmosphere Packaging to Improve Postharvest Quality of Pigeon Pea in Puerto Rico: The research and extension project has developed and provided guidelines for optimum storage conditions to double the shelf-life of fresh pigeon pea, which is an important staple crop in Puerto Rico. This project could resulted in an increase in human consumption of fresh pigeon pea and green-shelled common beans both locally and oversea. It also could increase the value of pigeon pea and provide greater economic return to the grower. [Special Grant]

Improving Quality and Safety of Complex Food Items Using E-Beam Technology: An innovative mathematical scheme was developed to precisely calculate X-ray dosage in 3-D complex and non-homogeneous shaped foods. The new knowledge provided critical information to ensure effective irradiation processes to ensure food quality and safety. It will help improve consumer confidence and acceptability of irradiation processed foods and ingredients. [Industry Grant]

Applied Food Technologies received a SBIR Phase I grant in FY 2007 that developed a cost-effective DNA-based diagnostic tool to distinguish Red Snapper, *Lutjanus campechanus* from other snapper species. In the United States there are many species of snapper marketed worldwide and *L. campechanus* is known as the true red snapper and the only species that can legally be labeled “Red Snapper”. The Phase I research developed a species-specific primer that discriminates red snapper from the competitor. The Phase I project was able to successfully procure and authenticate *L. capepechanus* and *L. purpureus* (a competitor species). The Phase I results will lead to an effective qualitative assessment tool to ensure product quality, supply and proper labeling. This project will contribute to better management of fishery resources by reducing consumer fraud from misbranding of the true red snapper species. A follow-up Phase II was funded in FY 2008.

Knowledge Area 502: New and Improved Food Products

KA 502: New and Improved Food Products' Introduction

This KA includes research, education and extension activities to improve existing food products and developing novel food products. Specifically, this KA addresses basic chemical and biological mechanisms involved in the interaction of molecules in the food matrix in controlling structure, texture, stability, and flavor delivery in foods. In addition, this KA explores the stability and delivery of bioactive components in foods that exert a positive influence on health. This KA also addresses the instrumental and subjective evaluation of the sensory properties of foods.

KA 502: New and Improved Food Products' Logic Model:

Situation	Inputs	Activities	Outputs	Outcomes		
				Knowledge	Actions	Conditions
New products, new uses, and value added processes must have consumer acceptance to create effective demand. Bio-based technologies promise opportunities for energy, industrial, pharmacological, and other non-food markets for U.S. producers. New markets are emerging for environmental concerns. The foundation for economic and technological advancement is timely, valid and reliable research that leads to inventions and practices that help establish new products in the market place.	**Financial Resources:** - Federal - State - Some provide funding that contributes to research, extension and education. **Human Capital:** - CSREES NPLs - Researchers - Faculty - Extension Practitioners - Teachers - Para-professionals - Stakeholders - Volunteers	**Research:** - Increase knowledge concerning the physical properties of the systems sensitive to chemical reactions that impact food quality - Develop an understanding of the factors which promote lipid oxidation in food emulsifiers - Study the critical factors impacting the chemistry of lipid oxidation in food emulsions **Education:** - Curriculum development - Sabbaticals - Equipment Grants - Capacity and Facility Building - Distance Education - Undergraduate and Graduate Student Training **Extension:** - Develop outreach programs and partnerships	- New fundamental or applied knowledge - Scientific publications - Patents - New methods & technology - Practical knowledge for policy and decision-makers - Information, skills & technology for individuals, communities and programs - Participants reached - Students graduated in agricultural sciences	- Improved understanding on the mechanism of lipid oxidation in food emulsions - Improved understanding of factors affecting the chemistry of lipid oxidation in food emulsions - Improved understanding on the physical properties of the systems sensitive to chemical reactions that impact food quality	- Efficient anti-oxidant technology developed - New technologies to incorporate healthy lipids in foods - Patent application for the new anti-oxidant technology - Anti-oxidant technologies to prevent fish oils from developing off-flavors	- New antioxidant technology - High quality nutritious foods - New anti oxidant technology - Improved health

ASSUMPTIONS - Bio-based technologies are feasible and cost efficient and that the added cost will not significantly impact consumer income.

EXTERNAL FACTORS - Variable funding; scientific advancements; changing priorities; producers' and consumers' attitudes; natural disasters; economic conditions; coordination and cooperation with other government entities; public policy

KA 502: New and Improved Food Products' Key Activities:

Activity 1:

A series of Special, NRI and Hatch grants awarded to the University of Arkansas supported assistance to several food and related industries and collaboration with other institutions in solving problems facing the stakeholders. In doing this, the researchers have leveraged State and Hatch funds and took a multidisciplinary approach. Some specific activities included:

- Assistance to companies and entrepreneurs in developing new products, improving existing ones, and solving problems related to food processing, safety and utilization
- Collaborated with national and regional trade organizations, such as the Institute of Food Technologists, Ozark Food Processors Association, and the USA Rice Foundation, to develop and sustain relationships with food industry partners
- Partnered with FDA and other governmental and private organizations to present workshops for food industry personnel and entrepreneurs on timely issues such as food labeling, regulatory issues, food defense, etc.
- Promoted the application of Good Agricultural Practices, Good Manufacturing Practices (GAPs and GMPs) and HACCP through training activities such as the Better Process Control School and producer and industry workshops
- Developed and/or promoted new production, processing and packaging technologies that enhance product quality and industry profitability and ensure safety throughout the food chain from production to consumption.
- Developed and implement technology transfer to assist the food industry in developing value-added products that are safe, high quality, appealing, and healthy.
- Utilized appropriate technology transfer methods to communicate research findings and develop a nationally and internationally recognized industry outreach program.

Activity 2:

- A combination of Hatch and NRI grants awarded to Purdue University addresses the physical nature of the starch and how it affects the modification of starch for use in food and non-food applications. The investigator in part collaboration with a scientist from the University of Idaho discovered that starch has micro-channels through which reagents flow pass before reacting with the starch. He prepared corn starch samples with channel proteins, determined the influence of channel constituents on granular reactions, determined relative amounts of granule proteins and lipids in channels and characterized granule proteins and lipids.

KA 502: New and Improved Food Products Key Outputs and Outcomes:

Activity 1:

At the University of Arkansas, over the past 10 years, the investigators provided excellence in fundamental and applied research. They have successfully partnered with 147 different food industry companies in 34 States and 7 foreign countries. Industry financial support has been more than 7.7 million dollars. The Scientists have published over 325 peer reviewed journal articles. The funding sources were congressional line items, NRI, and Hatch projects. The titles of the projects are provided below for each output/outcome.

Arkansas produces nearly half of the nation's rice, primarily in its counties included in the Mississippi Delta Regional Authority. Twenty percent of harvested rice consists of hulls, the fibrous coat surrounding the grain that is rich in amorphous (non-crystalline) silica. The hulls are removed in milling and constitute a significant waste disposal problem. For twenty five years or more, mills have been burning at least a portion of the hulls. Producers Rice Mill (Producers), a leading Arkansas rice processor, alleviated its problem to some degree by developing and patenting a unique rice hull gasification system to burn rice hulls. The gases generated are combusted to generate electricity to power the rice processing plant. Although the waste problem is reduced, the carbon ash residue remains. Until recently, this residue was a low value material that was used by the steel industry as refractory material.

Dr. Andrew Proctor, Professor of Food Science, approached Producers with the concept of dissolving the amorphous rice hull ash silica with sodium hydroxide to produce sodium silicate and a carbon adsorbent. Adsorbent carbon is a high value commodity and sodium silicate is an important material used in the chemical and ceramics industries. Producers funded the initial research followed by CSREES funding (see sources of funding and titles below).

The investigators successfully demonstrated the concept and showed that the silicate and carbon could be separated and that additional products such as silica gel could be produced from the sodium silicate. Outreach activities included visits by the faculty to international chemical companies such as Dow Corning and Minco, invited presentation at the Fourth Renewable Resources and Biorefineries Conference at the World Trade Center, Rotterdam, Netherlands on ‘An innovative green industrial approach to convert rice hull waste to silicate and activated carbon’. The sources of funds were from NRI project entitled “Silica-based industrial products fro rice hull silica” and a Hatch project entitled “The use of rice hull ash in oil processing, silica gel production and basic absorption studies.”

Later, producers partnered with AgriTec in Texas to form a new company, AgriTecSorbents, LLC. (http://agritecsorbents.com), to commercialize the process. A $3.2 million plant was built in Stuttgart, Arkansas near Producers' rice milling facilities. The 2008 proposed annual production is 3,175 metric tons of carbon and 13,608 metric

tons of sodium silicate from processing 20,890 metric tons of rice hulls. The operation has a terrific opportunity for growth since 700 metric tons of hulls are produced each day during milling and only 60 metric tons of hulls are burnt each day. (The total Arkansas rice crop in 2006 generated 959,000 metric tons of hulls.) Furthermore, this operation provides significant employment and development opportunities to rural Arkansas and is the State's first green chemical company. Unilever Corporation and BASF are currently showing interest in this technology.

In rice processing, the underlying reason(s) for kernel fissure development during the drying process-a major cause of milling quality degradation-has been determined. Using the findings of this work, a pilot-scale fluidized bed drier has been installed at a major producer's drying facility. The goal is to more rapidly dry rice without compromising milling quality. The title of the project is "Institute of Food Science and Engineering, Arkansas", funded by congressional line item. A related activity funded under the same project has developed a shear-based apparatus and method for predicting beef or pork tenderness. This method is currently being evaluated for its ability to accurately identify the more tender meat cuts during slaughter and processing.

In bioactive components area, under different Special and NRI projects the investigators at the University of Arkansas have achieved the following;

Processing unit operations can result in significant losses of bioactive Compounds in berries. The investigators identified key steps where losses occur and devised various mitigation strategies. The funding source for this is a special grant entitled "Institute of Food Science and Engineering, Arkansas".

Waste materials from berry and grape juice processing represent an excellent source of antioxidant-rich polyphenols that can potentially be recovered. The use of pressurized hot water, known as "subcritical" water (SCW), has been has been demonstrated to be very effective and environmentally friendly as opposed to organic solvent extraction. The source of funding for this project is NRI and the title is "Molecular based design and optimization of sub-critical water processing of flavonoid-rich grapes/byproducts".

Conjugated linoleic acids (CLA) are known to inhibit carcinogenesis, atherosclerosis, and promote weight loss. CLA-rich soy oil was produced by exposing the naturally occurring linoleic acid in soy oil to ultraviolet light in the presence of a catalyst. This oil was used to produce a "healthy" potato chip, and the process allows for incorporation of CLA into a variety of baked and fried processed products. The soy oils produced thus far have significant health benefits, in particular, reduction in fat disposition. The next step is a move toward commercialization. The funding source is NRI and the title is "High CLA soy oil production using photo-isomerization".

Activity 2:

Modification of the inherent properties of corn starch is important to its use. The corn starch industry, which consumes more than 200 million tons of corn annually, prepares

modified starch for use by other industries without completely understanding relationships of its granular nature to modification reactions. Two benefits from application of this knowledge are possible: (1) since channel proteins appear to be important in the crosslinking modification, breeders should look for cultivars that produce starch granules with more channels, and (2) modifications of the commercial isolation process, which removes some of the channel protein, should be explored. With regard to the first possibility, methods were developed to determine the relative average number of channels per starch granule, methods that can be used by breeders to develop granules with more channels, which should be important in making modified corn starch products and in conversion starch to ethanol.

At Purdue University two procedures were developed to extract proteins from starch granule channels. Two methods of determining relative amounts of protein present in the extracts were developed. Determined that channels of corn starch granules are lined with proteins and lipids. Using proteomics, some of the proteins in the channels of normal corn starch were identified. In channel lipids phospholipid was identified as being exclusively, or almost exclusively, lysophosphatidylcholine with palmitic or linoleic acid as the fatty acid component. NRI Project title is Improvements in Modified Food Starches and that of Hatch project is Structure and Function of Carbohydrates for Commercial Use.

Published 4 papers and presented two papers at professional society meetings. The following papers formed the basis for work developed at Purdue University mentioned above.

1. J.E. Fannon, J.A. Gray, N. Gunawan, K.C. Huber J.N. BeMiller. 2003. The channels of corn starch granules. Food Science and Biotechnology 12:700-704.
2. J.E. Fannon, J.A. Gray, N. Gunawan, K.C. Huber J.N. BeMiller. 2004. Hetereogeniety of starch granules and the effect of granule channelization on starch modifications. Cellulose 11:247-254.
3. T. Ji, Z. Ao, J.-A. Han, J.L. Jane, and J.N. BeMiller. 2004. Waxy maize starch subpopulations with different gelatinization temperatures. Carbohydrate Polymers 57:177-190.
4. J.A. Gray, and J.N. BeMiller. 2005. Influence of reaction conditions on the location of reactions in waxy maize starch granules reacted with a propylene oxide analog at low substitution levels. Carbohydrate Polymers 60:147-162.
5. Z.-Z. Han, M. Benmoussa, J. A. Gray, J.N. BeMiller, and B.R. Hamaker. 2005. Detection of proteins in starch granules. Cereal Chemistry 82:351-355.
6. V.K. Villwok and J.N. BeMiller. 2005. Effects of salts on the reaction of normal corn starch with propylene oxide. Starch/Staerke 57:281-290.

With the help of research findings of the project at the University, an industry partner has developed a novel phosphorylated starch for food applications. The fine structure and physicochemical and functional properties of this novel corn starch are being elucidated. The source of funding is industry.

Knowledge Area 503: Quality Maintenance in Storing and Marketing Food Products

KA 503: Quality maintenance in Storing and Marketing Food Products' Introduction:

It is imperative to maintain quality of food products during storage, distribution and marketing for safe consumption and minimal economic losses. This KA includes understanding of and minimizing food chemical, biochemical, physical, and physiological, deteriorations during preservation, storage, distribution, and marketing to retain the quantity and quality of foods delivered to consumers, minimize food loss and costs, ensure food security, and enhance profitability for food producers and marketers. This KA is another important and integral subject area of the portfolio to ensure wholesome food supply for human consumption and reduce economical loss due to food spoilage.

KA 503: Quality Maintenance in Storing and Marketing Food Products' Logic Model:

Situation	Inputs	Activities	Outputs	Outcomes		
				Knowledge	Actions	Conditions
New products, new uses, and value added processes must have consumer acceptance to create effective demand. Bio-based technologies promise opportunities for energy, industrial, pharmacological, and other non-food markets for U.S. producers. New markets are emerging for environmental concerns. The foundation for economic and technological advancement is timely, valid and reliable research that leads to inventions and practices that help establish new products in the market place.	**Financial Resources:** - Federal - State - Some provide funding that contributes to research, extension and education. **Human Capital:** - CSREES NPLs - Researchers - Faculty - Extension Practitioners - Teachers - Para-professionals - Stakeholders - Volunteers	**Research:** - Develop non-chemical approaches to postharvest disinfestations of fruits and nuts - Study postharvest quality of fresh cut vegetables and fruit - Develop reusable containers for fresh produce and meat packing **Education:** - Curriculum development - Sabbaticals - Equipment Grants - Capacity and Facility Building - Distance Education - Undergraduate and Graduate Student Training **Extension:** - Develop outreach programs and partnerships	- New fundamental or applied knowledge - Scientific publications - Patents - New methods & technology - Practical knowledge for policy and decision-makers - Information, skills & technology for individuals, communities and programs - Participants reached - Students graduated in agricultural sciences	- Increased understanding of eliminating harmful chemical treatments for disinfestations of stored food products - Increased understanding of safe and effective methods of disinfestations for food using short duration fumigants - Increased understanding of reusable containers for fresh produce and meat packaging	- Rapid on-line processes may be developed to use rapid frequency heating to destroy insects in harvesting produce while maintaining quality - Treated fresh cut salads with ozone-chlorine dioxide improved and extended the shelf life - New bulk containers are market tested with excellent results	- Improved health - Improved food quality - Improved economic gains

ASSUMPTIONS - These bio-based technologies will enhance consumer confidence in the preservation and security of foods

EXTERNAL FACTORS - Variable funding; scientific advancements; changing priorities; producers' and consumers' attitudes; natural disasters; economic conditions; coordination and cooperation with other government entities; public policy

KA 503: Quality maintenance in Storing and Marketing Food Products' Key Activities:

- Effects of Mitochondria on Postmortem Myoglobin Redox Stability (NRI): The quality and value of meat are determined by color stability. Myoglobin, the protein responsible for red color, participates in complex biochemical reactions that affect consumer acceptance of meat products. A project was launched to investigate the fundamental basis for mitochondrial based effects on myoglobin biochemistry and meat color stability.
- Improved Quarantine Treatments for Tropical Fruit Using Thermal Energy [NRI]: Methyl bromide is the most effective fumigant for pest control, but it is a highly toxic gas and listed as an ozone depleting chemical under the Montreal Protocol of 1992. To find an alternative, scientists at Washington Sate University with colleagues at the University of California, Davis and USDA-ARS, Parlier, CA developed a way to harness electromagnetic energy at radio frequency (RF) to eliminate the targeted insect pests. This technology delivers more thermal energy to insects than in dry nuts such as walnuts, which is an appropriate form of pest control in low-moisture commodities. The results of this research are published in two papers in the latest issue of Postharvest Biology and Technology, a leading scientific journal in post-harvest research and presented in the new book entitled, *Heat Treatments for Postharvest Pest Control: Theory and Practice*.
- Investigation of Tropical/Subtropical Juice Spoilage by Spore-Forming Bacteria [Special Research Grant]: Sporeforming, acid-loving bacteria are a recent problem in commercial fruit juices that juice manufacturers must address. Scientists at University of Florida took this challenge to determine the extent of contamination in concentrated juices and investigate methods of control.
- National Needs Fellowships in Food Quality and Safety [SERD]: This project supported the National Need Area of Food Science and Human Nutrition. The project trained Fellows with degrees in Food Science and in Toxicology with research specialization in the control of foodborne hazards and effects of control interventions on food quality.
- Characterizing Packaging Systems through the Assessment of Mass Transfer and Degradability of Biopolymers [Hatch]: The assessment and prediction of mass transfer have become key issues to regulatory agencies worldwide. Food and pharmaceutical industries are also increasingly demanding better performance from packaging systems. Concurrently, increase use of polymer materials in food packaging and agricultural practices raised serious concerns on environmental quality and landfill capacity. This project studied about accurate measurement of package performance in terms of mass transfer to predict product shelf life, to optimize the design of package systems, and to protect, enhance, and guarantee the final quality of products; and the development of biodegradable pots and mulch films.
- Proper food handling is critical to the health of all of our population. It is critical for food handlers, whether at home or serving the public to know and understand what constitutes safe and hygienic food handling and those practices to assure that all food that is served or stored is indeed safe and nutritious. Under the Evans-Allen and Capacity Building Funding programs for 1890 Land grant Universities, North Carolina A&T and State University conducted food safety training programs by

Extension to allow those persons who handle foods to know and understand what practices to follow to prevent food contamination in the storage, preparation, and presentation stages. A specific program called ServSafe is a nationally recognized certification program to assure that food handlers have indeed demonstrated proficiency in knowledge and skills to assure that those who pass the certification examinations are proficient in exercising exemplary and safe food handling practices.

- According to the Centers for Disease Control and Prevention (CDC), hand washing is the single most important means of preventing the spread of disease and spoilage microorganisms. Studies in schools and childcare centers have shown links between improper or infrequent hand washing and colds, flu and foodborne illness outbreaks. Under the Hatch formula funding, In 2002 North Dakota State University Initiated the "Wash Your Hands" project. Instructors used a fluorescing dye and ultraviolet light to show areas the students missed washing. The students were provided a handout showing a hand and asked to mark the spots they missed washing (where the dye remained). A follow-up survey was implemented with teachers to determine their observations of behavior change among children in their classrooms.

- Food on American tables has never been more global than it is today. However, it has left a host of economic, social, and environmental problems in its wake. Local food systems have emerged as a possible strategy for addressing such problems. Unfortunately, little evidence exists to evaluate the benefits and costs of expanding local markets. The goal of the NRI funded project at Cornell University is to model regional food production potential relative to regional food needs within New York State. About 30% of this activity is attributable to KA 504.

<u>KA 503: Quality maintenance in Storing and Marketing Food Products' Key Outputs and Outcomes:</u>

- Effects of Mitochondria on Postmortem Myoglobin Redox Stability (NRI): This work extended a fundamental understanding of the effects of postmortem mitochondrial activity on meat color and quality. Results specifically have provided a greater understanding of the interaction of mitochondria and oxygen consumption with meat quality parameters, the effects of vitamin E concentration on mitochondrial activity, the temporal loss of mitochondrial integrity on oxygen consumption and the potential role for carbon monoxide to interfere with mitochondrial respiration and affect meat color stability. With the new knowledge gained through this project, meat industry and food technologists could change food storage conditions and handling practices to minimize color loss and extend keepability of meat products prior to cooking or further processing. Results from this project were timely disseminated to interested stakeholders through peer-reviewed scholarly journals and presented at various professional meetings.
- Improved Quarantine Treatments for Tropical Fruit Using Thermal Energy [NRI]: RF treatments effectively control insect pests at life stages present in in-shell walnuts without negatively affecting walnut quality or storability. RF treatments can potentially serve as a non-chemical alternative to chemical fumigants for post-harvest

pest control in similar commodities, such as almonds, pecans, pistachios, lentils, peas, and soybeans, thereby reducing the long-term impact on the environment, human health, and competitiveness of agricultural industries in an increasingly competitive global economy. This technological discovery could affect the world agricultural exports with value between US$220 billion to US$300 billion annually.

- Investigation of Tropical/Subtropical Juice Spoilage by Spore-Forming Bacteria [Special Research Grant]: Alicyclobacillus, a spoilage microorganism, was isolated from Florida orange juice concentrate, mango puree and concentrate, coconut cream, and pineapple concentrate. This research has improved the detection method with a threshold of 0.7 micrograms/L using a trained sensory panel. This research provided a much improved critical analytical strategies to detect spoilage bacteria at early stage so that intervention methods can be employed to control the problem. This improvement will substantially reduce economic loss due to product recalls as the result of the growth of Alicyclobacillus in fruit juices and other low pH beverages; and improve consumer confidence in the high quality of fruit juices.
- National Needs Fellowships in Food Quality and Safety [SERD]: The USDA National Needs Fellow has successfully completed courses including statistics, food microbiology, food science and toxicology. The fellow maintained a GPA above 3.50 and completed 18 months of research on the effectiveness of novel antimicrobials for controlling foodborne pathogens. A new graduate course (FSHN/TOX 627) on rapid methods for detection of microbial foodborne hazards was developed to fulfill the proposed curriculum requirements of the fellowship. The Fellow has gained research experience in: i) testing the efficacy of selected antimicrobials; and ii) knowledge the scientific and technical principles of various rapid microbial test methods. Research results were presented to food safety professionals and scientists at the Institute for Food Safety and Security Annual Symposium at Iowa State University in April 2007. This program trained high level food microbiologists who will take on leadership in food safety and quality research, education and extension endeavors.
- Characterizing Packaging Systems through the Assessment of Mass Transfer [Hatch]: Chlorine dioxide gas was found effective for vapor-phase decontamination, both in treating the produces before packaging, and sanitizing the products inside their packages, yet, very little is known about its effects on the packaging material properties, and performances. By understanding the interactions of chlorine dioxide with the different packaging materials it would be possible to design packaging systems that will include chlorine dioxide in the internal atmosphere. This study provides valuable information for designing packaging systems and modeling shelf life to assure best quality and safety of food packaged.

Knowledge Area 504: Home and Commercial Food Service

KA 504: Home and Commercial Food Service's Introduction:

This KA addresses the research, education and extension activities on developing and or improving methods for preparation, storage and service at the home and retail service level. Emphasis is placed on quality along with safety, consumer acceptability, effective management at retail food service, and product labeling. Thus, this KA directly addresses the final sector of the food system, i.e. consumer. Areas included, but not limited to, in this KA are:

After comparing their projects' objective, 13 projects cited KA 504 as relevant to their projects' aims.

KA 504: Home and Commercial Food Service's Logic Model:

Situation	Inputs	Activities	Outputs	Outcomes		
				Knowledge	Actions	Conditions
New products, new uses, and value added processes must have consumer acceptance to create effective demand. Bio-based technologies promise opportunities for energy, industrial, pharmacological, and other non-food markets for U.S. producers. New markets are emerging for environmental concerns. The foundation for economic and technological advancement is timely, valid and reliable research that leads to inventions and practices that help establish new products in the market place.	**Financial Resources:** - Federal - State - Some provide funding that contributes to research, extension and education. **Human Capital:** - CSREES NPLs - Researchers - Faculty - Extension Practitioners - Teachers - Para-professionals - Stakeholders - Volunteers	**Research:** - Understanding factors affecting quality of food prepared at home or commercially - Improve the quality of meals delivered to older citizens **Education:** - Increase the number of trained school food service directors - Teach food service providers about the mechanics of improving customer service **Extension:** - Increase awareness of food allergies	- New fundamental or applied knowledge - Scientific publications - Patents - New methods & technology - Practical knowledge for policy and decision-makers - Information, skills & technology for individuals, communities and programs - Participants reached - Students graduated in agricultural sciences	- Improved consumers and food delivery personnel understanding on food preparation and handling practices - Improved understanding of customer service practices - Improved understanding of food allergies	- Better informed consumers and food delivery personnel - Trained 68 school food service directors - National Restaurant Association incorporated food allergy information in their training - Taught dinning service employees in NE, KS and MO how to improve their customer service skills - Improved quality, better management, and effective methods of delivery	- Improved health - Increased economic opportunities - Cost reducing methods of food delivery systems

ASSUMPTIONS - Bio-based technologies are feasible and cost efficient and that the added cost will not significantly impact consumer income.

EXTERNAL FACTORS - Variable funding; scientific advancements; changing priorities; producers' and consumers' attitudes; natural disasters; economic conditions; coordination and cooperation with other government entities; public policy

KA 504: Home and Commercial Food Service's Key Activities Outputs and Outcomes:

Activity: Increases in daycare, hospital and nursing home populations as well as a growth in restaurant and deli businesses means a growing portion of the population is at risk from outbreaks of foodborne illness. In addition, quantity food preparation presents unique challenges for safe food handling and preparation. In this environment, more attention has been placed on the development and implementation of safe food handling guidelines. As a result, there is high demand for training and educational materials in food safety.

Under the aegis of Smith-Lever 3 b and c funds, North Dakota State University conducted ServSafe Food Safety Certification and HACCP training programs for foodservice managers and for members of the food industry. ServSafe is a nationally recognized food safety training program of the National Restaurant Association, with a standardized examination.

Outputs: About 86 percent of students taking the ServSafe exam have passed the national examination. On post-surveys administered to the students, they indicated they will implement the knowledge "more often" as a result of the training and certification in the following categories:

About 96 percent will train others about the importance of hand washing, and 91 percent plan to wash their hands more often when preparing food. About 91 percent will check the sanitizer concentration, 91 percent will take additional steps to avoid cross-contamination, 89 percent will teach others how to avoid cross-contamination and 85 will teach others how to use a thermometer and 91 percent will use a food thermometer more often. About 98 percent will apply what they learned at home. Participants reported that they will train 2,243 workers.

Outcome: The participants gained knowledge and passed the national examination. Putting knowledge into action is to be followed and assessed.

Knowledge Area 511: New and Improved Non-Food Products and Processes

KA 511: New and Improved Non-Food Products and Processes' Introduction:

Nonfood uses of agricultural and forestry materials offer the best opportunities to realize the full economic potential which agriculture and forestry can play, beyond the traditional food and fiber markets. Research and development in nonfood products can have a positive impact in many ways: 1) value-added products from new uses of conventional crops, forestry materials and wastes, 2) diversified agriculture through new crop development and expanded growing areas with modified crops, 3) new business opportunities, 4) economic development in rural areas through new farming and processing opportunities, and 5) development of sustainable, renewable resources for the U.S. industrial base. Even though increased profitability and rural economic development are the major incentives for new products research, current research is also driven by society's need for products that are more environmentally acceptable than traditional counterparts. Two problem areas in the CSREES portfolio address new nonfood products development. Knowledge Area 511 (KA 511) "New and Improved Non-Food Products and Processes" is broad and encompasses products and energy, product characterization and functionality, product performance and environmental impacts, and improved processing. Knowledge Area 512 (KA 512) "Quality Maintenance in Storing and Marketing Non-Food Products" focuses on quality maintenance of feeds, seeds, and other nonfood agricultural and forest products during handling, storage and marketing.

For the purposes of this review, KA 511 and 512 will be considered as a single KA, rather than separately.

KA 511: New and Improved Non-Food Products and Processes' Logic Model:

Situation	Inputs	Activities	Outputs	Outcomes		
				Knowledge	Actions	Conditions
New products, new uses, and value added processes must have consumer acceptance to create effective demand. Bio-based technologies promise opportunities for energy, industrial, pharmacological, and other non-food markets for U.S. producers. New markets are emerging for environmental concerns. The foundation for economic and technological advancement is timely, valid and reliable research that leads to inventions and practices that help establish new products in the market place.	**Financial Resources:** - Federal - State - Some provide funding that contributes to research, extension and education. **Human Capital:** - CSREES NPLs - Researchers - Faculty - Extension Practitioners - Teachers - Para-professionals - Stakeholders - Volunteers	**Research** - Genetically engineered maize as new crop to produce cellulases for ethanol production - Noevl conversion technology linking biochemical and thermochemical technologies to produce biofuel frrom lignocellulose Develop microorganism to metabolize syngas to ethanol and chemicals -Develop microorganism to produce new product succinic acid from glycerol and CO2 **Education** - Curriculum development - Sabbaticals - Equipment Grants - Capacity and Facility Building - Distance Education - Undergraduate and Graduate Student Training **Extension** - Develop outreach opportunities for researchers, farmers and commercial retailers - Develop partnerships among all stakeholders	- New fundamental or applied knowledge - Scientific publications - Patents - New methods & technology - Practical knowledge for policy and decision-makers - Information, skills & technology for individuals, communities and programs - Participants reached - Students graduated in agricultural sciences	- Improved understanding of alternative methods for developing biofuels and chemicals - Improved understanding about the use of cloned genes to create biofuel	- Biotech crop will produce enzymes for converting lignocellulosic materials into sugars - Efficient production into cellulases - Optimized gasification and fermentation systems - Elucidate pathways for anaerobic fermentation of glycerol and CO2 - Engineered microbes for the production of fuels and chemicals from glycerol and CO2	- Reduced dependency on petroleum - Improved environmental impact - Revenue generated from waste product - Efficient waste management - Rural processing

ASSUMPTIONS - These programs will produce economic gains in a number of industries and globally

EXTERNAL FACTORS - Variable funding; scientific advancements; changing priorities; producers' and consumers' attitudes; natural disasters; economic conditions; coordination and cooperation with other government entities; public policy

KA 511: New and Improved Non-Food Products and Processes' Key Activities

- The agency continues to expand the scope of research, education and Extension programs to include bioenergy and biobased products as priority topic areas. An extensive CRIS search on these topics reveals a significant increase in formula, competitive, and congressionally directed projects since 2000, and especially SBIR and Hatch funds over the last two years (see funding tables.)

- In addition to NRI and SBIR which traditionally include biofuels and biobased products topics, the SERD Challenge Grants program for higher and secondary education recently awarded 10 projects addressing bioenergy and biobased products.

- For Extension and outreach, an eXtension Community of Practice is underway with a focus on ethanol, biodiesel and on-farm energy conservation. Ag in the Classroom and 4-H programs includes bioenergy activities.

- The 2008 Farm Bill has reauthorized the Biodiesel Fuel Education Program because of evidence that the program has had a major impact on public awareness about biodiesel production and use.

USDA's Biopreferred Program, administered by USDA's Office of Administration, continues to grow, creating a market pull for CSREES research. The North Central Bioeconomy Consortium, comprised of 12 states, is implementing a biopreferred program based on USDA's model.

KA 511: New and Improved Non-Food Products and Processes' Outputs and Outcomes:

- (NRI) DEVELOPMENT OF A NOVEL FERMENTATION PROCESS FOR THE ANAEROBIC CONVERSION OF GLYCEROL AND CO2 INTO SUCCINIC ACID USING ESCHERICHIA COLI: The value of the project is the conversion of two byproducts in the production of biofuels (glycerol and CO2) into a value added chemical (succinic acid). The objectives of the project are to develop a novel fermentation process for the conversion of glycerol and CO2 into succinic acid, a higher-value feedstock used to produce industrially important chemicals having a domestic market of more than $1.3 billion per year. This technology has recently been licensed by a company in Texas.

- (IFAFS, special research grant) Conversion of Low Cost Biomass to Ethanol: Chemical engineers at Oklahoma State University and other university partners have developed a technology that links biomass gasification and fermentation to produce ethanol and chemicals. The process is more cost efficient than other conversion technologies by utilizing all portions of a variety of biomass and feedstock material including grasses, crop residues, processing plant byproducts and other waste materials. Coskata, an ethanol company, has partnered with General Motors to commercialize the technology, which is considered to be cost effective and environmentally friendly.

- (IFAFS) University of IL Wet Mill Optimization:
  A patented fractionation technology was developed at the University of Illinois, Champaign-Urbana in collaboration with ARS-ERRC to improve the corn wet milling process. Maize Processing Innovators, in partnership with FCStone Carbon, is the exclusive licensee to commercialize the technology called Quick Germ Quick Fiber. The QQ process utilizes a short soaking step and generates a pure germ and fiber fraction, minimizing the starch loss found with alternative “dry fractionation” techniques. Fractionation is a key technical gap for biorefineries, including corn wet and dry mills. This technology has the potential to make significant economic impacts in the corn wet milling industry.

- (SBIR) A NEW PROCESS FOR BIODIESEL PRODUCTION BASED ON WASTE COOKING OILS AND HETEROGENEOUS CATALYSTS United Environment and Energy LLC. :
  Biodiesel is a renewable and clean form of energy produced from biomass materials. In the United States, the vast majority of biodiesel is made commercially from soybean oil by an energy and labor-intensive alkali-catalyzed process. This homogeneous catalyst based process is far from being efficient and could be improved substantially. To improve this process and produce a cost-effective biodiesel product, a heterogeneous catalyst biodiesel production process was developed. The success of this project will lead to the replacement of the low-efficiency homogeneous alkali-catalyzed biodiesel production process that has been in place for more than 20 years with a highly efficient fixed-bed process. Waste cooking oils are agricultural by-products from vegetable oils or animal fats. The production of biodiesel from waste cooking oils with this new technology will recycle and add value to this agricultural material. The use of heterogeneous catalysts will protect the environment by eliminating waste streams produced from toxic acid or caustic solution.

- (SBIR) A KENAF FIBER BASED END-GRAIN SANDWICH CORE MATERIAL FOR COMPOSITES: Polymer Bridge Systems (dba Corlyte Corporation)/ Texas A&M University/ University of Maine. The purpose of this project is to provide an inexpensive Core Material by utilizing the inner "balsa-like" kenaf core. Large-scale growing of kenaf was established for this purpose, as well as simultaneously assembling the full production line for kenaf core blocks. The ultimate goal is to allow the commercialization of an inexpensive, and yet, high-performance end-grain core material for use in the composite industry for the sustainable construction of homes and commercial buildings. Kenaf cultivation practices were developed to produce uniform core material for the composite a thermoplastic resin process using a pressure press was developed to produce the wood-like materials. The kenaf core composites outperformed equivalent solid wood products as panels and as structural members. This technology has been extended to other core materials and has gained commercialization.

Knowledge Area 512: Quality Maintenance in Storing and Marketing Non-Food Products

The majority of currently active projects associated with KA 512 are not relevant to bioproducts; therefore KA 512 will not be addressed in this year's report and will not include a logic model. This KA will be revisited over the coming year. National Program Leaders anticipate a significant increase in biomass handling and storage projects, and will determine if KA 512 is the appropriate knowledge area.

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

Relevance

Overall Comment: *The chief weakness relates to the integration of education and extension with research.*

- *2008 Portfolio Response*
  - Higher Education competitive grant programs continue to give bioenergy and biobased products a priority in annual solicitations
  - The REE Strategic Energy Plan includes research, education, and extension activities.
  - The 2008 Farm Bill establishes the AFRI competitive grant program that requires a minimum of 30% of projects be integrated.
  - An eXtension Community of Practice was developed to focus on renewable energy production and conservation.
  - In FY 2008, CSREES requested $19.1 M to support a new competitive program to fund research, education, and extension projects on bioenergy. Efforts supported by the new program would utilize a systems approach to bioenergy, including the environmental and social implications of bioenergy production.
  - The 2008 Farm Bill established the Specialty Crop Research Initiative (SCRI) as a research and extension grants program. The RFA for FY 2008 tightly links those two functions. Education was not included in the Farm Bill language.
  - NRI 71.1 program continued supporting integrated projects for improving food quality and value, improving nutrition and addressing energy imbalance with the NRI bioactives program and obesity program.
  - NRI 75.0 program initiated a new priority to conduct three social science research projects to study public perception and acceptance of nanotechnology applications in agriculture and food systems. The funded project integrated extension and public education into the research activities.

- *2007 Portfolio Response*
  In early 2007, the Secretary submitted several proposals to the Congress for the 2007 Farm Bill authorization. One of those proposals involved new spending authorizations and mandatory funding for specialty crops. Shortly after this announcement, CSREES NPLs authored a white paper that laid out an implementation plan for the Secretary's Specialty Crop Research Initiative. A basic principle of that plan involves a tight integration of competitive research, education, and extension activities that would enhance problem-solving capabilities. A second proposal for the 2007 Farm Bill included a Bioenergy Biobased Products Initiative with a new spending authorization and mandatory funding.

  The USDA Research, Education, and Economics (REE) Mission Area, which includes CSREES, along with ARS, NASS, and ERS, held a strategic planning workshop September 5-6, 2007 to develop a coordinated mission-area plan in the area

of Energy Science, Education, and Extension. The strategic plan developed from the workshop promotes an integrated, transdisciplinary planning and implementation process based on the unique capacities of the REE agencies and their partners and stakeholders. The plan targets renewable energy and energy conservation and integrates research, education, and extension to reach specified goals.

Specialty crop industry stakeholders, university and federal researchers, educators, and federal program managers met in early 2007 for a workshop entitled, "Engineering Solutions for Specialty Crop Challenges." The workshop provided a forum for special crop industries to engage the science and technology community. Industry representatives voiced their concerns with regard to productivity, production efficiency, post-harvest processing, and environmental quality. In response, the research community offered some engineering science and technology capabilities that could form key components of eventual solutions. A workshop report details the dialog, and will be used as guidance for future federal science and engineering investments to assist this important segment of U.S. agriculture.

In FY 2008, CSREES requested $19.1 M to support a new competitive program to fund research, education, and extension projects on bioenergy. Efforts supported by the new program would utilize a systems approach to bioenergy, including the environmental and social implications of bioenergy production.

- *2006 Portfolio Response*
  The National Research Initiative has the authority to fund up to 22% of its annual budget for integrated projects. Many NRI programs have included integrated priorities in the annual request for applications. A Multistate committee, S-1007 Science and Engineering for a Biobased Industry and Economy, consisting of scientists representing research, education and extension from all over the country, has been holding annual meetings since 2001. This is an 11 excellent forum to develop integrated approaches to address critical issues in this important area.

Scope

The scope of the portfolio is very good, especially given the available resources. This is an emerging portfolio, though, so there is room for improvement. Even so, the Portfolio is not falling behind in coverage and some areas are exceptional. For example, the Portfolio is moving into nanotechnology, and some older programs have been dropped. In the Panel's opinion, while *spread thin*, the Portfolio is very deep and has exceptional breadth.

- *2008 Portfolio Response*
  Activities in 2007/2008 are continued, and an increasing number of projects focus on energy and biobased products. New engineering emphases are emerging in research and extension activities for specialty crops. Nanotechnology programs maintained its broad scope in nanotechnology applications in crop production, animal production, food safety and biosecurity, novel delivery mechanisms for nutraceuticals and functional foods, soil conditioning and improvement, forest products, and many

others through a combination of competitive grants, formula funds, and special research grants. Societal issues are now included in the nanotechnology portfolio.

- *2007 Portfolio Response*
  The shared faculty has identified and analyzed over 500 projects that have some activity in biobased or bioenergy, and to help the agency determine research needs.

  Other sections and units in CSREES are now including bioenergy and biobased products as topic areas in their programs. NRE Water Quality Program included bioenergy crop production and conversion as a priority in 2007; SERD Challenge Grants and National Needs Fellowships programs addressed curriculum development and student support, Agriculture in the Classroom; ECS SARE program, new NPL for the Bioeconomy has training in rural sociology, NPL Agricultural Economist is addressing bioenergy from an environmental perspective. In PAS, the NPL for Animal Nutrition is addressing issues related to distillers' grains and solubles as an animal feed.

  An internal bioenergy working group has been formed, and meets periodically. This effort is coordinated by a Program Specialists (hired in 2006) with a background in bioenergy and forest products.

  The REE Under Secretary established a task force (the ABBREE Council) in 2006 to help coordinate mission area activities in bioenergy and biobased products that can replace petroleum-based products.

  The USDA Small Business Innovation research (SBIR) Program Biofuels and Biobased Products topic area RFA exclusively focused on the development and production of biofuels and related value-added coproducts and the development of new industrial crops to supply raw materials for new biobased products.

- *2006 Portfolio Response*
  A shared faculty has been hired for expertise in the economics of bioenergy technologies.

  The National Research Initiative has focused the priorities of the Biobased Products Bioenergy Research Program. The current priorities of the program include the biological conversion of agricultural biomass and the identification of sustainable agricultural biomass for the production of value-added products including bioenergy.

  Basic plant science activities are now supported by NRI programs focusing on biochemistry and genomics.

<u>Focus</u>
The Portfolio was focused—every Program Area (PA) [*Note: currently KA*] presentation included contemporary issues and cutting edge technology, and is consistent with the Science Roadmap—but *could be better integrated as a portfolio instead of as individual*

KAs. The Panel believes NPLs may be operating individually, instead of as a team. Obesity is misplaced as an issue in this portfolio. The Panel believes that the portfolios need to be reviewed and integrated to make sure all appropriate areas are in the correct portfolios (e.g., food safety, economics, policy, international trade, and market development). The Panel believes that the Portfolio showed evidence of curiosity in seeking out what new knowledge needs to be found. The Portfolio process is new, and the progress is positive. *Based on the descriptor language, though, the Portfolio was not fully focused.*

- *2008 Portfolio Response*
  This portfolio is diverse. Bioenergy is a cross-cutting theme across KAs, as is engineering. The inclusion of engineering, technology, economics, and food safety in the SCRI will enhance focus for this portfolio. Furthermore, nanotechnology is also crosscutting through sensors and detection, food quality, bioenergy and bioproducts, and many others. If more resources can be provided, many more examples can be shown that nanotechnology is a true enabler across many KAs.

- *2007 Portfolio Response*
  The knowledge areas brought in to realign and strengthen the Food and Non-Food Product portfolio in 2007 has created the Processing, Engineering, and Technology for Food and Bioproducts portfolio. Obesity is no longer included in this portfolio. Also, the internal bioenergy working group mentioned under *Scope* provides a collaborative team environment for individualized NPL activities in this portion of the portfolio.

- *2006 Portfolio Response*
  The following knowledge areas will be brought in to realign and strengthen the Food and Non Food Product Portfolio. They will be included in the next internal annual review. The funding, activities, and outcomes for these KAs are not reflected in the current tables and logic models:
    - 401: Structure, Facilities, and General Purpose Form Supplies
    - 402: Engineering Systems and Equipment
    - 404: Instrumentation and Control Systems

- *2008 Portfolio Response*

This is a very diverse portfolio by the nature of the KA grouping.

- *2007 Portfolio Response*
  The Office of Planning and Accountability has completed revision of the score sheet and the instrument will be used in all 2008 reviews.

- *2006 Portfolio Response*
  The Office of Planning and Accountability will revise the score sheet to provide a more detailed definition for “focus.”

Contemporary and/or Emerging Issues*:*
The Panel encourages *further coordination with other agencies working with bio-based technologies, bioproducts and energy*. The NRI Request for Applications shows appropriate changes over time; nanotechnology, for example, has been identified as an emerging issue. The ability to identify emerging issues depends on NPLs having the time to meet with people doing work on the "cutting edge" of the fields encompassed by this Portfolio. *A process needs to be devised to keep the Portfolio current.*

a. *Panel encourages further coordination with agencies working with bio-based technologies, bio-products and energy*.

- *2008 Portfolio Response*
  NPLs participation on Biomass R&D Board interagency working groups including: feedstock development, biomass handling and logistics, conversion technologies, environment/health/safety, sustainable biofuels production.

  The nanotechnology program supports activities that address critical societal challenges of sustainability, crop and livestock productivity, food safety and biosecurity, nutraceutical and functional foods for human health, novel uses of natural resources, and environmental improvement.

  Over the past five years, agency staff have been working closely with specialty crop stakeholders to define and articulate broad industry needs. In the engineering area, a workshop was held in 2007 that brought together industry, academia, and government representatives. Following passage of the 2008 Farm Bill in June 2008 and the Specialty Crop Research Initiative, the agency published a Request for Applications that solicited proposals dealing many aspects of processing, engineering, and technology.

- *2007 Portfolio Response*
  NPLs continue to serve on USDA's Biobased Products Bioenergy Coordination Council; NPLs serve on subcommittees of the newly formed USDA Energy Council. The subcommittees address 1) research and development, 2) commercialization, 3) education/outreach, 4) international programs, 5) linking the Department's programs.

  NPLs continue to collaborate with U.S. Army on a full scale demonstration of biobased hydraulic fluids at Fort Leonard Wood in Missouri; successful testing has been completed and efforts are underway to require the use biobased hydraulic fluids in construction equipment on all army bases.

  NPLs continue to interact on a regular basis with DOE Office of Biomass to assist in evaluation of progress in key topic areas; NPL continues to serve on 2 advisory boards for projects that are funded by DOE.

CSREES continues to be an active participant in the Interagency Metabolic Engineering Working Group which is formed of eight federal agencies (NSF, NIH, NASA, EPA, DOE, NIST, USDA, and DOD).

CSREES participates with the DOE Office of Science to implement the Plant Feedstock Genomics program.

Under the National Nanotechnology Initiative, NPL coordinates the agency's nanotechnology program, which encourages and supports research and education relevant to this portfolio, with 22 other participating Federal agencies.

CSREES collaborates with the EPA Office of Science on sustainable biofuels production.

As noted above, in 2006, the Under Secretary established an REE task force (the ABBREE Council) on bioenergy to aid inter-agency coordination.

In July 2006 The CSREES-administered USDA SBIR Program partnered with DOE and Oak Ridge national laboratories to sponsor and implement a joint USDA/DOE SBIR Energy Summit. The summit introduced over 75 small businesses to the renewable energy-related programs within USDA and DOE.

- *2006 Portfolio Response*
  NPLs continue to serve on USDA's Biobased Products Bioenergy Coordination Council; NPL is collaborating with U.S. Army on a full scale demonstration of biobased hydraulic fluids at Fort Leonard Wood in Missouri; NPLs interact on a regular basis with DOE Office of Biomass to assist in evaluation of progress in key topic areas; NPL serves on 2 advisory boards for projects that are funded by DOE.

  CSREES is an active participant in the Interagency Metabolic Engineering Working Group which is formed of eight federal agencies (NSF, NIH, NASA, EPA, DOE, NIST, USDA, and DOD). The agency leverages a $400,000 investment to the total Working Group investment of $6M to support metabolic engineering for bioproducts and biofuel production.

  Under the National Nanotechnology Initiative, NPL coordinates the agency's nanotechnology program, which encourages and supports research and education relevant to this portfolio, with 22 other participating Federal agencies.

b. *A process needs to be devised to keep the Portfolio current*

- *2008 Portfolio Response*
  NPLs are actively engaged, to the best extent possible given existing personnel and financial resources, with NSTC, USDA IWG, industrial and other stakeholders, professional societies to seek inputs while planning relevant programs. CSREES is leading an REE effort to implement a strategic energy science plan for the next 5

years. A stakeholder planning session was held in 2007 followed by formation of implementation teams and an annual summit to facilitate partnerships and measure progress toward the goals identified in the plan.

- *2007 Portfolio Response*
  NPLs are responsible for ensuring the portfolio is kept current. A major element of their performance includes assuring relevancy, quality and performance through effective planning, implementation, and evaluation of new and existing programs that address high priority issues. They take leadership and overall responsibility for the coordination and integration of these programs within and outside the agency, and exhibit understanding of the broad portfolio of Federal programs within the program area. NPLs must stay abreast of new developments, technologies, trends, and/or changing legal requirements in their areas of responsibility, and they apply new technologies/knowledge to the priority setting process.

- *2006 Portfolio Response*
  The process is described in the performance elements for NPLs.

<u>Integration</u>
The Review Panel was presented with separate projects for education and extension but was shown little evidence of integration (the best job was done by the SBIR program). Although there were a few anecdotal examples of funding, there was an apparent disconnecting between education and extension in the Portfolio. This was due in part to the nature of the Portfolio. It has greater challenges than most in matching education and extension to research because of a *general lack of curricula dealing with biobased resources*. On the other hand, emerging food-processing centers in states are and example of a success story in this arena and represent integrated, multidisciplinary activities. Figuring out how to capture appropriate, integrated data represents an opportunity for this relatively new portfolio.

a. Lack of curricula dealing with biobased resources

- *2008 Portfolio Response*
  Workforce Development is a major goal in the REE Strategic Energy Science Plan. Targeted results by 2012 include tripling the number of students in college and university-based bioenergy and bioeconomy education programs. A complementary effort is the Biomass R&D Board interagency working group for sustainable biofuels. This group had identified workforce development as a criterion and will develop indicators for tracking progress.

NRI 71.1 program supported integration of research with education and/or extension activities. In food products area, under the NRI Improving Food Quality and Value program, a total of 8 proposals that integrated research, outreach and/or education were awarded during the period of 2006-2008. There was significant improvement in the quality of the integrated proposal submitted to this program. For example, one proposal in the high priority category was not funded in fiscal year 2008 due to the limits on the

availability of funds. Not only the integrated grants activity was successful in this program, but also three additional proposals were funded in the joint priority integrated program addressing disciplines of both nutrition and food science in the same proposal.

NRI 75.0 program supported a research and extension integrated project at Michigan State University on public perception and acceptance of nanotechnology applications in agriculture and foods.

- *2007 Portfolio Response*
  As of 2006, all U.S. agricultural engineering departments now include "biological" or "bio" in their name, e.g., Agricultural and Biosystems Engineering. Furthermore, the associated professional society changed their name in 2006 to the American Society for Agricultural and Biological Engineers, and has recommended that all academic programs change their name to "biological engineering."

  North Dakota State University, along with five other institutions (including one 1890 school), will be establishing a graduation certification program in biological sensorics in 2008.

- *2006 Portfolio Response*
  The Multidisciplinary Graduate Education Training award to Cornell University in 2001 has resulted in approximately 25 graduate students trained in biobased related technologies;

  Department of Bioproducts and Biosystems Engineering was established at University of Minnesota;

  Higher Education has made awards for curriculum development that focuses on biomass and product development;

  2006 Higher Education Challenge Grants RFA includes biobased product and technologies as a priority area;

  Institute of Biobased Products at Montana State University is in its third year;

  Ohio State University has established a The Ohio Bioproducts Innovation Center.

<u>Multidisciplinary Balance</u>
The topical areas covered in this portfolio make it an opportunistic one for multidisciplinary activities. Other areas for inclusion in this Portfolio include business and managerial activities, economics, and competitive impacts.

- *2008 Portfolio Response*
  The 2008 Farm Bill established AFRI which will encourage multidisciplinary projects.

The emphasis on bioproducts that are sustainable, requires economics and social impacts be taken into consideration during project planning stages.

The new SCRI requires trans-disciplinary teams, emphasizing biological, physical, and socio-economic sciences.

Nanotechnology program is multidisciplinary and supports many cross-disciplinary collaborations among engineers, chemists, biologists, and even social scientists.

- *2007 Portfolio Response*
  While business, managerial and economic KAs are not included in this portfolio, our new NPL in Bioeconomy and Rural Communities (2006) brings that perspective to intra-agency activities surrounding this portfolio.

- *2006 Portfolio Response*
  Integration of research, education, and extension and multidisciplinary activities cannot necessarily be required across the KAs because of the nature of various funding authorities.

  Most biobased projects are inherently multidisciplinary and many include economic and marketing activities. The best examples of integrated/multidisciplinary activities can be found in IFAFS projects, some of which are still active through 2005;

  The Biodiesel Fuel Education Program at the University of Idaho addresses outreach by educating the public about the benefits of using biodiesel through technical reports and workshops tailored for a variety of audiences.

Quality

This is the weakest portion of the Portfolio and due, for the most part, to the fact that definitions on the scoring sheet were difficult to understand. In the future, with better clarity around these definitions, panels should see what is needed to achieve scores in the highest category. The data presented showed high quality, but metrics were limited and CSREES needs to have very clear examples of performance indicators for future reviews. *The evaluation process needs work*.

- *2008 Portfolio Response*
  The post award management has been in place for the NRI programs for last few years. For example, the NRI nanotechnology program has had four annual grantees meetings with 100% grantee attendance for every year. These grantees meetings served as highlights of the cutting edge researches in food and agricultural conferences, catalysts for collaboration in multistate research committee meetings, and connectors with other professionals.

- *2007 Portfolio Response*
  The new POW report system ensuring data needed for good program evaluation will be available in April 2008.

- *2006 Portfolio Response*
  The effective management of programs is at the heart of the work conducted at CSREES and program evaluation is an essential component of effective management. In 2003 the PREP process and subsequent internal reviews were implemented. Over the past three years fourteen portfolios have been reviewed by expert panel members and each year this process improves. NPLs are now familiar with the process and the staff of the Office of Planning and Accountability has implemented a systematic process for pulling together the material required for these reports.

  Good program evaluation is a process that requires constant attention by all stakeholders and the agency has focused on building the skill sets of stakeholders in the area of program evaluation. The Office of Planning and Accountability has conducted training in the area of evaluation for both NPLs and for staff working at Land-Grant universities.

  This training is available electronically and the Office of Planning and Accountability will be working with NPLs to deliver training to those in the field. The Office of Planning and Accountability is working more closely with individual programs to ensure successful evaluations are developed, implemented and the data analyzed. Senior leadership at CSREES has begun to embrace program evaluation and over the coming years CSREES expects to see state leaders and project directors more effectively report on the outcomes of their programs as they begin to implement more rigorous program evaluation. The new POW system ensures data needed for good program evaluation will be available in the future.

<u>Significance of Findings</u>
The Panel saw evidence of research findings that influence industry definitions, including commercially viable products, curricula, and patents. There is an opportunity to engage in outreach to capture and integrate teaching and extension, with research.

- *2008 Portfolio Response*
  The REE Energy Strategic Plan includes a workshop this fall that will focus on partnerships among stakeholders, and developing strategies to integrate research, education and extension.

  Bioenergy Awareness Day has been held for the past two years to publicly showcase REE-supported technologies and Extension activities.

  The Biodiesel Fuel Education Program is credited for effective public outreach about the benefits of biodiesel and about issues associated with fuel quality that were addressed through research. This program is reauthorized in the 2008 Farm Bill.

  The new SCRI requires 100% matching non-federal support, which will provide important opportunities for stakeholder (industry) engagement. The RFA for this grants program also requires substantial programmatic stakeholder involvement.

Nanotechnology program supports bionanosensor development and applications in numerous applications. CSREES Partner Video Magazine highlighted four exciting research breakthroughs which could significantly impacts value-added products, food safety and biosecurity, monitoring complex biological system, and no-point pollution control.

- *2007 Portfolio Response*
  The portfolio continues to demonstrate an emphasis on emerging issues and sharing of significant findings.

- *2006 Portfolio Response*
  The portfolio demonstrates an emphasis on emerging issues.

Stakeholder/Constituent Input:
The Portfolio was presented with well-developed evidence for stakeholder input, but little evidence was presented regarding stakeholder feedback. Though the KAs have existed for some time, there was no stakeholder assessment of the Portfolio. The Panel feels that the rubrics of this aspect of evaluation need to be broken apart; input, feedback, and assessment are different.

- *2008 Portfolio Response*
  While there is no stakeholder input for the portfolio as a separate entity, individual initiatives and programs elicit stakeholder input on multiple occasions.

- *2007 Portfolio Response*
  Several significant stakeholder meetings were held in the past year on various topics including specialty crops, REE, and bioenergy.

- *2006 Portfolio Response*
  The portfolio continues to have many stakeholders/constituents inputs.

Alignment with Current State of Science
Peer-reviewed publications are an indication of the quality and currency of the Portfolio alignment with current science. The Portfolio appears to be well aligned.

- *2008 Portfolio Response*
  NPLs ensure the alignment of the programs with the current state-of-art of sciences and technologies.

- *2007 Portfolio Response*
  The portfolio staff work closely with and collaborate with many different agencies.

- *2006 Portfolio Response*
  The portfolio continues to demonstrate alignment with the current state of science-based knowledge and previous work.

Appropriate and/or Cutting Edge Methodology
The methodology shown in peer-reviewed research projects is good, but the Review Panel would like to see examples of cutting-edge methodologies highlighted.

- *2008 Portfolio Response*
  CSREES nanotechnology program continues its concerted efforts in advancing the frontiers of science, engineering and technology in the NNI. Opportunities to use the NNI funded national nanotechnology user facilities and world class advanced instrumentations were introduced to the scientists and engineers involved in CSREES supported research projects. The NRI nanotechnology competitive grant program uses a balanced panel consisting of about a half of nanotechnology experts and a half of agricultural and food scientists from universities, industries and National Laboratories.

- *2007 Portfolio Response*
  Since 2001, CSREES has actively participated in the coordination, leadership, planning, and management of nanotechnology under the framework of the National Nanotechnology Initiative (NNI), which currently involves 23 Federal departments and agencies. Through the NNI, the agency is taking a concerted effort in charting the course for the research, education and public engagement for nanoscale science, engineering and technology. The importance of the new cutting edge science and technology on improving agriculture and food has gained an increased recognition among the NNI agencies. A number of projects relevant to agriculture and food systems have been funded by several NNI agencies to support activities led by our LGU partners. The Current Research Information System (CRIS) homepage, under "What's New in CRIS?" has a direct link to CSREES bioenergy/biofuels projects. These projects illustrate examples of cutting edge methodologies.

- *2006 Portfolio Response*:
  NPLs did that for the review. SBIR added Animal Waste as a topic area in 2005, and value-added products are included in the RFA.

Performance

Overall Comment: Performance indicators such as Timeliness, Agency Guidance, and Accountability are management issues and should not be questions for a Panel to consider. The Review Panel has rated the general Portfolio performance as adequate, though this was done mostly on the basis of personal experience, instead of presented evidence. The Portfolio needs to address the issue of documentation and evidence and implement a better reporting system before the next review. In the future, evidence should be stronger as mapping and assessment efforts identify outputs and linkages.

Portfolio Productivity
Anecdotal examples of Portfolio productivity were presented to the Panel, but there was no evidence of productivity on a significant enough scale to permit analysis. The Panel

has made an intuitive evaluation of this Portfolio aspect to be adequate at this time, given current resources and portfolio mix. This represents an opportunity for CSREES to provide portfolio analysis for future portfolio reviews.

- *2008 Portfolio Response*
  During a 100-day period at the end of FY 2008, a SCRI RFA was written and published, proposals were received and peer-reviewed, and awards were made.

- *2007 Portfolio Response*
  The portfolio has improved its productivity based on electronic grant submission, the development and use of the Leadership Management Dashboard, a reduction in the turn around time for awarding a grant, and the work in the NPL State Liaison program.

- *2006 Portfolio Response*
  The portfolio continues to improve its services through funding, directing, managing, and partnering with its various stakeholders.

<u>Portfolio Comprehensiveness</u>
The Review Panel's comments for this area are similar to those expressed in Portfolio Productivity. The Review Panel did not see the sufficient evidence of completeness necessary to permit analysis. As stated in the Multidisciplinary Balance section, the Panel recommends that a cross-walk of portfolios be done to ensure that all relevant subjects, such as economics, are included in this Portfolio. In addition the wording of the evaluation definitions for this aspect were confusing. The Panel believes the definitions should be reworded so that a score of three would indicate, "All Portfolio projects accomplished stated objectives," and a score of two would indicate, "Most Portfolio projects accomplished stated objectives." If outputs are redefined in this manner then the Panel believes that the Portfolio is fairly complete, but ignores some critical areas. *Better post-award management is necessary to garner requisite data*. This represents an opportunity for improvement.

- *2008 Portfolio Response*
  Many of the grant programs represented in this portfolio now require project director attendance at subsequent post-award workshops. These workshops were performed regularly on annual basis.

  While significant advancements have been achieved in the programs of the portfolio, more comprehensive outcomes can be achieved by increasing investment of funding to the portfolio. Many more opportunities in value addition of food and biobased products, better utilization of enabling power of nanoscale science, engineering and technology crosscutting through broad field of biological science and agricultural technologies can be better captured to substantially impact the national economy, human health, the environment, and agricultural community.

The recently established Specialty Crop Research Initiative solicits project proposals that include: stakeholder advisory boards, transdisciplinary research and extension teams (biological, physical, and socio-economic sciences), clearly stated outreach plans, and systems approaches to solving problems. Having these components in each funded project helps ensure that supported research and extension activities will achieve demonstrable impacts.

- *2007 Portfolio Response*
  The portfolio continues the activities cited in the 2006 response. Additionally, project director meetings were convened in 2005-2006 for awardees of special research grants covering a common theme, e.g., food safety.

- *2006 Portfolio Response*
  S-1007 Multistate committee is completing first round of site visits to Biomass Initiative awardees and reports serve as the basis for a report to Congress in 2005 regarding the status of the program;

  Specific instructions are given to principal investigators regarding substantive and timely reporting to CRIS;

  Template for reporting results and impacts is under development.

  The NRI and SBIR have initiated many post award management activities including: presenting highlights in an annual report, conducting annual PI meetings, preparing success story highlights for dissemination to stakeholders, and site visits.

<u>Portfolio Timeliness</u>
There was a lack of evidence presented for this aspect. The Panel was not even provided with anecdotal evidence of timeliness and believes that no-cost extensions are common to competitive grants programs, due to funding availability, in a fiscal year. *CSREES needs to present evidence of system timeliness and completeness*.

- *2008 Portfolio Response*
  NPLs and program staff strive to process grants in timely fashion. Congressional Q&As for the ear-marked projects require annual reports. These reports were prepared and submitted on time by NPLs and program specialists.

- *2007 Portfolio Response*
  Under the law, no projects can extend over five years. Also, annual progress, final, and termination reports are required. The portfolio continues to improve in encouraging projects to complete on time and make judicious use of no-cost extensions.

- *2006 Portfolio Response*
  The portfolio continues to require projects to complete on time.

Agency Guidance

Based on the Panel's experience, the Portfolio is judged to be excellent as it relates to the solicitation process. CSREES has provided a number of grants workshops and many have been targeted towards specific audiences, such as 1890 institutions. CSREES also has encouraged diverse partnerships among grant applicants.

- *2008 Portfolio Response*
  The portfolio staff involved in the NRI annual grantsmanshiop workshops provided guidance through breakout session presentation and answering questions, one-on-one consultation, mock panel review, and other means to help grant seekers. NPLs attend, as regularly as travel budget and schedule availability permit, to multistate research committees, state liaison visits, and professional meetings to provide information about the portfolio and the agency to scientific, producer, and processor communities.

- *2007 Portfolio Response*
  The strength of CSREES portfolio leadership and management relating to the portfolio continues to be excellent, and the portfolio continues to be well managed.

- *2006 Portfolio Response*
  The portfolio continues to provide excellent leadership and management to its partners.

Portfolio Accountability

The Panel was not provided with any evidence of accountability. Accountability metrics also appear to be lacking and there is room for improvement in the quality of the self-study document, and supporting materials.

- *2008 Portfolio Response*
  NPLs uses a variety of tools, including grantees' workshop, NPL Dashboard, reviewing project progresses, etc. to ensure the program accountability.

- *2007 Portfolio Response*
  The portfolio continues to improve its requirements that funded projects complete with thoroughness, clarity, timeliness, adequacy, and usefulness. The portfolio has improved its post-award management.

- *2006 Portfolio Response*
  The portfolio will improve post-award management and its requirements that funded projects complete with thoroughness, clarity, timeliness, adequacy, and usefulness.

Section V: Self-Assessment

Portfolio Scoring

Criteria	Panel Score	2006 Score	2007 Score	2008 Score
Relevance				
Scope	3	3	3	3
Focus	2	2	3	3
Contemporary and/or Emerging Issues	2	2	2.5	3
Integration	1	2	2.5	3
Multi-disciplinary Balance	3	3	3	3
Quality				
Significance of Findings	3	3	3	3
Stakeholder/Constituent Inputs	2	3	3	3
Alignment with Current State of Science	3	3	3	3
Appropriate and/or Cutting Edge Methodology	3	2	2.5	2.5
Performance				
Portfolio Productivity	2	2	2.5	2.5
Portfolio Comprehensiveness	2	2	2	2
Portfolio Timeliness	1	2	2	2
Agency guidance	3	3	3	3
Portfolio Accountability	2	2	2	2.5
Overall score	80	83	91	93

2008 Portfolio Score Change Discussion

Relevance

Scope:
External Panel commended the portfolio for having an exceptional breadth and depth in its scope, especially given the limited resources allocation. The portfolio review team maintained the scope excellence, and further expands in bioenergy and nanotechnology, and established a new major program in specialty crops. The team gave a rating of 3 again for 2008.

Focus:
The portfolio focus was significantly improved in 2007 by given extensive attention on key program areas in nanotechnology, bioenergy, food safety, and food security through NRI and SBIR RFA development and execution. This effort continued in 2008 in these key areas. The new specialty crop program also reflected a good integration of engineering and technology. The portfolio team rated in 3 again with good confidence.

Contemporary and/or Emerging Issues:
CSREES national program leaders have made significant efforts in identify contemporary and emerging issues, and effectively converted the visions into actions. The specialty crop research initiative (SCRI) competitive grant program was designed and implemented for the first time in 2008. Societal issues were identified and addressed for the first time through NRI nanoscale science, engineering and technology program in 2008. CSREES is leading an REE effort to implement a strategic energy science plan for the next five years. Based on the significant improvement, the portfolio review team felt strongly to edge up the rating from 2.5 to 3 for 2008.

Integration:
Integration across research, education and extension has been more evident in this year's report. Workforce training for the biobased economy vision has been amply reflected in strategic planning, financial investment and program implementations. NRI Improving Food Quality and Value program continued its supported in integrated projects in both emerging food processing technologies and use of bioactives in foods to combat obesity and energy imbalance. Nanotechnology programs supported efforts in Extension for improving public understanding of the new cutting-edge science and its broad impacts. The specialty crops research initiative program has research, education and extension well integrated from get-go. The evidences are well documented; hence increasing the rating from 2.5 to 3 is warranted.

Multi-disciplinary Balance:
Multi-disciplinary balance of the portfolio has been well maintained from beginning. There are ample examples of multi-disciplinary approaches in this portfolio.

<u>Quality</u>

Significance of Findings:
The External Panel rated the significance of findings of the portfolio as 3. The portfolio has continued producing highly significant results. More significant findings in the portfolio have been documents. Two out of four issues of CSREES Partner Video magazines produced and disseminated in 2008 related to the work in this portfolio. They are biofuels and nanotechnology, to highlight the most significant works supported by the agency. The current review panel kept the rating of 3 for 2008.

Stakeholder/Constituent Inputs:
The current review panel retained the score of 3 for its traditional approach of soliciting many stakeholder/constituent inputs. Significant stakeholder meetings held on topics including specialty crops, bioenergy, and nanotechnology are exemplary in many ways.

Alignment with Current State of Science:
The portfolio continues its demonstration of alignment with the current state of science-based knowledge—a score of 3. CSREES program staff work closely with and collaborate with many different agencies on important national initiatives such as bioenergy, nanotechnology, sustainability, and food for health.

Appropriate and/or Cutting Edge Methodologies:
The appropriate and/or cutting edge methods and techniques are interpreted as those employed in the agency funded projects that are carried out at our partner institutes.
It is recognized although variation in technology and methodology use across the broad partner institutions does exist; constant improvement over previous years is generally agreed. Moreover, the works performed in some areas of research works of this portfolio such as nanotechnology are at true world leading edge. Evidences are recorded in this report. The score remains as 2.5, the same as the last year.

Performance

Portfolio Productivity:
The NPLs demonstrated a tremendous potential of achieving highest productivity through the remarkable 100-day completion from the SCRI RFA development to awards. The use of electronic grant submission and processing, a reduction in the turn around time for awarding a grant, and the work completed in the NPL liaison program were all improved in 2008. However, the review team believes that CSREES can continue to build capacity and increase productivity, hence gave a conservative score of 2.5, the same as the last year.

Portfolio Comprehensiveness:
The External Panel and all the previous review teams gave the portfolio a score of 2 for demonstrating moderate comprehensiveness of the portfolio in terms of areas of work, outputs, and outcomes. Though some improvements are evident in certain KAs, the current review team did not see a cross board improvement, partly because of no significant new dollars, hence kept a score of 2.

Timeliness:
Internal timeliness is a measure how the portfolio program staff to process grant applications, awards, and House Q&As. It is evident that the program staff were able to carry out these tasks in timely fashion. External timeliness refers to the degree that the grant awardees complete the projects timely as proposed. While most of the projects are completed on time, there are a small percentage of them needing non-cost extensions. It is frequently due to unexpected externalities. This will remain as an issue to be addressed in the future. The score remains 2.

Agency Guidance:
The strength of CSREES portfolio leadership and management relating to the portfolio has remained a strong trait of this portfolio. The score remains the same as all previous years as well as the one given by the External Panel.

Portfolio Accountability:
The post-award management has continued to improve by utilization of various tools and that program staff are developing capability to trace project impact years past the funded project expiration. Grantees' workshops are common practice now to observe the

progress of funded projects. NPLs provide timely feedbacks to the project directors to assure the accountability in conducting research, education and extension projects. The score hence reflected the improvement – from 2 to 2.5 – for 2008.

Overall Portfolio 2008 Score Comments

The overall portfolio score increased from 91 to 93. This increase is indicative of the National Program staff's leadership, will and energy to maintain and improve the quality and impact of this portfolio. NPLs have devoted significant efforts in creatively design and implement new ideas to address the weakness identified in previous reviews. Significant improvements, especially in capturing opportunities in emerging issues, function integration, and project execution accountability are made in 2008. The increase in score is well-justified, as demonstrated by this updated report.

2007 Portfolio Score Change Discussion

Relevance

Scope:

The portfolio review team rated the portfolio's description of what it can provide in terms of coverage of work with the funds available as a 3, which is the same ranking as last year. External reviewers noted weaknesses in sensors and other new technologies, but great progress has been made within the SBIR program and the NRI Nanoscale Science and Engineering programs which fully address the external review panel's concern.

Focus:

The previous score for the portfolio's demonstrated ability to remain focused on issues, topics, and critical needs of the nation was a 2. The current internal portfolio review team rated the area as a 3, based on extensive attention paid to topics in nanotechnology, bioenergy, food safety, and food security. Requests for Applications from SBIR and the NRI were focused more closely in the past year to draw attention to critical issues and topics.

Contemporary and/or Emerging Issues:

The previous internal review process netted a score of 2 in terms of the portfolio's ability to identify contemporary and/or emerging issues that are consistent and relevant to the portfolio and its mission. After review of progress made in the past year, the current review team gave the portfolio a score of 2.5. It is demonstrated in the portfolio that CSREES program leaders have the ability to identify contemporary and emerging issues and attempts have been made to focus on those issues. However, as of yet, there is still a significant weakness in the ability to capture and address all of the contemporary and emerging issues. It may not be possible to act on each and every issue that is identified.

Integration:

Last year's internal review team gave the portfolio a score of 2 in terms of demonstration of functional integration of CSREES research, extension, and education efforts in the portfolio. The review team struggled with the definition of "integration." After close review of the portfolio, the team gave the current document a score of 2.5, citing some

improvement over last year, but pointing out that the portfolio is still not as well-integrated as it has potential to be. However, there are several examples provided that demonstrate forward thinking and projects in early stages with components of integration.

Multi-disciplinary Balance:
The review teams from last year and the current year gave the portfolio a score of 3 for strong demonstration of a multi-disciplinary balance of the portfolio in solving scientific problems. The current portfolio reaches across several diverse disciplines.

Quality

Significance of Findings:
The review teams from last year and the current year gave the portfolio a score of 3 for demonstrating many significant findings in the portfolio. The current review panel found an emphasis on emerging issues, as well as identification and sharing of significant findings.

Stakeholder/Constituent Inputs:
The current review panel gave the panel a score of 3 for its many stakeholder/constituent inputs. This score is the same as last year. Several new significant stakeholder meetings were held in the past year on topics including specialty crops, REE, and bioenergy.

Alignment with Current State of Science:
The review panel from last year and the current year rated the portfolios demonstration of alignment with the current state of science-based knowledge and previous work as highly aligned—a score of 3. CSREES program staff work closely with and collaborate with many different agencies.

Appropriate and/or Cutting Edge Methodologies:
The review panel from the previous year gave the portfolio a score of 2 in terms of demonstrated use of appropriate and/or cutting edge methods and techniques for funded projects. There was some confusion during the current review regarding whether the evaluation was to be applied to the physical management of funds or to the funded projects actually doing the research. The current review panel gave the portfolio a score of 2.5, citing several examples of CSREES use of appropriate methodologies including revising how RFAs are written to solicit the most innovative and cutting edge proposals. Further, the portfolio demonstrates that funded projects are using the best methods available to carry out their work. Program staff at CSREES are working to do everything within their control to ensure that projects are utilizing the most innovative and cutting edge techniques.

Performance

Portfolio Productivity:
The previous review panel gave the portfolio a score of 2 for its demonstration of the ability of CSREES to create and provide service through funding, directing, managing,

and partnering with its various stakeholders. The current review panel gave the portfolio a score of 2.5 based on its demonstration of improvement in electronic grant submission, the development and use of the Leadership Management Dashboard, a reduction in the turn around time for awarding a grant, and the work completed in the NPL liaison program. The review team believes that CSREES can continue to build capacity and increase productivity.

Portfolio Comprehensiveness:
The previous review team and the current review team gave the portfolio a score of 2 for demonstrating moderate comprehensiveness of the portfolio in terms of areas of work, outputs, and outcomes. The portfolio is varied and there are impacts across the breadth of the portfolio although not necessarily in each and every KA. As a whole, the portfolio is moderately comprehensive, but did not demonstrate significant enough improvement to warrant an increase in score.

Timeliness:
The previous review team and the current review team gave the portfolio a score of 2 for demonstrating to a moderate extent that funded activities are completed within the funding time frame. The review panel agreed that there is still room for improvement in encouraging projects to complete on time and make judicious use of no cost extensions.

Agency Guidance:
The current review team concurred with the previous review team and gave the portfolio a score of 3. The portfolio demonstrates strength of CSREES portfolio leadership and management relating to the portfolio. The portfolio is well-managed.

Portfolio Accountability:
The current review team concurred with the previous reviewers' score of 2 regarding the demonstrated extent to which funded projects of the portfolio have been completed with thoroughness, clarify, timeliness, adequacy, and usefulness. The review panel noted that post-award management has improved since the last review and that program staff are developing closer relationships with project directors that extend past the funded project expiration date. This action is helpful for identifying impacts that occur after the project is terminated, when the project director can no longer access CRIS to update project impacts.

<u>Overall Portfolio 2007 Score Comments</u>
The overall portfolio score increased from 83 to 91. This increase is indicative of several things, including program staff efforts to improve the portfolio, as well as the inclusion of KA 401, 402, and 404. The portfolio restructuring has served to strengthen the foundation of the portfolio. National program leaders have taken portfolio reviewers' comments and made efforts to improve weaker areas of the portfolio and reinforce the strong aspects of the portfolio. The increase in score is well-justified, as demonstrated by the updated review document.

Appendix A – External Panel Recommendations to the Agency

In response to directives from the Office of Management and Budget (OMB) of the President, CSREES implemented the Portfolio Review Expert Panel (PREP) process to systematically review its progress in achieving its mission. Since this process began in 2003, fourteen expert review panels have been convened and each has published a report offering recommendations and guidance. These external reviews occur on a rolling five-year basis. In the four off years an internal panel is assembled to examine how well CSREES is addressing the expert panel's recommendations. These internal reports are crafted to specifically address the issues raised for a particular portfolio. Electronic versions of both external and internal reviews for all portfolios are located on the Agency's website (http://www.csrees.usda.gov/about/strat_plan_portfolio.html).

Even though the expert reports were all written independent of one another on portfolios comprised of very different subject matter, several themes common to the set of review reports have emerged. This set of issues has repeatedly been identified by expert panels and requires an agency-wide response. The agency has taken a series of steps to effectively respond to those overarching issues.

- **Issue 1: Getting Credit When Credit is Due**
  For the most part panelists were complimentary when examples showing partnerships and leveraging of funds were used. However, panelists saw a strong need for CSREES to better assert itself and its name into the reporting process. Panelists believed that principal investigators who conduct the research, education and extension activities funded by CSREES often do not highlight the contributions made by CSREES. Multiple panel reports suggested CSREES better monitor reports of its funding and ensure that the agency is properly credited. Many panelists were unaware of the breadth of CSREES activities and believe their lack of knowledge is partly a result of CSREES not receiving credit in publications and other material made possible by CSREES funding.

  Issue 1: Agency Response:
  To address the issue of lack of credit being given to CSREES for funded projects, the Agency implemented several efforts likely to improve this situation.

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

  Second, the Agency is in the process of implementing the "One Solution" concept. One Solution will allow for the better integration, reporting and publication of CSREES material on the web. In addition, the new Plan of Work (POW), centered by a logic model framework, became operational in June 2006. Because of the new POW requirements and the POW training conducted by the Office of Planning and Accountability (OPA), it will be simpler for state and local partners to line up the work they are doing with agency expenditures. This in turn

will make it easier for project managers to cite CSREES contributions when appropriate.

The Agency has started the process of upgrading the Current Research Information System (CRIS), once upgraded it will be named the CSREES Information System (CIS). The CIS will allow users to access information from the Plan of Work (POW) and new Standard Report in a more effective and efficient manner. In addition to the CIS, the new Annual Reporting system that is based on activities discussed in the POW was launched in 2008.

- **Issue 2: Partnership with Universities**
  Panelists felt that the concept of partnership was not being adequately presented. Panelists saw a need for more detail to be made available. Panelists asked a number of questions revolving around long-term planning between the entities they also asked how the CSREES mission and goals were being supported through its partnership with universities and vice versa.

  Issue 2: Agency Response:
  CSREES has taken several steps to strengthen its relationship with university partners. During the November 2005 National Association of State University and Land Grant Colleges (NASULGC) meeting in Washington, D.C., Dr. Colien Hefferan announced a new cooperative program entitled the new NPL Institutional Liaison program. The primary goal of this program is to strengthen the relationship between CSREES and its state partners, thus enhancing the effectiveness of the work done by CSREES. Through teleconferences, campus visits, e-mails and other meeting opportunities; CSREES' knowledge and understanding of institutional interests and needs will increase. CSREES is committed to learning more about state research, extension and education activities, strategic plans, and goals.

  NPL Liaisons have the following duties:
  - Become knowledgeable about the administrative structure budget sources and major program commitments of your institution
  - Meet regularly with the CSREES deputy administrator liaison with your region
  - Make quarterly phone calls or teleconferences to appropriate university officials in order to create ongoing dialogue of shared interests and needs
  - Schedule campus visit/s in order to enhance the partnership
  - Serve as the joint reviewers of your integrated annual plans of work from cooperative extension and research
  - Identify partnership opportunities within CSREES and other federal agencies to strengthen your programs and assist in meeting your goals

  Finally, several trainings that focused on the POW were conducted by CSREES in geographic regions throughout the country. A major goal of this training was to

better communicate CSREES goals to state leaders which will facilitate better planning between the universities and CSREES.

- **<u>Issue 3: National Program Leaders</u>**
  Without exception the portfolio review panels were complimentary of the work being done by NPLs. They believe NPLs have significant responsibility, are experts in the field and do a difficult job admirably. Panelists did however mention that often times there are gaps in the assignments given to NPLs. Those gaps leave holes in programmatic coverage.

  Issue 3: Agency Response:
  CSREES values the substantive expertise that NPLs bring to the Agency and therefore requires all NPLs to be experts in their respective fields. Given the budget constraints often times faced by the agency, the agency has not always been able to fund needed positions and had to prioritize its hiring for open positions. In addition, because of the level of expertise CSREES requires of its NPLs, quick hires are not always possible. Often, CSREES is unable to meet the salary demands of those it wishes to hire. It is essential that position not only be filled but filled with the most qualified candidate.

  Operating under these constraints and given inevitable staff turnover, gaps will always remain. However, establishing and drawing together multidisciplinary teams required to complete the portfolio reviews has allowed the Agency to identify gaps in program knowledge and ensure that these needs are addressed in a timely fashion. To the extent that specific gaps are mentioned by the expert panels, the urgency to fill them is heightened.

- **<u>Issue 4: Integration</u>**
  Lack of integration has been highlighted throughout the panel reviews. While review panelists certainly noted in their reports where they observed instances of integration, almost without fail panel reports sought more documentation in this regard.

  Issue 4: Agency Response:
  Complex problems require creative and integrated approaches that cut across disciplines and knowledge areas. CSREES has recognized the need for these approaches and has undertaken steps to remedy this situation. CSREES has recently mandated that up to twenty-six percent of all NRI funds be put aside specifically for integrated projects. These projects cut across functions as well as disciplines and ensure that future Agency work will be better integrated. Integration is advanced through the portfolio process which requires cooperation across units and programmatic areas.

- **<u>Issue 5: Extension</u>**
  While most panels seemed satisfied at the level of discussion that focused on research, the same does not hold true for extension. There was a call for more

detail and more outcome examples based upon extension activities. There was a consistent request for more detail regarding not just the activities undertaken by extension but documentation of specific results these activities achieved.

Issue 5: Agency Response:
Conferences have been conducted to increase the awareness of improved methodologies and reporting systems for documenting outcomes and impacts for the Agency. A Mini-Conference of CSREES Planning and Evaluation was held April 23-24, 2007 in conjunction with the Administrative Officers' Conference in Seattle, WA. This mini-conference was designed for those planning programs or engaged in performance measurement and program evaluation. Participants learned about Plan of Work reporting, what CSREES has learned from the 2007-2011 Plans submitted, and how CSREES has used and expects to use information from annual reports and plans.

In addition to the CSREES Planning and Evaluation Mini-Conference, CSREES, in partnership with Texas A&M University, started a bi-monthly CSREES Reporting Web Conference Series (RWC) in February 2008. This series originated from requests for more information on various topics identified at the 2007 CSREES Planning and Accountability Mini-Conference. Topics for the series include:

- Agricultural Research, Extension, and Education Reform Act (AREERA);
- Plans of Work (POW);
- Annual Reports;
- One Solution;
- CRIS (soon to become CSREES Information System (CIS)); and
- Outcome reporting.

The AREERA Plan of Work and Annual Reporting system (POW) made extension-based results and reporting a priority. The new POW includes program descriptions and progress reports limited to four legislatively prescribed lines of funding. POW includes descriptions and annual accomplishments for each subject program. POW is a database application containing a combination of structured data and unstructured text box fields. These reports provide state level documentation of extension outcomes and impacts not previously captured in Agency wide reporting systems. Approved state plans of work and annual reports will be available in the Research, Education, and Economics Information System (REEIS) in the fall of 2008.

- **Issue 6: Program Evaluation**
  Panelists were complimentary in that they saw the creation of OPA and portfolio reviews as being the first steps towards more encompassing program evaluation work; however, they emphasized the need to see outcomes and often stated that the scores they gave were partially the result of their own personal experiences rather than specific program outcomes documented in the portfolios. In other words, they know first hand that CSREES is having an impact but would like to

see more systematic and comprehensive documentation of this impact in the reports.

Issue 6: Agency Response:
The effective management of programs is at the heart of the work conducted at CSREES and program evaluation is an essential component of effective management. In 2003 the PREP process and subsequent internal reviews were implemented. Over the past four years 14 portfolios have been reviewed by expert panel members and continue to be self-assessed annually. Each year this process improves, including reconfiguration of several portfolios to become better structured for planning and assessment. NPLs are now familiar with the process and the staff of the Office of Planning and Accountability (OPA) has implemented a systematic process for pulling together the material required for these reports.

Simply managing the process more effectively is not sufficient for raising the level of program evaluations being done on CSREES funded projects to the highest standard. Good program evaluation is a process that requires constant attention by all stakeholders and the agency has focused on building the skill sets of stakeholders in the area of program evaluation. The OPA has conducted training in the area of evaluation for both NPLs and for staff working at Land-Grant universities. This training is available electronically and the OPA will be working with NPLs to deliver training to those in the field.

The OPA is working more closely with individual programs to ensure successful evaluations are developed, implemented and the data analyzed. Senior leadership at CSREES has begun to embrace program evaluation and over the coming years CSREES expects to see state leaders and project directors more effectively report on the outcomes of their programs as they begin to implement more rigorous program evaluation. The new POW system ensures data needed for good program evaluation will be available in the future.

The newly formatted annual review document has encouraged the discussion of program evaluations conducted regarding programs funded by the Agency for the particular portfolio being highlighted.

- **<u>Issue 7: Logic Models</u>**
  Panelists were consistently impressed with the logic models and the range of their potential applications. They expressed the desire to see the logic model process used by all projects funded by CSREES and hoped not only would NPLs continue to use them in their work but, also, that those conducting the research and implementing extension activities would begin to incorporate them into their work plans.

Issue 7: Agency Response:

Logic models have become a staple of the work being done at CSREES and the Agency has been proactive in promoting the use of logic models to its state partners.

Two recent initiatives highlight this. First, in 2005, the POW reporting system into which states submit descriptions of their accomplishments was completely revamped. The new reporting system now closely matches the logic models being used in portfolio reports. Beginning in fiscal year 2007, states will be required to enter all of the following components of a standard logic model. These components include describing the following:

- Program Situation
- Program Assumption
- Program Long Term Goals
- Program Inputs which include both monetary and staffing
- Program Output which include such things as patents
- Short Term Outcome Goals
- Medium Term Outcome Goals
- Long Term Outcome Goals
- External Factors
- Target Audience

A series of training workshops were conducted by the OPA for staff from CSREES and from the land grant partnership. OPA senior staff traveled to regional conferences attended by Project Directors and Principal Investigators funded by CSREES. They conducted workshops on budget and performance integration and logic models. These sessions helped our partners understand the full picture and emphasized the need for our partners to report their accomplishments. Senior staff presented the logic model as a conceptual as well as an application tool useful for planning and reporting. Partners have now begun to use logic model in their work as well as report their accomplishments. In fact the Competitive Program unit of the Agency has made the inclusion of logic models a requirement for Integrated Programs.

Appendix B - Detailed Funding Tables for Primary KAs – CSREES Funding *If data is unavailable note n/a in the allocated space.*

KA 401: Structures, Facilities, and General Purpose Farm Supplies CSREES Funding						
Combined Research and Extension Funding						
	$ in the thousands					
Funding Source	**FY 2003**	**FY 2004**	**FY 2005**	**FY 2006**	**FY 2007**	**Total**
Hatch	$425.00	$339.00	$354.00	$316.00	$337.00	$1,771.00
McIntire-Stennis	$99.00	$147.00	$169.00	$99.00	$151.00	$665.00
Evans Allen	$0.00	$0.00	$0.00	$0.00	$116.00	$116.00
Animal Health	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Special Grants	$820.00	$281.00	$359.00	$240.00	$0.00	$1,700.00
NRI Grants	$216.00	$21.00	$246.00	$0.00	$340.00	$823.00
SBIR Grants	$38.00	$80.00	$0.00	$198.00	$80.00	$396.00
Other CSREES	$84.00	$225.00	$49.00	$95.00	$350.00	$803.00
Total Reported in CRIS	*$1,682.00*	*$1,093.00*	*$1,177.00*	*$948.00*	*$1,374.00*	*$6,274.00*
Smith-Lever 3(b) and (c)	n/a	n/a	n/a	n/a	$607.279	$607.279
1890 Extension	n/a	n/a	n/a	n/a	$56.767	$56.767
Total Extension Reported in POW	*n/a*	*n/a*	*n/a*	*n/a*	*$664.045*	*$664.045*
Combined CSREES Total	**$2,020.00**	**$1,419.00**	**$1,177.00**	**$948.00**	**$2,038.045**	**$6,938.045**

Source of Funding: Current Research Information System (CRIS) and Plan of Work (POW) Annual Report

KA 402: Engineering Systems and Equipment CSREES Funding						
Combined Research and Extension Funding						
	$ in the thousands					
Funding Source	**FY 2003**	**FY 2004**	**FY 2005**	**FY 2006**	**FY 2007**	**Total**
Hatch	$1,095.00	$990.00	$905.00	$974.00	$1,103.00	$5,067.00
McIntire-Stennis	$34.00	$28.00	$44.00	$155.00	$329.00	$590.00
Evans Allen	$0.00	$0.00	$53.00	$60.00	$60.00	$173.00
Animal Health	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Special Grants	$694.00	$605.00	$674.00	$1,531.00	$0.00	$3,504.00
NRI Grants	$388.00	$53.00	$493.00	$524.00	$232.00	$1,690.00
SBIR Grants	$403.00	$987.00	$1,090.00	$1,001.00	$836.00	$4,317.00
Other CSREES	$1,110.00	$632.00	$523.00	$1,948.00	$997.00	$5,210.00
Total Reported in CRIS	*$3,724.00*	*$3,295.00*	*$3,782.00*	*$6,193.00*	*$3,557.00*	*$20,551.00*
Smith-Lever 3(b) and (c)	n/a	n/a	n/a	n/a	$823.114	$823.114
1890 Extension	n/a	n/a	n/a	n/a	$40.443	$40.443
Total Extension Reported in POW	n/a	n/a	n/a	n/a	*$863.557*	*$863.557*
Combined CSREES Total Funding	$3,724.00	$3,295.00	$3,782.00	$6,193.00	$4,420.56	$21,414.56

Source of Funding: Current Research Information System (CRIS) and Plan of Work (POW) Annual Report

KA 404: Instrumentation and Control Systems CSREES Funding						
Combined Research and Extension Funding						
	$ in the thousands					
Funding Source	**FY 2003**	**FY 2004**	**FY 2005**	**FY 2006**	**FY 2007**	**Total**
Hatch	$879.00	$1,034.00	$990.00	$952.00	$949.00	$4,804.00
McIntire-Stennis	$75.00	$55.00	$20.00	$34.00	$54.00	$238.00
Evans Allen	$53.00	$25.00	$124.00	$0.00	$0.00	$202.00
Animal Health	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Special Grants	$759.00	$748.00	$579.00	$582.00	$0.00	$2,668.00
NRI Grants	$289.00	$596.00	$782.00	$440.00	$33.00	$2,140.00
SBIR Grants	$743.00	$130.00	$830.00	$710.00	$908.00	$3,321.00
Other CSREES	$172.00	$317.00	$415.00	$71.00	$63.00	$1,038.00
Total Reported in CRIS	*$2,970.00*	*$2,905.00*	*$3,740.00*	*$2,789.00*	*$2,007.00*	*$14,411.00*
Smith-Lever 3(b) and (c)	n/a	n/a	n/a	n/a	*$270.317*	$270.317
1890 Extension	n/a	n/a	n/a	n/a	*$10.358*	$10.358
Total Extension Reported in POW	n/a	n/a	n/a	n/a	*$280.675*	*$280.675*
Combined CSREES Total Funding	$2,970.00	$2,905.00	$3,740.00	$2,789.00	$2,287.675	$14,691.675

Source of Funding: Current Research Information System (CRIS) and Plan of Work (POW) Annual Report

KA 501: New and Improved Food Processing Technologies CSREES Funding						
Combined Research and Extension Funding						
	$ in the thousands					
Funding Source	**FY 2003**	**FY 2004**	**FY 2005**	**FY 2006**	**FY 2007**	**Total**
Hatch	$2,781.00	$3,088.00	$3,512.00	$3,184.00	$3,600.00	$16,165.00
McIntire-Stennis	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Evans Allen	$395.00	$515.00	$704.00	$166.00	$166.00	$1,946.00
Animal Health	$0.00	$0.00	$1.00	$4.00	$13.00	$18.00
Special Grants	$2,526.00	$3,458.00	$3,391.00	$3,185.00	$0.00	$12,560.00
NRI Grants	$2,932.00	$1,322.00	$3,533.00	$3,093.00	$1,137.00	$12,017.00
SBIR Grants	$594.00	$1,376.00	$511.00	$948.00	$1,806.00	$5,235.00
Other CSREES	$1,249.00	$1,143.00	$1,167.00	$3,448.00	$357.00	$7,364.00
Total Reported in CRIS	*$3,176.00*	*$3,603.00*	*$12,819.00*	*$14,029.00*	*$7,079.00*	*$40,706.00*
Smith-Lever 3(b) and (c)	n/a	n/a	n/a	n/a	$1,584.087	$1,584.087
1890 Extension	n/a	n/a	n/a	n/a	$318.974	$318.974
Total Extension Reported in POW	n/a	n/a	n/a	n/a	*$1,903.060*	*$1,903.060*
Combined CSREES Total Funding	$3,176.00	$3,603.00	$12,819.00	$14,029.00	$8,982.06	$42,609.06

Source of Funding: Current Research Information System (CRIS) and Plan of Work (POW) Annual Report

KA 502: New and Improved Food Products CSREES Funding						
Combined Research and Extension Funding						
	$ in the thousands					
Funding Source	**FY 2003**	**FY 2004**	**FY 2005**	**FY 2006**	**FY 2007**	**Total**
Hatch	$3,045.00	$2,929.00	$2,435.00	$2,538.00	$3,023.00	$13,970.00
McIntire-Stennis	$1.00	$0.00	$0.00	$0.00	$0.00	$1.00
Evans Allen	$654.00	$570.00	$341.00	$352.00	$549.00	$2,466.00
Animal Health	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Special Grants	$3,220.00	$2,470.00	$3,228.00	$3,047.00	$0.00	$11,965.00
NRI Grants	$584.00	$2,732.00	$3,638.00	$2,323.00	$2,183.00	$11,460.00
SBIR Grants	$453.00	$776.00	$374.00	$296.00	$0.00	$1,899.00
Other CSREES	$597.00	$493.00	$1,178.00	$1,605.00	$25.00	$3,898.00
Total Reported in CRIS	*$8,554.00*	*$9,970.00*	*$11,194.00*	*$10,161.00*	*$5,780.00*	*$45,659.00*
Smith-Lever 3(b) and (c)	n/a	n/a	n/a	n/a	$1,159.387	$1,159.387
1890 Extension	n/a	n/a	n/a	n/a	$147.442	$147.442
Total Extension Reported in POW	n/a	n/a	n/a	n/a	$1,306.830	$1,306.830
Combined Total CSREES Funding	$8,554.00	$9,970.00	$11,194.00	$10,161.00	$7,086.83	$46,965.83

Source of Funding: Current Research Information System (CRIS) and Plan of Work (POW) Annual Report

KA 503: Quality Maintenance in Storing and Marketing Food Products CSREES Funding						
Combined Research and Extension Funding						
	$ in the thousands					
Funding Source	**FY 2003**	**FY 2004**	**FY 2005**	**FY 2006**	**FY 2007**	**Total**
Hatch	$1,758.00	$1,148.00	$1,508.00	$1,280.00	$1,417.00	$7,111.00
McIntire-Stennis	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Evans Allen	$440.00	$307.00	$318.00	$143.00	$129.00	$1,337.00
Animal Health	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Special Grants	$1,019.00	$1,116.00	$1,139.00	$982.00	$0.00	$4,256.00
NRI Grants	$591.00	$608.00	$1,544.00	$963.00	$363.00	$4,069.00
SBIR Grants	$741.00	$936.00	$587.00	$158.00	$402.00	$2,824.00
Other CSREES	$225.00	$1,142.00	$170.00	$1,682.00	$366.00	$3,585.00
Total Reported in CRIS	*$4,774.00*	*$5,257.00*	*$5,266.00*	*$5,208.00*	*$2,677.00*	*$23,182.00*
Smith-Lever 3(b) and (c)	n/a	n/a	n/a	n/a	$973.507	$973.507
1890 Extension	n/a	n/a	n/a	n/a	$50.348	$50.348
Total Extension Reported in POW	*n/a*	*n/a*	*n/a*	*n/a*	*$1,023.854*	*$1,023.854*
Combined CSREES Total Funding	$4,774.00	$5,257.00	$5,266.00	$5,209.00	$3,700.85	$24,205.85

Source of Funding: Current Research Information System (CRIS) and Plan of Work (POW) Annual Report

KA 504: Home and Commercial Food Service CSREES Funding						
Combined Research and Extension Funding						
	$ in the thousands					
Funding Source	**FY 2003**	**FY 2004**	**FY 2005**	**FY 2006**	**FY 2007**	**Total**
Hatch	$26.00	$16.00	$7.00	$7.00	$15.00	$71.00
McIntire-Stennis	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Evans Allen	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Animal Health	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Special Grants	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
NRI Grants	$0.00	$65.00	$219.00	$157.00	$0.00	$441.00
SBIR Grants	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Other CSREES	$1,383.00	$435.00	$1,607.00	$507.00	$188.00	$4,120.00
Total Reported in CRIS	*$1,409.00*	*$516.00*	*$1,833.00*	*$671.00*	*$203.00*	*$5,546.00*
Smith-Lever 3(b) and (c)	n/a	n/a	n/a	n/a	$805.645	$805.645
1890 Extension	n/a	n/a	n/a	n/a	$111.455	$111.455
Total Extension Reported in POW	*n/a*	*n/a*	*n/a*	*n/a*	*$917.100*	*917.09992*
Combined CSREES Total Funding	1,409	516	1,833	671	$1,120.10	6,463

Source of Funding: Current Research Information System (CRIS) and Plan of Work (POW) Annual Report

KA 511: New and Improved Non-Food Products and Processes CSREES Funding						
Combined Research and Extension Funding						
	$ in the thousands					
Funding Source	**FY 2003**	**FY 2004**	**FY 2005**	**FY 2006**	**FY 2007**	**Total**
Hatch	$1,282.00	$1,255.00	$1,377.00	$1,420.00	$2,398.00	$7,732.00
McIntire-Stennis	$1,086.00	$823.00	$784.00	$1,170.00	$1,739.00	$5,602.00
Evans Allen	$0.00	$0.00	$145.00	$347.00	$423.00	$915.00
Animal Health	$2.00	$1.00	$5.00	$0.00	$0.00	$8.00
Special Grants	$5,391.00	$6,351.00	$6,570.00	$6,791.00	$0.00	$25,103.00
NRI Grants	$6,478.00	$3,218.00	$7,899.00	$5,405.00	$3,838.00	$26,838.00
SBIR Grants	$3,502.00	$2,106.00	$1,471.00	$2,022.00	$2,514.00	$11,615.00
Other CSREES	$2,099.00	$2,769.00	$2,200.00	$2,387.00	$1,260.00	$10,715.00
Total Reported in CRIS	*$19,840.00*	*$16,523.00*	*$20,451.00*	*$19,544.00*	*$12,172.00*	*$137,276.00*
Smith-Lever 3(b) and (c)	n/a	n/a	n/a	n/a	$681.693	$681.693
1890 Extension	n/a	n/a	n/a	n/a	$18.612	$18.612
Total Extension Reported in POW	*n/a*	*n/a*	*n/a*	*n/a*	*$700.305*	*$700.305*
Combined CSREES Total Funding	$19,840.00	$16,523.00	$20,451.00	$19,544.00	$12,872.30	$137,976.30

Source of Funding: Current Research Information System (CRIS) and Plan of Work (POW) Annual Report

KA 512: Quality Maintenance in Storing and Marketing Non-Food Products CSREES Funding						
Combined Research and Extension Funding						
	$ in the thousands					
Funding Source	**FY 2003**	**FY 2004**	**FY 2005**	**FY 2006**	**FY 2007**	**Total**
Hatch	$185.00	$319.00	$258.00	$334.00	$331.00	$1,427.00
McIntire-Stennis	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Evans Allen	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Animal Health	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Special Grants	$216.00	$152.00	$109.00	$0.00	$0.00	$477.00
NRI Grants	$247.00	$0.00	$2.00	$0.00	$0.00	$249.00
SBIR Grants	$155.00	$0.00	$80.00	$0.00	$40.00	$275.00
Other CSREES	$146.00	$132.00	$171.00	$178.00	$1.00	$628.00
Total Reported in CRIS	*$949.00*	*$603.00*	*$620.00*	*$512.00*	*$372.00*	*$3,056.00*
Smith-Lever 3(b) and (c)	n/a	n/a	n/a	n/a	$58.76	$58.76
1890 Extension	n/a	n/a	n/a	n/a	$1.47	$1.47
Total Extension Reported in POW	*n/a*	*n/a*	*n/a*	*n/a*	*$60.23*	*$60.23*
Combined CSREES Total Funding	$949.00	$603.00	$620.00	$512.00	$432.23	$3,116.23

Source of Funding: Current Research Information System (CRIS) and Plan of Work (POW) Annual Report

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

KA 401: Structures, Facilities, and General Purpose Farm Supplies Overall Funding						
Combined Research and Extension Funding						
	$ in the thousands					
Year	FY 2003	FY 2004	FY 2005	FY 2006	FY 2007	Total
Combined CSREES Total	$1,681.00	$1,093.00	$1,177.00	$948.00	$2,039.05	$6,938.05
Other USDA	$487.00	$192.00	$113.00	$85.00	$60.00	$937.00
Other Federal	$303.00	$220.00	$347.00	$81.00	$743.00	$1,694.00
State Appr.	$2,683.00	$2,401.00	$3,589.00	$2,236.00	$3,774.00	$14,683.00
Self-Gen	$305.00	$588.00	$790.00	$534.00	$874.00	$3,091.00
Ind/Gr Agrmt	$217.00	$190.00	$383.00	$412.00	$914.00	$2,116.00
Other Non-Fed	$419.00	$251.00	$506.00	$244.00	$534.00	$1,954.00
Total	$6,094.00	$4,934.00	$6,906.00	$4,540.00	$8,938.05	$31,412.05

Source of Funding: Current Research Information System (CRIS) and Plan of Work (POW) Annual Report

KA 402: Engineering Systems and Equipment CSREES Funding						
Combined Research and Extension Funding						
	$ in the thousands					
Funding Source	FY 2003	FY 2004	FY 2005	FY 2006	FY 2007	Total
CSREES Admin	$3,725.00	$3,296.00	$3,782.00	$6,193.00	$4,420.56	$21,416.56
Other USDA	$273.00	$168.00	$320.00	$590.00	$1,255.00	$2,606.00
Other Federal	$611.00	$941.00	$969.00	$1,337.00	$2,121.00	$5,979.00
State Appr.	$4,704.00	$5,480.00	$5,967.00	$5,967.00	$7,024.00	$29,142.00
Self-Gen	$660.00	$359.00	$1,040.00	$524.00	$1,077.00	$3,660.00
Ind/Gr Agrmt	$847.00	$717.00	$1,270.00	$1,167.00	$1,560.00	$5,561.00
Other Non-Fed	$506.00	$625.00	$856.00	$542.00	$1,490.00	$4,019.00
Total	$11,326.00	$11,587.00	$14,205.00	$16,320.00	$18,947.56	$72,385.56

Source of Funding: Current Research Information System (CRIS) and Plan of Work (POW) Annual Report

KA 404: Instrumentation and Control Systems Overall Funding						
Combined Research and Extension Funding						
	$ in the thousands					
Funding Source	FY 2003	FY 2004	FY 2005	FY 2006	FY 2007	Total
CSREES Admin	$2,969.00	$2,905.00	$3,740.00	$2,789.00	$2,287.68	$14,690.68
Other USDA	$245.00	$266.00	$277.00	$262.00	$341.00	$1,391.00
Other Federal	$1,162.00	$1,100.00	$2,569.00	$947.00	$3,026.00	$8,804.00
State Appr.	$4,705.00	$5,155.00	$5,681.00	$6,061.00	$7,124.00	$28,726.00
Self-Gen	$553.00	$422.00	$646.00	$514.00	$640.00	$2,775.00
Ind/Gr Agrmt	$637.00	$741.00	$1,074.00	$1,105.00	$1,102.00	$4,659.00
Other Non-Fed	$468.00	$521.00	$1,040.00	$417.00	$875.00	$3,321.00
Total	$10,739.00	$11,110.00	$15,027.00	$12,095.00	$15,395.68	$64,366.68

Source of Funding: Current Research Information System (CRIS) and Plan of Work (POW) Annual Report

KA 501: New and Improved Food Processing Technologies Overall Funding						
Combined Research and Extension Funding						
	$ in the thousands					
Funding Source	**FY 2003**	**FY 2004**	**FY 2005**	**FY 2006**	**FY 2007**	**Total**
CSREES Admin	$10,478.00	$10,900.00	$12,819.00	$14,029.00	$8,982.06	$57,208.06
Other USDA	$1,730.00	$1,892.00	$787.00	$514.00	$671.00	$5,594.00
Other Federal	$2,276.00	$2,999.00	$5,368.00	$3,920.00	$5,188.00	$19,751.00
State Appr.	$18,143.00	$17,331.00	$19,531.00	$17,993.00	$22,450.00	$95,448.00
Self-Gen	$1,396.00	$1,204.00	$2,687.00	$2,191.00	$4,322.00	$11,800.00
Ind/Gr Agrmt	$5,302.00	$4,649.00	$5,856.00	$3,978.00	$6,499.00	$26,284.00
Other Non-Fed	$2,593.00	$2,503.00	$3,174.00	$2,539.00	$3,490.00	$14,299.00
Total	$41,918.00	$41,478.00	$50,222.00	$45,164.00	$51,602.06	$230,384.06

Source of Funding: Current Research Information System (CRIS) and Plan of Work (POW) Annual Report

KA 502: New and Improved Food Products Overall Funding						
Combined Research and Extension Funding						
	$ in the thousands					
Funding Source	**FY 2003**	**FY 2004**	**FY 2005**	**FY 2006**	**FY 2007**	**Total**
CSREES Admin	$8,553.00	$9,971.00	$11,194.00	$10,161.00	$7,086.83	$46,965.83
Other USDA	$415.00	$394.00	$915.00	$636.00	$1,046.00	$3,406.00
Other Federal	$1,688.00	$2,535.00	$1,898.00	$1,739.00	$2,503.00	$10,363.00
State Appr.	$15,859.00	$16,820.00	$18,138.00	$15,571.00	$16,956.00	$83,344.00
Self-Gen	$1,460.00	$1,679.00	$2,037.00	$1,745.00	$1,960.00	$8,881.00
Ind/Gr Agrmt	$3,929.00	$3,684.00	$5,324.00	$3,851.00	$4,911.00	$21,699.00
Other Non-Fed	$2,781.00	$2,953.00	$2,612.00	$2,192.00	$1,844.00	$12,382.00
Total	$34,685.00	$38,036.00	$42,118.00	$35,894.00	$36,306.83	$187,039.83

Source of Funding: Current Research Information System (CRIS) and Plan of Work (POW) Annual Report

KA 503: Quality Maintenance in Storing and Marketing Food Products Overall Funding						
Combined Research and Extension Funding						
	$ in the thousands					
Funding Source	**FY 2003**	**FY 2004**	**FY 2005**	**FY 2006**	**FY 2007**	**Total**
CSREES Admin	$4,773.00	$5,257.00	$5,266.00	$5,209.00	$3,700.85	$24,205.85
Other USDA	$1,119.00	$996.00	$895.00	$679.00	$390.00	$4,079.00
Other Federal	$447.00	$603.00	$839.00	$1,299.00	$1,152.00	$4,340.00
State Appr.	$8,664.00	$8,397.00	$9,770.00	$8,378.00	$8,290.00	$43,499.00
Self-Gen	$675.00	$856.00	$1,235.00	$952.00	$923.00	$4,641.00
Ind/Gr Agrmt	$2,791.00	$2,126.00	$2,169.00	$2,259.00	$2,862.00	$12,207.00
Other Non-Fed	$847.00	$821.00	$1,001.00	$1,093.00	$1,335.00	$5,097.00
Total	$19,316.00	$19,056.00	$21,176.00	$19,869.00	$18,652.85	$98,069.85

Source of Funding: Current Research Information System (CRIS) and Plan of Work (POW) Annual Report

KA 504: Home and Commercial Food Service Overall Funding						
Combined Research and Extension Funding						
	$ in the thousands					
Funding Source	FY 2003	FY 2004	FY 2005	FY 2006	FY 2007	Total
CSREES Admin	$1,409.00	$516.00	$1,833.00	$671.00	$1,120.10	$5,549.10
Other USDA	$5.00	$3.00	$4.00	$0.00	$23.00	$35.00
Other Federal	$89.00	$147.00	$68.00	$19.00	$18.00	$341.00
State Appr.	$160.00	$140.00	$401.00	$119.00	$713.00	$1,533.00
Self-Gen	$66.00	$6.00	$6.00	$4.00	$15.00	$97.00
Ind/Gr Agrmt	$35.00	$107.00	$111.00	$71.00	$90.00	$414.00
Other Non-Fed	$0.00	$6.00	$27.00	$3.00	$18.00	$54.00
Total	$1,766.00	$925.00	$2,450.00	$887.00	$1,997.10	$8,025.10

Source of Funding: Current Research Information System (CRIS) and Plan of Work (POW) Annual Report

KA 511: New and Improved Non-Food Products and Processes Overall Funding						
Combined Research and Extension Funding						
	$ in the thousands					
Funding Source	FY 2003	FY 2004	FY 2005	FY 2006	FY 2007	Total
CSREES Admin	$19,840.00	$16,524.00	$20,451.00	$19,544.00	$12,872.30	$89,231.30
Other USDA	$1,919.00	$1,423.00	$2,027.00	$1,690.00	$2,203.00	$9,262.00
Other Federal	$2,258.00	$4,619.00	$7,250.00	$4,756.00	$10,146.00	$29,029.00
State Appr.	$15,410.00	$14,058.00	$18,751.00	$14,799.00	$26,570.00	$89,588.00
Self-Gen	$1,754.00	$2,811.00	$2,710.00	$1,827.00	$3,577.00	$12,679.00
Ind/Gr Agrmt	$2,418.00	$2,738.00	$4,259.00	$4,211.00	$6,256.00	$19,882.00
Other Non-Fed	$2,041.00	$1,818.00	$4,082.00	$2,595.00	$8,321.00	$18,857.00
Total	$45,641.00	$43,992.00	$59,529.00	$49,422.00	$69,945.30	$268,529.30

Source of Funding: Current Research Information System (CRIS) and Plan of Work (POW) Annual Report

KA 512: Quality Maintenance in Storing and Marketing Non-Food Products Overall Funding						
Combined Research and Extension Funding						
	$ in the thousands					
Funding Source	FY 2003	FY 2004	FY 2005	FY 2006	FY 2007	Total
CSREES Admin	$949.00	$603.00	$621.00	$512.00	$432.23	$3,117.23
Other USDA	$134.00	$158.00	$463.00	$32.00	$316.00	$1,103.00
Other Federal	$731.00	$893.00	$1,011.00	$421.00	$300.00	$3,356.00
State Appr.	$1,385.00	$1,175.00	$1,608.00	$1,657.00	$1,626.00	$7,451.00
Self-Gen	$35.00	$70.00	$266.00	$72.00	$79.00	$522.00
Ind/Gr Agrmt	$219.00	$180.00	$130.00	$134.00	$422.00	$1,085.00
Other Non-Fed	$279.00	$351.00	$923.00	$852.00	$731.00	$3,136.00
Total	$3,731.00	$3,430.00	$5,022.00	$3,680.00	$3,906.23	$19,769.23

Source of Funding: Current Research Information System (CRIS) and Plan of Work (POW) Annual Report

Appendix D - List of Supporting Programs:

Programs Related to Processing Engineering and Technology for Food and Bio Products Portfolio	
Name of Related Program	**Description of Relationship**
Hatch	Formula research grant program to the 1862 land grant universities that provides broad funding, including support for this portfolio
Evans-Allen	Formula research grant program to the 1890 land grant universities that provides broad funding, including support for this portfolio
National Research Initiative	Broad competitive research grants program that provides broad funding, including support for this portfolio
Small Business Innovation Research	Broad competitive research grants programs to small businesses that provides broad funding, including support for this portfolio
McIntire-Stennis	Formula grant program that broadly supports forestry and related research
Smith-Lever 3(b) and (c)	Formula extension grant program to the 1862 land grant universities that provides broad funding, including support for this portfolio
1890 Extension	Formula extension grant program to the 1890 land grant universities that provides broad funding, including support for this portfolio
Special Grants	Congressional Earmarks
406 Water Quality	The program identified the impact of bioenergy development on water use and water quality as an area of special emphasis in FY 2007 and 2008
Economic and Community Systems Unit	Two NPLs are addressing economics and social aspects of the bioeconomy
SARE	Regions are soliciting for projects that address sustainable biofuels production
Biotechnology Risk Assessment Research Grant Program	Influence of genetically-engineered bioenergy crops on ecosystem function
Critical Agricultural Materials	R & D of biobased paints, coatings, adhesives with low volatile organic compound emissions to replace petroleum-based products

Federally Recognized Tribes Extension Program	Increasing knowledge of bioenergy and biomass conversion as an example topic
Higher Education Challenge Grants	Encourages new academic curricula covering sustainable biobased technologies and economies at the baccalaureate degree level. It also supports curriculum development in food science and technology, and agricultural engineering areas.
Multicultural Scholars Program	Student training support towards baccalaureate degree in a Program Area of Emphasis: Agricultural Sciences and Engineering for Bioenergy
National Needs Fellowship Program - Graduate and Post Graduate	Student training support towards Master's and Doctoral degrees in the Target Expertise Shortage Area: Agricultural Systems Engineering – Biobased Products, Bioenergy, Food Science, and Engineering.
Plant Feedstock Genomics for Bioenergy (Jointly administered by USDA & DOE)	Fundamental research advancing knowledge for the production of biofuels from lignocellulosic feedstocks
Secondary Education, Two-Year Postsecondary Education, and Agriculture in the K-12	Encourages new academic curricula covering sustainable biobased technologies and economies at the secondary and associate degree level.
Tribal Colleges Extension Program	Purpose and priorities description includes increasing knowledge of bioenergy and biomass conversion as an example topic
Tribal Colleges Research Grant Program	Program area description includes alternative energy sources as an example

Appendix E - Partnering Agencies and Other Organizations:

Processing Engineering and Technology for Food and Bio Products Portfolio Partnering Agencies and Organizations	
Name of Program	**Agency Type**
Office of Energy Policy and New Uses (Biodiesel Education Program)	USDA Agency
Department of Energy (Energy Feedstocks Genomics Program)	Non-USDA Federal Agency
Department of Transportation (Sun Grant Initiative)	Non-USDA Federal Agency
U.S. Army (biobased product testing)	Non-USDA Federal Agency
25X25 (supported Bioenergy Awareness Days in 2008)	Non Federal Organization