Portfolio Annual Report 2009: Food Safety

United States Department of Agriculture
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Section I: Portfolio Overview

Portfolio Planning

Portfolio Mission

The Food Safety Program supports research, education and extension activities at public and private partner organizations to: 1. Reduce/eliminate food borne pathogens and reduce adverse levels of harmful chemicals in the food chain, 2. Bring about changes in the risky food practices used by consumers and the food safety personnel, and 3. Prepare the future work force in food safety. The National Institute of Food and Agriculture (NIFA) will accomplish this mission by providing leadership in determining the direction of science and administering grant funding for such activities.

Portfolio Vision

Pathogenic microorganisms and their toxic products, chemical residues, and natural toxins in foods consumed in the US are at lower levels than those which cause food borne illness, producers and the consumers of the food are well informed about food safety practices, and there is a fully prepared food safety workforce in place.

Portfolio Introduction

While the food supply in the United States is one of the safest in the world, the Center for Disease Control (CDC) estimates that 76 million people get sick, more than 300,000 are hospitalized, and 5,000 Americans die each year from food borne illness. Preventing food borne illnesses and death remains a major public health challenge. The nation's food system(s) are large and highly complex, which increases the difficulty in addressing this societal issue. It also mandates government involvement.

In 1997 in response to increased concerns about food borne illnesses, President Clinton introduced the Food Safety Initiative (FSI). The initial focus and goal of FSI was to reduce the number of illnesses caused by microbial contamination of food and water. The responsibilities for different aspects of food safety are necessarily shared among various government agencies. Consequently, there is a need for close coordination of activities. The initiative stimulated the formation of numerous task forces, committees, initiatives, and funding incentives over the following years. Some of the actions included major reports and recommendations on food safety in the U.S. such as "Food Safety from Farm to Table: A National Food Safety Initiative - A Report to the President, a report of the National Academy's findings "Ensuring Safe Food from Production to Consumption", and the Guide to Minimize Microbial Food Safety Hazards for Fresh Fruits and Vegetables. Other activities included the formation of many national and interagency task forces and working groups such as the Joint Institute for Food Safety Research, the Risk Assessment Consortium, and the National Food Safety System. Major initiatives included the implementation of the 1996 Pathogen Reduction and Hazard Analysis and Critical Control Point (HACCP) rule, which was passed to help reduce microbial pathogens in processing plants and to clarify federal and industry roles. The culmination of these

efforts was the signing of the National Strategic Food Safety Plan in January 2000. The broad goal of the strategic plan was "the protection of public health by significantly reducing the prevalence of food borne hazards through science-based and coordinated regulations, surveillance, inspection, enforcement, research, and education programs." The plan also established an outcome measurement. The goal by 2004 was a 25% decline in the incidence of the most common food borne illnesses and a 50% reduction in residues of carcinogenic and neurotoxic pesticides on foods. In 2002, The Food Safety Council became the Presidential Food Safety and Security Council, which was redefined to include the threat of bioterrorism. The Public Health Security and Bioterrorism Preparedness and Response Act of 2002 has changed the focus of some activities and initiatives. See (http://www.fda.gov/oc/bioterrorism/bioact.html). During the time period of the current peer review, programs that include research, outreach, and educational components within NIFA continued to address the need for new scientific information critical in assisting National science-based decisions based relating to food safety. Centers for Disease Control and Prevention provided preliminary data on the estimated prevalence of food borne illness caused by major pathogens, up to 2007. Compared with 2004-2006 data, the estimated incidence of infections caused by *Campylobacter, Listeria*, Shiga toxin-producing *Escherichia coli* O157 (STEC O157)*, Salmonella, Shigella, Vibrio,* and *Yersinia* did not change significantly, and *Cryptosporidium* infections increased. CDC further noted that the progress toward the targets for Healthy People 2010 national health objectives and targets regarding the incidence of foodborne infections occurred before 2004; however, none of the targets were reached in 2007. *Salmonella* incidence was the farthest from its national health target, suggesting that reaching this target will require new approaches (CDC 2008, MMWR, 57(14): 366-370).

In the past decade food borne illness, associated with consumption of contaminated fresh and fresh-cut produce steadily increased Produce is now a significant source of food borne illness. In 2006, Utah and New Mexico health departments investigated a multistate cluster of *Escherichia coli* O157:H7. A case–control study of 22 case-patients found that consuming bagged spinach was significantly associated with illness ($p<0.01$). The outbreak strain was isolated from 3 bags of 1 brand of spinach. Nationally, 205 persons were ill with the outbreak strain (Grant et. al. Emerg Infect Dis. Oct; 2008), This incidence and recent salmonellosis outbreak resulting from the consumption of Serrano peppers (www.fda.gov) , attracted the attention of consumers, producers of fresh produce, and regulators. Outbreaks of food borne illnesses caused by the consumption of contaminated fruit and vegetables have been increasingly reported in the past several years. NIFA noted the emerging importance of fresh crops in food borne illness and in 2005 started funding research in this area.

In April 2009 news release (http://www.cdc.gov/media/pressrel/2009/r090409.htm), CDC affirms that the incidence of the most common foodborne illnesses has changed very little over the past three years, Because of this plateau, CDC recommends that "there must be new efforts to develop and evaluate food safety practices from the farm to the table."This, the infamous 2009 Salmonella out-break, and issues of coordination across the agencies resulted in the appointment of a Food Safety Working Group (FSWG) by President Obama. This working group brought together cabinet secretaries form USDA

and DHHS and senior officials to advise on strategies to upgrade our food safety laws for the 21st century and foster coordination throughout government. In July of 2009, the FSWG announced specific steps designed to advance its core principles (http://www.whitehouse.gov/)

Food Safety Portfolio has nine interrelated activities in order to implement their mission:

1. Generate basic knowledge: The Food Safety Program supports research to enhance the knowledge of mechanisms of pathogenesis in food borne illness eventually aimed at risk mitigation measures. Examples of research include, but are not limited to: investigations of vector-based transmission of pathogens, toxins and contaminants; development of novel vaccines; molecular and biochemical approaches to understanding the genetic and physiological mechanisms influencing pathogen virulence; model development to predict aspects of food production and processing wherein mitigation will be most effective; socioeconomic factors affecting food safety; and genetic modification of crops to mitigate toxin producing microorganisms.

2. Epidemiological Approaches: The Food Safety Program supports an integrated approach to enhance epidemiological methods available for the study of food-borne diseases and antibiotic resistance to understand the occurrence, transmission, distribution, persistence, and human health risk associated with different levels of food-borne pathogens across the food system continuum, and to provide recommendations for specific intervention strategies/prevention and control programs for food-borne disease and antimicrobial resistance. Examples of research include, but are not limited to: Novel epidemiologic approaches that will provide the ability to evaluate the impact of intervention or management strategies on microbial contamination or food safety; innovative studies to quantify the effectiveness of new or existing interventions or management strategies in reducing pathogen loads across farm-to-fork; and innovative studies which seek to identify new risk factors or quantitative evaluation of existing risk factors that may affect prevalence, transmission, or persistence of food-borne organisms from pre-harvest production through consumption.

3. National Integrated Food Safety Initiative (NIFSI): This program supports food safety grants that integrate research, education and extension to solve problems in applied food safety issues driven by stakeholders from farm to fork.. Examples of activities supported by integrated programs include, but are not limited to: Providing food safety education and training for consumers of all ages, including those at increased risk for foodborne illnesses; providing food safety education, training, and certification for farmers, industry, and retail, including small farm direct-food-sales vendors and processors; improving the safety of fresh and fresh-cut fruits and vegetables; filling knowledge gaps about sources and persistence of microbial pathogens in meat, poultry, dairy, and fish, and applying control measures for reducing those pathogens; applying new or improved food processing technologies and monitoring their impact on food safety; practical

approaches to reducing antimicrobial resistance; strengthening the nation's food defense system through threat prevention, threat response, risk management, risk communication, and public education; improving national support and coordination of food safety programs by building an information infrastructure for integrated food safety.

4. Supporting Training of Future Work Force: National Needs Fellowships to train highly qualified and motivated graduate students in food safety are awarded to the universities with world renowned programs in food safety. At the undergraduate level, challenge grants are provided to design innovative curricular approaches. This is a relatively a small program. Additionally, AFRI and NIFSI grants frequently include funds for supporting training of graduate students and postdoctoral fellows. The Food Safety program provided support for graduate students (and postdoctoral researchers).

5. Support of Small Businesses: As part of the Government-wide Small Business Innovation Research (SBIR) program, NIFA administers the grants program for small businesses. The purpose of SBIR program includes stimulating technological innovation in the private sector, strengthening the role of small businesses in meeting Federal research and development needs, increasing private sector commercialization of innovations derived from USDA-supported research and development efforts and fostering and encouraging participation by women-owned and socially and economically disadvantaged small business firms in technological innovation. The Food Safety Program in SBIR funds 2 to 3 phase grants per year.

6. Nanoscale Science and Engineering: Nanotechnology is a new enabling technology, which has the potential to revolutionize agriculture and food systems. The goal of this program is to provide knowledge, expertise, and highly qualified R&D human capital in nanotechnology for agricultural and food systems. This program has funded several grants in food safety related areas. Specifically, in the areas of nanoscale recognition, reception, and transmission mechanisms and novel materials for developing nano-based sensors specifically for targets important to food safety and agriculture biosecurity.

7. Water and Watersheds: The goals of the Water and Watersheds program are to protect and enhance the natural resource base and environment by improving and maintaining healthy watershed habitat and water supply protection; enhance economic opportunities by reducing economic liability from water contamination; improve the quality of life in rural America through adequate clean water supplies; and protect food safety through clean irrigation and livestock drinking water supplies. This program funds proposals in the area of water safety as it relates to irrigation of crops and subsequent contamination of food crops, especially fresh produce.

8. Systems Science: Recognizing that solutions to complex problems, such as food safety, cannot be solved by narrowly examining a single component of the food system in isolation, the Specialty Crop Research Initiative (SCRI) supports research and extension activities that take a systems approach to the many interrelated aspects of food safety. In doing so, the SCRI further expects that funded projects will bring the full breadth of biological, physical, and socio-economic sciences to bear on these key issues. Only then will viable solution be environmentally sound, economically appropriate, and socially equitable and acceptable.

9. International Science and Education: This is relatively a new program. The purpose of the International Science and Education (ISE) competitive grants program is to support the internationalization of food, agriculture and related programs at U.S. universities and colleges. It is intended that ISE will improve the ability of American students, business people, and community members to compete more effectively in the global world of agriculture. ISE projects are to strengthen the global competence and competitiveness of American colleges, universities and businesses in the food, agriculture, and related sectors. In addition, ISE projects must be directed to agricultural research, extension, and/or teaching activities that enhance the capabilities of American colleges and universities to conduct international collaborative research, extension and teaching. Several grants related to food safety have been awarded in the past.

10. Hatch Act funds are provided for agricultural research on an annual basis to the State Agricultural Experiment Stations (SAES's). These funds are distributed according to a statutory formula. States are required match the Hatch funds 100%. The scope of the Act includes research on all aspects of agriculture. One of the areas of emphasis is food safety. SAES propose and conduct research projects, supported with Hatch formula and matching funds. Thus the priorities originate from SAES. A quarter of these funds are allocated for the Multistate Research Fund which provides funds for cooperative research employing multidisciplinary approaches conducted by the SAES, working with another SAES, the Agricultural Research Service, or a college or university, to solve problems that concern more than one state. For fiscal year 2008, the Hatch formula funds expended/obligated in food safety area were $ 6.6 million and the contribution of the State for this period was at $ 25.9 million.

11. Evans-Allen formula grants support agricultural research at the 1890 land grant institutions. Recipients of these funds must also provide a 50% match from non-federal sources. The scope includes all agricultural areas with food safety being one of them and the priorities originate from the States. Evan-Allen funds expended/obligated in food safety area in year 2008 were $ 0.55 million.

12. The other formula fund expenditures in food safety for 2008 area were in extension area. These funds are appropriated on a n yearly basis for to cover the entire area of agriculture. Like other formula funds the priorities originate from

the States. The amounts expended/obligated for food safety in 2008 was approximately $ 6.0 million.

Linkage to CSREES Strategic Plan

CSREES Supported Strategic Goal:
This portfolio supports strategic goal four, entitled "Enhance Protection and Safety of the Nation's Agricultural and Food Supply." Through cooperation with its partners, CSREES sponsors the development and distribution of scientific-based information, technology and practices to producers, manufacturers, the work force, and regulatory agencies to help ensure the safety of agriculture and the food supply to domestic and global consumers. 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.

CSREES Supported Strategic Objective:
This portfolio supports strategic goal 4.1 entitled "Reduce the Incidence of Foodborne Illnesses and Contaminants through Research, Education, and Extension. CSREES sponsors education, research, extension, and technology development to identify and assess the impact of contributors to agricultural environmental related human diseases in foods, and in the processing and distribution system of food. CSREES supports the development and transfer of practices and intervention strategies that manage, reduce, or eliminate food safety risks throughout the food chain.

CSREES Strategic Plan Performance Measures Progress Table

Key Long-Term Outcome: Reduced incidence of prevalence of food borne illnesses and contaminants through increased knowledge and/or the development of mitigation, intervention, or prevention strategies via research or integrated research, education, and extension areas: pre-harvest food production and transportation, post-harvest processing and distribution, retail preparation and distribution, and consumer preparation, consumption, and behavior.
Performance Measures: 1. The number of methods that reduce food contamination and growth of foodborne organisms. 2. The number of food safety training, education, and certification courses that target multiple audiences, which includes all those who make food safety decisions in a variety of settings (i.e. foodservice workers, sanitarians, inspectors, retailers, growers, packers, shippers, processors, farmers, consumers, etc.)
Performance Criteria (objective 4.1)**:** • Ensure food products are free of harmful chemicals, including residues from agricultural and other sources • Protect food from contamination by pathogenic microorganisms, parasites and naturally occurring toxins

Actionable Strategies (objective 4.1)**:**

- Sponsor research to provide a science-based, cost effective approach to food safety that is valuable to industry, policy makers, academia, and the public;
- Sponsor education and extension to provide the public with information addressing food safety, recommended handling practices, microbiological testing, and innovative methods and technologies;
- Sponsor development of information on the epidemiology, ecology, and mechanisms of foodborne pathogens and diseases;
- Sponsor research for the development and implementation of new methods and approaches for foodborne pathogens and foodborne diseases;
- Work with federal food safety agency partners, industry, and academia, to evaluate foodborne illness data and the development of accurate measures on the effectiveness of prevention, control, or intervention strategies to reduce preventable food-borne illness;
- Support the recruitment, retention, training, graduation, and placement of the next generation of research scientists, educators, and practitioners in the food and agricultural sciences;
- Sponsor research that will fill existing data gaps and aid the development of risk assessments and models that will ensure implementation of science based policies;
- Provide educational and extension outreach to food animal and produce growers, to owners and operators of small and very small plants, and to food prepares and handlers, including minority populations such as Native Alaskans, Asian Pacific Islanders, and American Indians; and
- Provide educational and extension support for the implementation of HACCP

Performance Measure Progress Table

1.Performance Measure Description: Methods that reduce food contamination and growth of foodborne organisms		
Explanation of Measure: The number of contamination reducing methods (interventions, mitigations) for priority, high public health risk, and economically important microbial pathogens and contaminates that have been developed and used		
Baseline (FY 2002): 2	**Target**	**Actual**
Fiscal Year 2003	3	3
Fiscal Year 2004	6	6
Fiscal Year 2005	8	8
Fiscal Year 2006	10	10
Fiscal Year 2007	12	11
Fiscal Year 2008	14	12
Fiscal Year 2009	16	
Fiscal Year 2010	18	
Fiscal Year 2011	19	
Fiscal Year 2012	20	

2. The number of food safety training, education, and certification courses.		
Explanation of Measure: The number of food safety training, education, and certification courses that target multiple audiences, which includes all those who make food safety decisions in a variety of settings (i.e. foodservice workers, sanitarians, inspectors, retailers, growers, packers, shippers, processors, farmers, consumers, etc.)		
Baseline (FY 2008): 2	**Target**	**Actual**
Fiscal Year 2008	3	2 New Graduate Courses
Fiscal Year 2009	6	1 Secondary Postsecondary
Fiscal Year 2010	8	
Fiscal Year 2011	10	
Fiscal Year 2012	12	
Fiscal Year 2013	14	
Fiscal Year 2014	16	
Fiscal Year 2010	18	
Fiscal Year 2011	19	
Fiscal Year 2012	20	

NIFA Food Safety Logic Model

Situation	Inputs	Activities	Outputs	Outcomes		
				Knowledge	Actions	Conditions
Situation: Food safety needs to be enhanced through research, education and extension programs. Contamination of food by chemicals, toxic compounds and allergens need to be detected and reduced. Actions are needed toward improving public health by improving the safety of food, e.g., development of sensitive and user-friendly detection methods, and interventions to reduce contamination of food should be developed and used.	**Funding Sources:** - Federal - NIFA (AFRI, NIFSI, SBIR, Special Grants) - State-matching from Hatch Formula, Evans-Allen - other (ARS, FDA, and ERS through collaboration) **Human Capital:** - NIFA NPLs - Administrative Support - Grantees (Researchers, educators, and extension specialists) - Para-professionals - Stakeholders (Industry, etc.) - Volunteers - End Users - Consumers	Related to Research, Extension, Education: - Specific and sensitive detection of foodborne pathogens and toxins hazardous to human health - HACCP implementation - Recognition of AR as a public health problem - Emerging diseases - Risk Assessment - Evaluate established and innovative Processing technologies - Assess Regulatory impact - Understand the fate and transmission of foodborne pathogens in both the Pre & post harvest environments -outreach to: Consumers, farmers and food safety personnel in between	- Disseminate Research findings - Publications - Citations - Disclosures - Patents - Findings Vetted by Scientists - Activities related to extension programs are implemented by grantees/partners - Activities related to integrated programs are implemented by grantees/partners - Undergraduate and graduate education programs are implemented - Diplomas granted new technologies and methodologies developed and evaluated that decrease food safety risks -Workshops Conferences Bulletins Audio-visuals	**Changes in knowledge, attitudes, skills, motivations, decisions of users, demands on producers and processors regarding**: - New discoveries - New food safety approaches & methods; science-based practices	**Changes in behavioral practices, management uses or input that**: - Leads to reduction of food-borne contaminants in food. - Leads to reduced use of synthetic antimicrobials. - Development of novel environmentally compatible treatments of stored grains and other products. -Changes in Educational Curricula -Adaption of technologies	National needs met: - Reduction in *Listeria* in processed foods, *Campylobacter* in poultry and other pathogens and foodborne diseases - Antimicrobials such as (fluoroquinolone) removed from market - Classification of risky foods -Changes in production practices (Green leafy vegetables)

Assumptions - NIFA has the funds, personnel and facilities to accomplish this objective. There is a need to collaborate with lateral partner organizations and agencies

External factors - A number of factors could have a significant impact on programs. Some of those include change in funding; priorities, attitudes; food production, distribution and preparation habits; average lifespan & number of immune-compromised individuals; emergence & virulence of new pathogens; food safety issues requiring new management strategies & regulatory framework; trends in food contamination & hazard survivability and risk assessment; biosecurity issues; natural disasters; economic conditions; coordination & cooperation with other government entities.

Portfolio Inputs

Agency funding data for fiscal year 2007 was 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.

Portfolio Level Funding Table and Bar Charts

Table1 is a summary of the portfolio's funding for fiscal years 2004-2008. Data for this table were provided by the Current Research Information System (CRIS) and the Plan of Work- Annual Report (POW-AR). Detailed KA funding tables are in appendices B (Agency funding) and C (Overall funding).

Table 1: Food Safety Portfolio Summary Funding Table
Combined Research and Extension Funding
($ in the Thousands)

Funding Sources	FY 2004	FY 2005	FY 2006	FY 2007	FY 2008	Grand Total
All NIFA Funding Reported in CRIS	34,665	41,882	35,825	28,060	41,785	182,217
All NIFA Extension Funding Reported in POW-AR	n/a	n/a	n/a	5,961	6,511	12,472
All non-NIFA Funding	51,248	55,535	52,382	50,840	57,623	258,287
Total Funding	85,913	97,417	88,207	84,862	105,919	462,318
Percentage of NIFA Funding	40%	43%	41%	40%	46%	43%

*n/a = Funding data are not available for that fiscal year

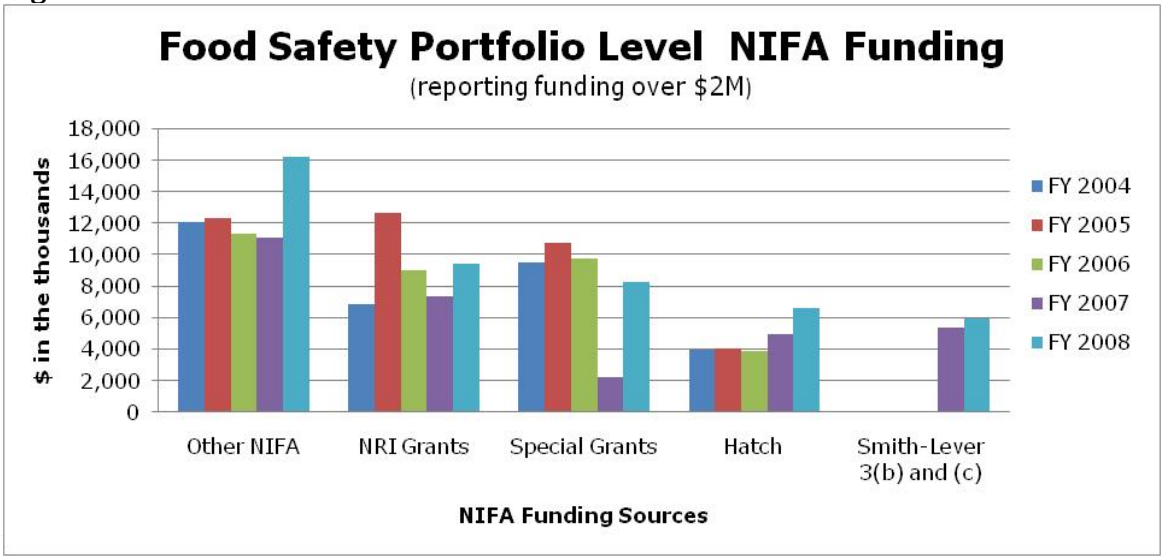
For research and integrated activities, as percentage of total funding reported, the NIFA contribution was 46% as compared to 40% in fiscal year 2007. The expenditure/obligations of funds for KA 711 were about the same compared to those of last year. However, for KA 712, there was a substantial increase in the total (research and extension) expenditure/obligations of funds in food safety research, education, and extension activities administered by the NIFA (previously CSREES) from fiscal year 2007 to fiscal year 2008; total expenditure/obligations were $ 34,021,000 and 47,996,000 in fiscal years 2007 and 2008, respectively amounting to a an increase of 41%. The increase was mainly due to the return of special grants in fiscal year 2008. Other notable increase was due to the addition of a new program in Specialty Crops in fiscal year 2008. This area addresses five priority areas including food safety. In addition there were slight increases in Hatch formula and NRI competitive grants. The funding pattern shows a recovery from losses since fiscal year 2005. The increase in funds enabled the agency to put more emphasis on risk-based interventions to reduce pathogen loads in the food system.

Table 2: Food Safety Portfolio Summary Funding Table Combined Research and Extension Funding in Constant Dollars						
($ in the Thousands)						
Funding Sources	**FY 2004**	**FY 2005**	**FY 2006**	**FY 2007**	**FY 2008**	**Grand Total**
All NIFA Funding Reported in CRIS	39,510	46,172	38,260	29,137	41,785	194,865
All NIFA Extension Funding Reported in POW-AR	n/a	n/a	n/a	6,190	6,511	12,701
All non-NIFA Funding	58,411	61,223	55,942	52,792	57,623	285,992
Total Funding	97,921	107,395	94,203	88,119	105,919	493,557

*n/a = Funding data are not available for that fiscal year

Table 2 shows portfolio level funding in constant dollars. These figures were configured to show changes in funding while controlling for inflation using the Consumer Price Index (CPI) calculator, which is located at http://data.bls.gov/cgi-bin/cpicalc.pl. For accurate calculations, the inflation calculator uses the average Consumer Price Index for a selected calendar year. This data represents changes in prices of all goods and services purchased for consumption by urban households. Table 2's figures were calculated using 2008 as the base comparative year.

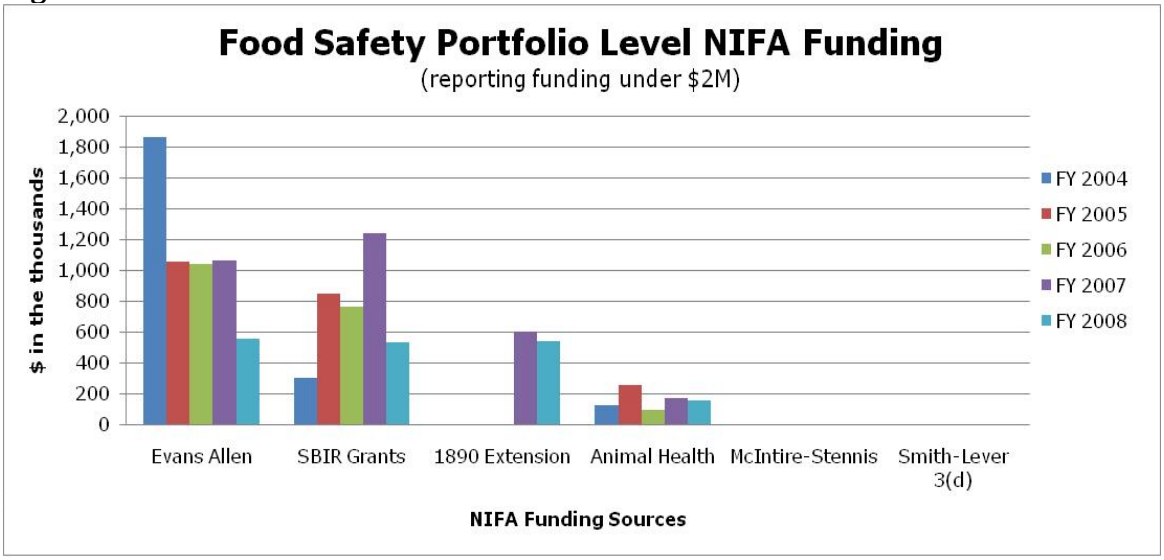
Figure 1



portfolio level funding over two million dollars. As shown in figure 1, "Other NIFA" provides the largest amount of funding ($62.9M total for FY 2004-2008), there an increase in 2008 funding for this category because an increased number of grant programs started reporting dollars and activities in CRIS.

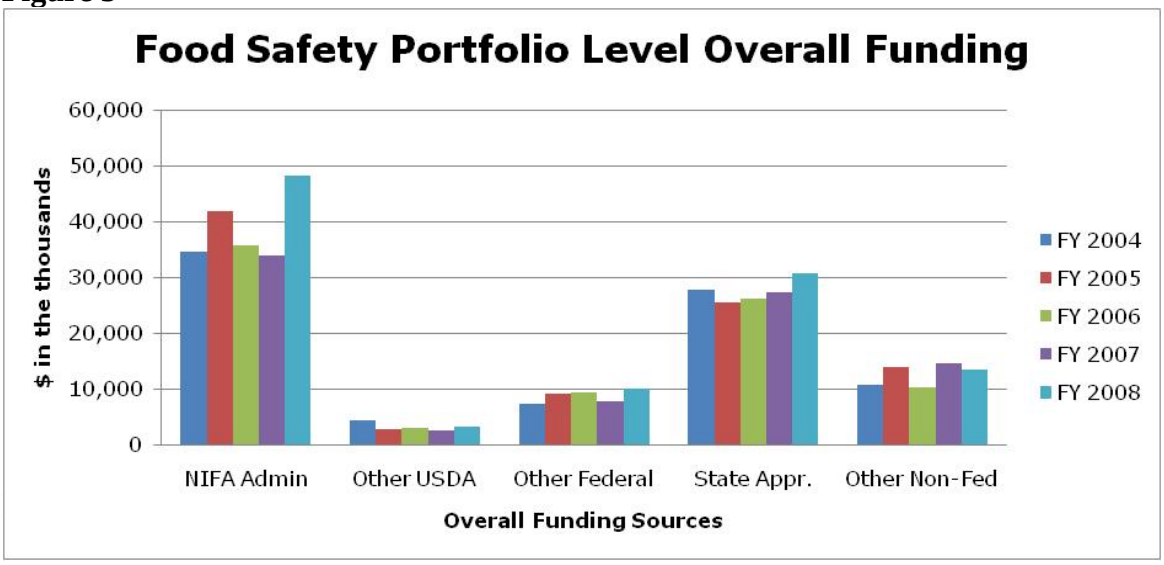
The NRI Grants program was not reauthorized in the Food, Conservation, and Energy Act of 2008, but the Agriculture and Food Research Initiative (AFRI) Competitive Grants Program was authorized in 2009 in place of the NRI. This funding chart identified NRI obligated dollars because dollars received were under this funding category during the reporting timeframe. Information regarding the AFRI program may be found on the Agency's website at http://www.csrees.usda.gov/funding/afri/afri_synopsis.html.

Figure 2



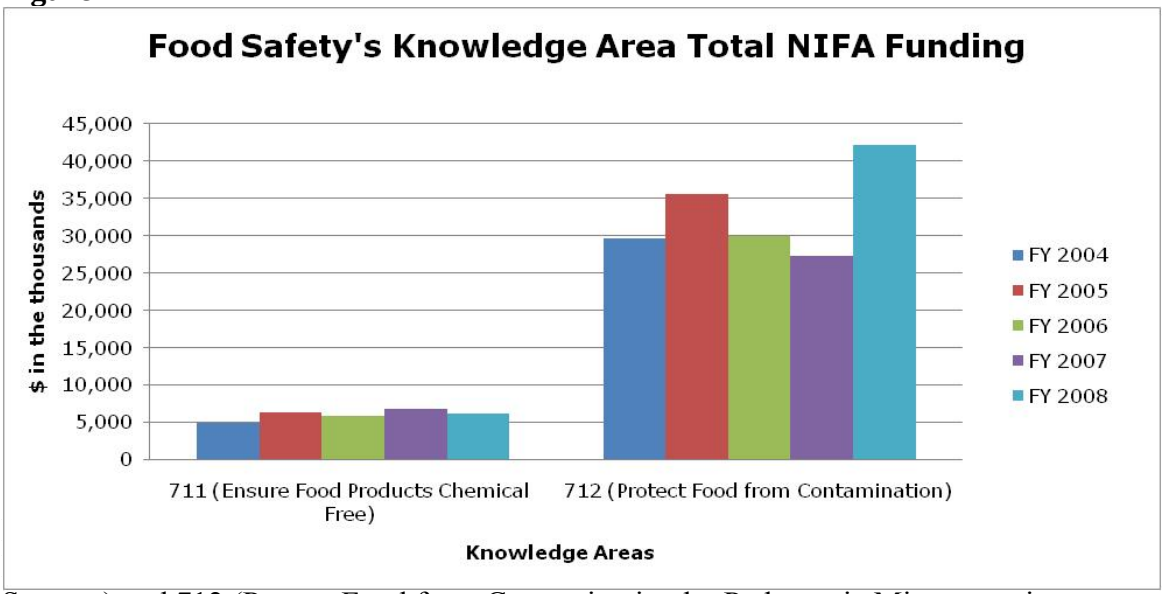
Smith-Lever 3(d) during this time period. Evans Allen expended over $5M for FY 2004-2008, funding decreased by a little under $500,000 between FY 2007 and 2008 and funding significantly decreased between FY 2004 and FY 2005 (a reported decrease of $800,000). SBIR grant obligations decreased from $1.2M in FY 2007 to $530,000 in FY 2008. This fluctuation may be due to differences in award dates going beyond fiscal year (e.g. fiscal year 2006 awards showing up in 2007) or a lack of qualified proposals in food safety area.

Figure 3



portfolio's funding during these reporting years came from NIFA, but State Agricultural Experiment Stations reportedly contributed 31% ($137.5 M) of this portfolio's total budget.

Figure 4



Sources) and 712 (Protect Food from Contamination by Pathogenic Microorganisms, Parasites, and Naturally Occurring Toxins) for the reported years. Knowledge Area 712 accounts for 85% ($164.6M) of the portfolios NIFA funding.

In 2008 the Congress passed the Food, Conservation, and Energy Act of 2008, which added section 412 to the Agricultural Research, Extension, and Education Reform Act of 1998 (AREERA). 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 Act also requires that 10% of the mandated funds ($3M in 2008, and $5M subsequently) be expended on food safety for specialty crops. These funds are awarded annual based on a competitive grant process.

Portfolio Results

Portfolio Outcomes

2009 Outcomes

1. Researchers at Arizona State University are developing a novel vaccine to reduce *Salmonella* and avian pathogenic *E. coli* (APEC) in poultry. This NRI-funded project sets out to produce a vaccine that will not only create protection against a pathogen of great economic importance to the poultry industry (APEC) but also confer protection against *Salmonella*, an important foodborne pathogen. One of the initial studies was reported in the scientific literature in 2009. The researchers identified the full sequence of a plasmid found to be important in pathogenesis of APEC strains and conducted a comparative analysis of this plasmid. Their results show that the studied APEC plasmid was present in some human extra-intestinal pathogenic *E. coli* strains indicating not only horizontal transfer between strains but also the potential for zoonotic risk of APEC strains (PLOS One , 2009;4:e4232).

2. Anthrax is caused by *B. anthracis* and is considered as a high priority biological weapon. Development of a rapid detection *B. anthracis* kit for adulterated liquids and foods is critical for enhancing food safety. Guild Associates, Inc. received a Small Business Research Innovation (SBIR) Phase I grant that developed a genetically engineered reporter phage that could detect *B. anthracis*. The project director published the results of the proof of concept for the novel method of Phase I proof of principle results in the *Journal of Applied Microbiology* and developed a bioluminescent reporter bacteriophage that is capable of specifically detecting *B. anthracis*.

   Guild Associates received a subsequent Phase II grant that will build upon the Phase I research by demonstrating that the reporter phage can detect many different forms of *B. anthracis* and that the reporter phage detects *B. anthracis* only, and not other non-pathogenic bacteria in order to reduce the possibility of false alarms. If successful, the research proposed in this application will potentially save lives by providing the surveillance methodology for the identification of *B. anthracis* on deliberately contaminated liquids and foods.

3. A multidisciplinary team of scientists led by Michigan State University, under the aegis of a grant from USDA-NIFA National Integrated Food Safety Initiative (Sub award to MSU, NIFSI), "A systems approach to minimize *Escherichia coli* O157:H7 food safety hazards associated with fresh and fresh-cut leafy greens", studied the effect of low energy X-Rays on the survival of E. coli on lettuce and spinach leaves. They were able to leverage funding from International Life Science Institute-North America (ILSI-NA and Michigan Initiative for Innovation & Entrepreneurship (MIIE) to supplement this grant from NIFA. They have used low-energy X-Ray radiation as a microbial inactivation strategy for a wide range

of products, including lettuce, spinach, parsley, almonds, walnuts and ground beef. Based on these findings, low-energy X-ray irradiation appears to be a promising microbial inactivation strategy for leafy greens and potentially other types of fresh produce. In addition, these findings should help reduce the incidence of *E. coli* O157:H7 on fresh-cut commercially produced leafy greens, with this novel x-ray technology providing a cost-effective means to completely eradicate *E. coli* O157:H7.

Rayfresh Foods Inc. (Ann Arbor, MI), who supplied our current prototype x-ray irradiation unit, is developing a commercial-scale, in-line machine for irradiating ground beef patties for the team. Many requests have been received from the food industry for x-ray irradiation trials on a wide range of other products, including fruits and vegetables, nuts, and other dry food products.

4. In 2006, Riverside Community College (RCC) received $294,000 from the HSI Education Grants Program for a 3-year project to collaborate with University of California (UC), Riverside. This pairs a research grant (UC, Riverside) and an education grant (RCC) in a unique partnership to educate and increase interest among minority students at community colleges about food safety issues. The collaboration would provide RCC students an experiential learning opportunity in cutting-edge water quality research and exposure to a 4-year college experience at UC Riverside. The partnership aims to motivate students to graduate from RCC and transfer to a 4-year university to pursue careers in science and engineering. The investigators of NRI grants made to the ARS-USDA Salinity Laboratory, UC, Riverside, University of Vermont and University of Utah studied the transport behavior of E. coli and *Cryptosporidium* in soil. UC Riverside took the lead in training the minority students. The topic was on the migration and persistence of food pathogens (E. coli) in soil.

   Six Hispanic students who went to RCC entered B.S. programs at UC, Riverdale to pursue training in food safety. The program's success has garnered interest among students at RCC. Hundreds of students and faculty have shown interest by participating in the program's seminar series at RCC, and an enhanced interest in science and engineering fields has been observed through programmatic assessment.

2008 Outcomes

1. Recent years have seen a dramatic worldwide increase in all allergies, including food allergies. NRI grantees form Florida State University have developed monoclonal antibodies specific to the tree nut allergens for the detection of minute amounts of these allergens in the food. They have developed a prototype method to for detection of tree nut allergens. It is anticipated that the methodology will be used for the development of commercial kits for routine use.

2. Virginia Polytechnic Institute and State University (an 1862 land grant university) along with the Virginia State University (an 1890 land grant university) using Hatch and Evans-Allen funds, respectively, and in cooperation with the Southern Region Integrated Pest Management Center supported by AREERA 406 grant, constructed an advisory website for responsible pesticide use. Many extension specialists were able to use this advisory to help to help in using integrated pest management and10 applicators were recertified as pesticide applicators. Such activity continues to reduce the pesticide contamination levels through the integrated pest management practices.

3. NIFA funded the development of a rapid, sensitive and specific and field-usable method (Lateral-flow nucleic-acid based) assay for *Cryptosporidium parvum* (a water pathogen), developed using Hatch funds. It is currently undergoing field testing. Once the field trials are successful, several collaborating companies will be adding new fabrication facilities and personnel for production, commercialization and marketing. Subsequently, several of the other assays are expected to be commercialized using similar technology. These simple, inexpensive, single-use tests will be further developed by the use of microfluidics and should improve food safety, homeland security and environmental quality.

4. Rapid and sensitive detection of animal feed containing banned ruminant tissues is the first line of defense against the spread of, Bovine Spongiform Encephalopathy (Mad Cow disease). Using a special research grant, Auburn University have developed test kits for detection of ruminant tissue which are currently sold by Neogen so the farmers can test the livestock feed before feeding. They have also developed a very high-powered optical microscope that can provide resolution down to 100 nanometers for live organisms. With this scope scientists can view microbial foodborne pathogens such as *Salmonella*. This work has resulted in the establishment of a new company (Cyto Viva) which now routinely sells the microscope currently used by many scientists in microbiological and other laboratories. In addition, there were spin-off technologies that resulted in commercialization of detection devices (Test Kits for detecting the adulteration of meat of one animal with meats from other animals and a device tracking time-temperatures during shipments).

5. A series of grants were awarded using Hatch funds, NRI, and NIFSI programs. Notable areas emphasized were consumer food safety education, irradiation of complex and irregularly shaped foods such as fruits and vegetables, and irradiation of green leafy vegetables. United Fresh Produce Association, Food Products Association (now Grocery Manufacturers Association and other parties used the outputs of this activity, along with those resulting from ARS research, in support of their petition to FDA for approval of irradiation of fruits and vegetables. FDA analyzed existing and new data on the safety and on August 21, 2008 approved the irradiation of fresh iceberg lettuce and fresh spinach at a dose level of up to 4.0 KiloGrays. The anticipated outcome is use of this technology for reducing pathogens (such as E. coli and Salmonella) which should lead to a

reduction in foodborne diseases associated with produce, and increase the shelf life of iceberg lettuce and spinach.

6. A grant awarded to Sterilex under NRI program, a private entity, resulted in the optimum formulation of sanitizers to completely kill *Listeria* in biofilms on processing surfaces. Total destruction of *Listeria* is needed before dumping the sanitizers and process water into sewage. Additional laboratory and field studies of the optimized formulations will be used to petition EPA for registration of the products for the control of *L. monocytogenes* biofilms in food plants, food service, and animal health facilities.

7. A highly specific and ultra sensitive nanobiosensor was developed for the direct detection of prions in the blood of cows with mad cow disease prior to slaughter. Researchers supported by NRI developed modified Resonating Mechanical nano-Biosensors (RMBs), which increased the sensitivity of detection by five orders of magnitude (X100, 000) to a point where 200 picograms of prions /ml of serum can be detected. Currently efforts are underway to achieve sensitivity by another two orders of magnitude, which is needed for direct detection of prions in cow blood.

8. One education grant has connected a 2 year Hispanic Serving community college with University of California, Riverside to work on water and food safety. Two minority community college students were selected each year for 3 years for a total of 6 students. They served an 8 week summer internship working on water and food safety issues at UC Riverside and continued as student interns throughout the school year. They had an intensive mentoring and evaluation program to continue with advanced education in food safety and water issues. Two students have already enrolled in 4 year engineering programs. An open house for the project drew 200 students and faculty interested in future participation. A graduation ceremony drew 500 students, parents and faculty interested in these opportunities. Students were also involved in grade 6-12 science fair project judging to encourage younger students to also consider careers in food safety and water careers. An additional grant from NSF will continue to expand higher education opportunities for minority students to other projects. A video, website and news story on this project was featured in the UC Riverside magazine and local cable TV channel. The website is www.bridges.engr.ucr.edu. The students presented their own research at the California Undergraduate Research conference on "Establishing the phenotypic nature of Salmonella spp. and Escherichia coli isolates as a function of environmental stress". Students are pursuing advanced college degrees in the food safety and water issues and additional students are becoming interested in joining the program.

9. In a USDA National Needs Fellowship (NNF) in Food Safety and Quality award to Iowa State University, in 2008, one NNF doctoral student advanced to candidacy, made national presentations and based on research conducted by the fellow new knowledge was gained on how the antimicrobial effectiveness of

essential oils against pathogenic foodborne bacteria can be improved. An Invention Disclosure (ISURF 03603; Weinkauf, H. and B.F. Brehm-Stecher, 2008) was submitted on enhancement of antimicrobial activities of plant essential oils by polyionic compounds. This doctoral National Needs Fellow gained improved food safety knowledge and expertise that enabled the doctoral candidate to be a problem-solver and a potential creative and innovative contributor in the food safety enterprise.

10. In 2008, Cornell University with an NNF award for Graduate Training Program in Food Safety Engineering, enhanced programming in training graduate students with knowledge and skills at the interface between food & biological engineering and food microbiology and safety. For NNF 3 Ph.D. and 1 M.S. Fellows, they attained comprehensive knowledge and skills in Food Safety Engineering with new graduate instruction design that responds to recent changes in the food processing industry, which is currently adopting non-traditional processing methods for microbial inactivation. The latter created new employment opportunities for specialists able to apply sound engineering principles to design efficient microbial inactivation treatments or detection methods. These NNF Fellows made several presentations at national meetings: Hsu L. (NN fellow), Sauer A. and Moraru C.I. (NN grant PI). 2008. Effect of spatial distribution of fluence on the in depth inactivation of E. coli by Pulsed Light in liquid substrates. Annual Meeting of IFT, New Orleans, July 2008; Uesugi A. R., Hsu L. (NN fellow), and Moraru C. I. (NN grant PI). 2008. A closer look at Pulsed Light treatment: Listeria innocua and Escherichia coli survivor growth and resistance behavior in the plateau region of inactivation curves. Annual Meeting of IFT, New Orleans, July 2008; and Moraru, C.I., Wiedmann, M. and Boor, K. 2007. National Needs Graduate Fellowships in Food Science at Cornell University.

Portfolio Leadership and Management:

In fiscal year 2009, the portfolio leadership and management core team consisted of four National Program Leaders and one Program Specialist. Two of the NPLs joined the core group within last one year. During the preparation of the report five other NPLs provided input from different programs mentioned in Portfolio Introduction earlier.

All of the food safety programs implemented during fiscal year 2009 were enhanced using extensive stakeholder input which was solicited through the following mechanisms.

Position papers form Professional organizations were considered in synthesizing stakeholder input. Two such examples are: The latest commentary (July 2009) form Council for Agricultural Science and Technology (CAST)—*Food Safety and Fresh Produce: An Update*—that brings together the current scientific research and recommended practices at the consumer level that will reduce the risk of produce-borne illness, and March 2009 Expert Advisory Panel' recommendations to the Institute of

Food Technologists (IFT) for direction of Food Science and Technology with specific components on food safety.

An annual research planning meeting jointly sponsored by the Agricultural Research Service and the Food Safety and Inspection Service, held in February 2009: Participants included university partners, representatives from industry, and federal partners from ARS, FSIS, FDA, and CSREES. Participants presented food safety research results from their representative organizations. In small group break-out sessions, participants identified overall food safety research priorities. Their recommendations provided guidance for food safety program priorities identified in FY 2009.

A Program Update for Southern Region Program Leaders held in February 2009: Dr. Singleton provided a briefing on food safety programs and priorities, and asked for input on future needs and priorities of the programs. Discussion included a focus on developing a continuing dialog between with the Southern Regional Program Leaders.

A Program Update for Veterinary Deans of Research held in March 2009: Dr. Singleton provided a briefing on CSREES food safety programs and priorities, and asked for input on future needs and priorities of the programs. Discussion included a focus on developing a continuing dialog with the Veterinary Deans of Research.

A joint planning meeting between* CSREES *and FDA, held at College Park, MD, in March 2009: Dr. Singleton met with FDA program leaders and staff to finalize plans and develop language for a jointly sponsored risk assessment initiative to be included in the AFRI 2009 RFA.

An IFT-sponsored annual business meeting and Council of Food Science Administrators' Luncheon held in Anaheim, CA, in July 2009: Drs. Singleton, Rao, and Saltos attended both the annual meeting and the luncheon during the annual meeting of the Institute for Food Technologists. Each NPL gave food safety program updates during the meeting and luncheon, and received input from participants on food safety program priorities.

An AFRI-sponsored Project Directors' Meeting held at the IFT Annual Conference and Food Expo, in Anaheim, CA, in July 2009: Participants included university, industry, public, and private Project Directors awarded competitive grants through the Agriculture and Food Research Initiative. Project Directors gave updates on their research, networked with those conducting similar research, and met jointly with food safety National Program Leaders to provide input about program priorities and competitive review processes and procedures.

A NIFSI-sponsored Project Directors' Meeting held at the IAFP Annual Conference in Grapevine, TX, in July 2009: Participants included university Project Directors awarded competitive grants through the National Integrated Food Safety Initiative. Project Directors gave updates on their research, networked with those

conducting similar research, and met jointly with food safety National Program Leaders to provide input about program priorities and competitive review processes and procedures.

A joint planning meeting between* CSREES *and FDA, held at College Park, MD, in June 2008: Drs. Singleton and Rao met with FDA program leaders and staff to discuss joint research priorities focusing on improving the safety of fresh and fresh-cut fruits and vegetables.

A* CSREES*-sponsored grant writing workshop in Crystal City, Virginia, held in October 2008: Participants included university and industry partners interested in learning how to compete successfully for food safety grant funds. Breakout sessions were held for the various competitive food safety programs offered within the agency. During those sessions, participants were encouraged to provide input on program priorities and competitive review processes.

A Program Update for Agriculture and Natural Resource (ANR) Leaders held in November 2008: Dr. Singleton provided a briefing on food safety programs and priorities, and asked for input on future needs and priorities of the programs. Discussion included a focus on developing a continuing dialog with the ANR leaders.

A joint meeting of the Council of Food Science Administrators and Nutrition Department Heads, sponsored by IFT and* CSREES*, held in November 2008: Drs. Singleton and Rao gave food safety program updates and solicited input on food safety priorities for the upcoming year.

Stakeholder input was solicited in the annual Request for Applications. Each year stakeholders are encouraged to provide written comments about food safety program priorities in annual Requests for Applications. The RFAs include instructions for submitting comments, which are forwarded to NIFA Program Leaders. Comments provide guidance for priority-setting each successive funding year.

Stakeholder input was solicited from members of peer review panels, and from the Panel Managers. Annual competitive review panels include university, industry, and Federal (FSIS, FDA, ARS, and NAL) partners with expertise in food science, food safety, food microbiology, and food technology. Panelists conclude their deliberations by providing recommendations for program priorities and suggesting improvements for the competitive review process.

Various stakeholder meetings throughout the fiscal year 2008: Participants included—depending on the meeting— industry representative (both growers and processors), equipment manufacturers, and university, federal lab, and industry partners interested in learning how to compete successfully for NIFA food safety grant funds. During discussions, participants were encouraged to provide input on program priorities and competitive review processes, and to subsequently volunteer for consideration as future peer-review panelists.

All NIFA food safety programs have been developed and modified using extensive stakeholder input. The discussion of stakeholder input is presented as an aggregate discussion in the 2007 portfolio review document. In 2007, stakeholder input for food safety programs was solicited through a variety of ongoing mechanisms. Those mechanisms have included:

A* CSREES *-sponsored food safety stakeholder session held in July 2007: Participants included university partners, representatives from industry, and federal partners from FSIS, FDA, and ARS. Participants presented food safety priorities from their representative organizations. In small group break-out sessions, participants identified overall food safety priorities. Their recommendations provided guidance for food safety program priorities identified in FY 2008.

A* CSREES *-sponsored grant writing workshop in Scottsdale, Arizona, held in July 2007: Participants included university and industry partners interested in learning how to compete successfully for CSREES food safety grant funds. Breakout sessions were held for the various competitive food safety programs offered within the agency. During those sessions, participants were encouraged to provide input on program priorities and competitive review processes.

A Briefing for the Coalition on Funding Agricultural Research Missions (Co-Farm) held in June 2007: Drs. Singleton and Rao, met with the Executive Board of Co-Farm to provide a briefing on CSREES food safety programs and priorities, and to seek input from the Board on future needs and priorities of the programs. Discussion focused on developing a continuing dialog between CSREES and Co-Farm members.

An IFT-sponsored annual business meeting and Council of Food Science Administrators' Luncheon held in Chicago, IL, in August 2007: Dr. Rao attended both the annual meeting and the luncheon during the annual meeting of the Institute for Food Technologists. Dr. Rao gave food safety program updates during the meeting and luncheon, and received input from participants on CSREES food safety program priorities.

A Food Safety Information-Sharing Meeting held in Philadelphia, PA, in September 2007: University, industry, and federal, and international stakeholders met with Dr. Singleton during an international food safety conference (the Annual Meeting of the American Dietetic Association) to share highlights of their food safety research, and to make recommendations to CSREES for FY 2008 program priorities. Federal partners provided agency updates, and discussed areas where each agency could work together to strengthen overall food safety programs throughout the government.

An NRI-sponsored Project Directors' Meeting held in November of 2007: Participants included university, industry, public, and private Project Directors awarded competitive grants through the National Research Initiative. Project Directors gave updates on their research, networked with those conducting similar research, and met jointly with food

safety National Program Leaders to provide input about program priorities and competitive review processes and procedures.

Stakeholder input was solicited in the annual Request for Applications. Each year stakeholders are encouraged to provide written comments about food safety program priorities in annual Requests for Applications. The RFAs include instructions for submitting comments, which are forwarded to NIFA Program Leaders. Comments provide guidance for priority-setting each successive funding year.

Stakeholder input was solicited from members of peer review panels, and from the Panel Managers. Annual competitive review panels include university, industry, and Federal (FSIS, FDA, ARS, and NAL) partners with expertise in food science, food safety, food microbiology, and food technology. Panelists conclude their deliberations by providing recommendations for program priorities and suggesting improvements for the competitive review process.

Prioritization of stakeholder inputs and resource allocation was based primarily on the following factors.

- Emerging issues of national or global concern
- National food safety initiatives and Congressional directives
- Critical need to achieve reduction in microbial pathogens and toxic substances in the food chain
- Effective integration of research, education and extension to solve complex food safety problems
- Science and research needs of sister Federal food safety agencies
- Implementation of new food safety guidelines and regulations
- Health and economic impacts of foodborne illness outbreaks in the U.S.
- Results of research conducted by other food safety agencies and private entities

Integrated and Interdisciplinary Approaches to Focus on Issues:

Despite many research and outreach efforts, by the partners USDA and FDA, foodborne illness associated with fresh produce continued to increase in the past 10 years. The Centers for Disease Control and Prevention estimated that, in the 1990's, at least 12 percent of foodborne illnesses were linked to fresh produce items. Between 1996 and 2006, there were at least 65 foodborne illness outbreaks, resulting in over 8,040 reported illnesses and several deaths due to contaminated fresh and fresh-cut produce. Stakeholder input in this area was overwhelming. As a result, in 2007 and 2008 Request for Applications, this topic was identified for special emphasis grants of up to $ 2 to 2.5

million each in the NIFSI program. As per the program goals the investigators were asked to integrate research, education and extension with a multidisciplinary, multistate and multiinstitutional approach. In 2007 two projects of 2.5 million dollars each were awarded. One of the projects is briefly described below.

A grant entitled "A systems approach to minimize Escherichia coli 0157:H7 food safety hazards associated with fresh and fresh cut leafy greens was awarded to a consortium of universities led by the University of Georgia. Briefly the objectives of this grant are to: Ensure inactivation of E. coli O157:H7 on the surface of composting heaps; 2. Determine if and how the organism is internalized into the leaves; 3. Assess the transfer of E. coli O157:H7 among leafy greens during processing; 4. Investigate the potential for using processing water as a contamination marker for leafy greens; 5. Assess the efficacy of intervention strategies; 6. Characterize survival and growth of E. coli O157:H7 in contaminated leafy greens during post-harvest storage and distribution conditions; 7. Develop a mathematical risk model for E. coli O157:H7 contamination; and 8. Disseminate outcomes and management strategies through annual steering committee meetings and regional stakeholder meetings, followed by evaluation of the practices. The results so far are encouraging. The project has potential to provide many solutions.

Note: More integrated activities, outputs and outcomes are reported in Appendix I.

Process for Providing Guidance to Partners/Grantees:

In general, guidance was provided to the potential grantees and partners through the standard agency approaches. These included NRI grants workshops, NRI Integrated workshop, contact information at the agency including grants.gov application process, information posted on NIFA website, and finally instructions in the RFA.

Post Award Review Process:

1. Each of the program areas undertakes post award management activity which is usually the meeting of all the project directors every 1-2 years. For example, NRI has conducted its workshop in connection with the Annual Meeting of the International Association of Food Protection in 2007. The objectives of the workshop are to monitor the progress of the project, make any midcourse corrections based on results, networking among the PDs, and sensing the general direction of the food safety research, education and extension activities.

2. In some instances, particularly when large multi-institutional and multidisciplinary projects are involved, the NPL managing the project serves on the technical/advisory committee to monitor the progress from a quarterly to a yearly interval. For example, on one the NIFSI projects addressing a systems approach to the safety of green leafy vegetables involving four universities, an FDA laboratory, and a strong technical committee, the NPL participates in the quarterly meetings and attends the annual meeting of the technical committee to monitor the progress.

3. One of the best methods is the meeting of the NPLs with individual PDs at professional society meetings and chatting informally about the progress of the project. In addition, the PDs are sometimes involved in organizing workshops and symposia at meetings around their project theme. Attendance and interaction at these meetings provides information on the progress of the project.

Programmatic or Management Shortcomings

The most critical programmatic shortcoming is the emergence of new food safety issues and new priority areas for which additional funding is not available. Current strategies to address this shortcoming have involved reducing funds previously allocated to existing priority areas. An alternative strategy would be to link new and emerging issues with new funding. Another strategy would be to develop mechanisms for rapid response to emerging issues with a portion of funds set aside for emerging issues. In any case, these strategies are an agency wide issue and should be addressed as such.

Key Future Activities and Changes in Direction

1. Prevention of contamination and decontamination strategies for irrigation water contaminated with hazardous levels of chemicals and pathogenic microorganisms,
2. Role of food chain and commensal microbes in antimicrobial resistance
3. Collection of quantitative data on levels of pathogens and chemicals in foods for food safety risk assessment and establishing metrics for risk factors.
4. Risk assessment on H1N1 in Swine (similar to AI in chicken)
5. Control strategies for foodborne zoonotic diseases
6. Retail and consumer food safety

In the next 5 to 8 years, NIFA food safety programs will focus on the following:

Improving the Safety of fresh and fresh-cut fruits and vegetables: Recent foodborne illness outbreaks in fresh tomatoes, spinach, lettuce, and peppers have focused the attention of the Food and Drug Administration on microbial contamination of produce. Preliminary results of research funded by the National Integrated Food Safety Initiative have indicated that food safety alerts issued by the Federal government are not always clear, concise, and easily understood. Many consumers (up to 30%) ignore the alerts, while others eliminate broad classes of foods from their diets, even though the alerts are often very narrowly focused. Additional research is needed on how to improve media messages and consumer awareness and behaviors following a food safety alert or food recall.

Improving the safety of beef and beef products: In 2007, more than 11 million pounds of tainted beef and beef products were recalled in the U.S. Many of the recalls involved ground beef. The most common pathogens of concern were *Salmonella* and *E. coli* 0157:H7. A less common, but equally grave concern, involved *Listeria monocytogenes* in ready-to-eat deli meats. Consumer attitudes about the safety of ground beef and other

beef products have steadily eroded over the past few years, and sales of ground beef have dropped precipitously. To address these issues, additional research is needed to detect microbial contamination and to trace contamination back to its source. Additional research is needed on how to improve media messages and consumer awareness and behaviors following a food safety alert or a food recall.

Improving food safety through novel and alternative processing technologies: The Food and Drug Administration has recently approved, for the first time, the irradiation of fresh lettuce and spinach for improved consumer safety. It was recognized that leafy green vegetables were a particular food safety concern, and that advice typically given to consumers to address these concerns were not always effective. It is likely that additional food products will be added to the list of irradiated foods in the future. Additional research is needed to identify safer and more effective alternative food processing technologies, including irradiation, for produce as well as other food products. In addition, risk-based communication and education and outreach to consumers is needed to accurately inform the public about new processing technologies and their potential effects on quality and nutritive value of foods.

Food Safety and Water Quality - Wastewater Reuse in Agriculture and Potential Risks to Human Health: The growing and harvesting of agricultural crops are very water-intensive processes. Yet water shortages across various regions in the United States are occurring regularly and frequently. In some countries in the global community, water shortages are chronic and critical. In areas where there are water shortages, wastewater reuse has become an acceptable alternative. But what do we really know about the safety of wastewater reuse on agricultural crops? What are the current standards and practices for ensuring the safety and quality of reused wastewater in agriculture? Are these standards and practices adequate to ensure food safety and human health? More research is needed on the human health implications of wastewater reuse on agricultural food and non-food crops. Audiences that are most at risk for foodborne illnesses associated with wastewater reuse must be targeted. Finally, research gaps that are critical for understanding the risks associated with wastewater reuse (testing, monitoring, and surveillance) must be identified and addressed.

Strengthening the Nation's Food Defense System: Research is needed in this area to support the development of food safety systems that prevent and/or reduce intentional or unintentional threats to the safety of the U.S. food supply. Particular focus should be given to the following: 1) threat prevention (e.g. probabilistic assessment of vulnerabilities in postharvest area); 2) threat response (e.g. high throughput, fieldable and robust analytical methods for threat agents in food matrices); 3) risk management and communication; and 4) public awareness and education.

Molecular Mechanisms of persistence of pathogenic microbes in the food and its environment: For an effective intervention to reduce/eliminate microorganisms from the food and its environment, an understanding of how microbes interact with the food and its environment and persist for extended periods in needed. This basic knowledge can be used to assess current and develop new intervention technologies.

Plant-pathogen interactions: Research is severely lacking regarding the interactions between plants and food-borne pathogens. Understanding the attachment, internalization, growth and survival of foodborne pathogens in fresh crops will be a research focus in the AFRI food safety programs.

Emerging Issues: Not only should research be focused on known agents threatening the safety of our food supply, but research needs to be focused on agents which have characteristics that may allow them to be food-borne threats. Research should not be a priority only after a major outbreak has occurred. Thus, "forward looking" research will be sought to tackle potential food-borne pathogen issues.

Risk-based Approach to Management of Food Safety: Total elimination of microorganisms is not possible unless sterilization techniques are used which may compromise the quality of the food and are not cost effective. Thus, a risk based approach is essential in the management of food safety across the food chain. Novel epidemiological approaches and innovative risk based approaches are needed.

Traceability: Rapid methods of traceability are essential to track the source of the organism in case of intentional or unintentional contamination.

What are Others Doing

- **Agricultural Research Service-USDA:** This is an intramural research program of the USDA and provides means to ensure that the food supply is safe and secure for consumers and that food and feed meet foreign and domestic regulatory requirements. Food safety research seeks ways to assess, control, or eliminate potentially harmful food contaminants, including both introduced and naturally occurring pathogenic bacteria, viruses and parasites, toxins and non-biological-based chemical contaminants, mycotoxins, and plant toxins. The research program also involves international collaborations through formal and informal partnerships. ARS also works with CDC to collect information about food consumption at the individual/household level. This agency, however, is not involved in extension and education activities. We collaborate with the national program staff in ARS to avoid any duplicate research.
- **Agricultural Marketing Service (AMS)-**USDA: Microbiological Data Program and Pesticide Data Program manage the collection, analysis, data entry, and reporting of food-borne pathogens and pesticides on agricultural commodities in the U.S. food supply. The National Science Laboratory provides chemical, microbiological, and molecular biology testing and assistance.

- **Economic Research Service (ERS)-USDA:** Provides analysis of economic impacts of food safety problems. Collects and publishes data on food consumption at the commodity level.

- **Food Safety Inspection Service (FSIS)-USDA**: Related work at FSIS is mainly in outreach/education. There are a variety of information resources for consumers. Notable among these are: Be Food Safe, Food Safety Mobile, Thermy, Is it Done Yet, Fight Bac, *Food Safety Channel* and Food Safety Education Conference. In addition, there are several guidance documents for the meat and poultry and egg processing industry to facilitate compliance. FSIS also has information on HACCP and Pathogen Reduction, Laboratories and Procedures, Data and Reports, and Risk Assessment. There is limited targeted research sponsored by FSIS.

- **Food and Nutrition Service (FNS)**: The Food and Nutrition Service (FNS) administers the food and nutrition assistance programs in the U.S. Department of Agriculture. FNS provides children and needy families with better access to food and a more healthful diet through its programs and nutrition education efforts. There is emphasis on foods especially in school lunch programs. In administering the school lunch programs, FNS provides educational material to the workers for safe handling of food.

- **Food and Drug Administration**: Food and Drug Administration enforces the safety and prevention of adulteration of food other than Meat, poultry and egg products. Through Center for Food Safety and Applied Nutrition, FDA provides guidance documents for producers, processors, packers, and consumers on food safety. FDA sponsors targeted research on a targeted basis.

- **Centers for Disease Control and Prevention**: The mission of this agency is is "to promote health and quality of life by preventing and controlling disease, injury, and disability." Food borne illness is a significant portion of the mission. CDC, FDA, and USDA trace the source of the pathogen in food borne illness out breaks. There is in house research on the detection of food pathogens.
- **Department of Defense and Department of Homeland Security** support contract and in house research for the development of detection of pathogenic microorganisms and toxic substances.
- **Private Organizations**: In 2007, Fresh Express supported research worth about $2.0 million in the area of safety of green leafy vegetables. American Meat Foundation funds proposals every year over a million dollars for research on meat safety.

Section II: Primary Knowledge Areas

Knowledge Areas 711 Ensure Food Products Free of Chemicals, Including Residues from Agricultural and Other Sources

KA 711: Introduction:
This knowledge area addresses the occurrence, detection, toxicity, metabolism, risk, and measures to decontamination of toxic compounds from the food chain. Toxic compounds include: harmful chemicals such as contaminants from industry, food allergens, and agricultural residues and food processing contact chemicals such as pesticide residues and packaging additives. Research, education and extension activities are funded to prevent and remove contaminants from the food chain.

Areas of work include but are not limited to:

- Safe or acceptable levels of residues and environmental contaminants on or in farm products for human consumption.
- Behavior and fate of pesticides, antibiotics, hormones, and other applied chemicals and environmental contaminants, on or in food plants and animals and their products.
- Methods to remove or mitigate the effects of chemicals harmful to human health.
- Rapid, accurate methods for monitoring pesticide residue, antibiotic, environmental, or other contaminants on or in food plants and animals and their products.
- Assessing risk to human health from harmful chemicals in food plants and animals and their products.
- Determining consumer attitudes and developing techniques to communicate relative risks of harmful chemicals in food plants and animals and their products
- Hazard analysis and critical control points (HACCP).

NIFA KA 711 Food Safety Logic Model

Situation	Inputs	Activities	Outputs	Outcomes		
				Knowledge	Actions	Conditions
Situation: Food safety needs to be enhanced through research, education and extension programs. Contamination of food by chemicals, toxic compounds and allergens need to be detected and reduced. Actions are needed toward improving public health by improving the safety of food, e.g., development of sensitive and user-friendly detection methods, and interventions to reduce contamination of food should be developed and used.	**Funding Sources:** - Federal - NIFA (NRI, NIFSI, SBIR, Special Grants) - other (ARS and ERS through collaboration) - State-matching from Hatch Formula **Human Capital:** - NIFA NPLs - Administrative Support - Grantees (Researchers, educators, and extension specialists) - Para-professionals - Stakeholders (Industry, etc.) - Volunteers - End Users - Consumers	Related to Research, Extension, Education: - Development of new knowledge and methods to test the presence of allergy causing compounds in tree nuts. Development Rapid response detection systems in food defense.	Publications and patents generated, prototypes developed	**Changes in knowledge, attitudes, skills, motivations, decisions of users, demands on producers and processors regarding**: Understanding of basic biochemistry of allergens in tree nuts. Understanding of basic principles of liposome immuno-analysis and Lateral flow nucleic acid assay for chemical residues, microbial toxins, Crypto-sporidium parvum (a water pathogen) and listeria developed Rapid, sensitive, and faster method for the detection of Ricin, a potential threat agent.	**Changes in behavioral practices, management uses or input that**: New test kits Market tested. The methods are being tested in field conditions New monoclonal antibodies developed. Ricin testing procedure 10 times faster than current methods. Under consideration for commercialization.	National needs met: - Once prototype is market tested, companies will have an opportunity to develop test kits for use. - Several companies are showing interest in fabricating the field testing devices once the field testing is successful.

Assumptions - NIFA has the funds, personnel and facilities to accomplish this objective. There is a need to collaborate with lateral partner organizations and agencies

External factors - A number of factors could have a significant impact on programs. Some of those include change in funding; priorities, attitudes; food production, distribution and preparation habits; average lifespan & number of immune-compromised individuals; emergence & virulence of new pathogens; food safety issues requiring new management strategies & regulatory framework; trends in food contamination & hazard survivability and risk assessment; biosecurity issues; natural disasters; economic conditions; coordination & cooperation with other government entities.

.KA 711 Key Activities, Outputs and Outcomes:

Selected examples of Activities, Outputs and Outcome under KA 711

Activity: A small Hatch grant to Cornell University to determine the microwave energy absorption, temperature rise in the food, and its sterilization led to subsequent two grants from NRI for exploring the use of computer aided prediction of food safety in a complex food processing system. In 2004, Cornell scientists teamed up with three other US universities, a National laboratory, a USDA lab, and three other university and research organizations in the UK to win a NIFSI grant. In this multidisciplinary effort, the scientists are using computer aided simulation to predict the likelihood of an unsafe condition for food during processing or distribution such prediction, however, is difficult due to tremendous variation in the types of food, how it is cooked, transported, stored, etc. This project exploited the highly underutilized advances in computer simulation to develop a tool for food science extension workers, educators and researchers that would allow easy and accurate prediction of unsafe food situations.

The researchers have integrated the process simulations with various databases such as USDA composition database to get the composition of food, a food property database and a chemical and microbiological database both form U.S. and U.K. A user friendly GUI (Graphical User Interface) has been built on top of the commercial software to make the software interactive and easy to use. The integration with various databases and the user-friendly interface makes the software unique and a useful tool to a much broader user base covering research, education and Extension.

Outputs:

- The software for food safety was demonstrated two years in a row in IFT Annual Meeting with standing room only audience (70+). Information has been disseminated through numerous meeting presentations and publications in both food and engineering community.
- Several peer-reviewed publications and presentations at major professional society meetings

Outcomes:

- Several food companies are working with the investigators and food appliance companies have donated equipment.
- Feedback from industry, academia and regulatory agencies, is being integrated in further refining the capabilities of the software and provide access to the food community in an appropriate manner.

Expected outcome: Ultimately, this quantitative predictive approach will make the food sector more safe, and efficient in developing novel products.

Activity: Our nation's food supply has been vulnerable to bioterrorist attacks, following the terrorist attacks on September 11, 2001 and the release of the anthrax in the United States Postal Service system. Food products such as milk and other liquids are of concern because they do not receive the protective benefit of cooking due to minimal processing.

Anthrax is caused by *B. anthracis* and is considered as a high priority biological weapon. Development of a rapid detection *B. anthracis* kit for adulterated liquids and foods is critical for enhancing food safety. Guild Associates, Inc. received a Small Business Research Innovation (SBIR) Phase I grant that developed a genetically engineered reporter phage that could detect *B. anthracis*. The reporter phage was constructed by integrating the bacterial *luxA* and *luxB* reporter genes into a nonessential region of the lysogenic Wβ phage genome of a *B. anthracis* phage. The resulting reporter phage was able to rapidly confer a bioluminescent signal to *B. anthracis* viable cells (10^3 CFU ml^{-1} was detectable within 60 min). After 16 minutes, post-infection of vegetative cells, a bioluminescent signal was evident. The strength and time required to generate the signal was dependent on the number of cells present.

Outputs: The project director published the Phase I proof of principle results in the *Journal of Applied Microbiology* and developed a bioluminescent reporter bacteriophage that is capable of specifically detecting *B. anthracis*.

Outcomes: Guild Associates received a subsequent Phase II grant that will build upon the Phase I research by demonstrating that the reporter phage can detect many different forms of *B. anthracis* and that the reporter phage detects *B. anthracis* only, and not other non-pathogenic bacteria in order to reduce the possibility of false alarms. If successful, the research proposed in this application will potentially save lives by providing the surveillance methodology for the identification of *B. anthracis* on deliberately contaminated liquids and foods.

Activity: An NRI grant was made to the University of California, Davis for fasr detection of ricin, a potential biothreat agent. Ricin is an easily available toxin which can be used as a bio-terror agent. It is simple to make from the beans of the caster plant and is easy to add to our food supply. Dr. Ian Kennedy and his team at University of California, Davis has developed a novel fluorescent nao-biosensor for ricin using magnetic-luminescent nanoparticles as carriers in a very small capillary tube. Antibodies are used to capture the ricin that is present in a food sample. An alternating magnetic field is used to speed up mixing of the particles with the target molecules in the miniature device. An automated system of electromagnets provided the alternating field as well as magnetic manipulation of the particles prior to detection.

Outputs: The total analysis time for ricin was reduced to about 10 minutes which is about 8-10 fold improvement in comparison with conventional methods. The sensitivity of the assay was sufficient to detect ricin in a variety of foods at levels at which harm to humans is not expected. This device and method can be manufactured cheaply and simply enough to permit wide-scale screening of our food supply for other bio-terror agents. The authors have published over a dozen articles in professional journals.

Outcome: A startup company has been formed in Davis based on this work. It aims to commercialize a test for pesticides in the raw materials for food flavorings and for

infectious diseases. Significant funding has been obtained from multi-national sources.

The authors have received a subsequent NRI grant in 2008 to implement immunoassays, assembled on the surface of luminescent/magnetic nanoparticles, to provide wide-spread screening for Staphylococcus enterotoxins and Shiga/Shiga-like toxin in foods. they will make use of nanoscale materials that are multifunctional, The techniques that will be developed as part of this research will significantly speed up the process and reduce the number of reagents and steps. Such rapid, simple assays will result in a greater ability to widely screen foods for toxins, thus protecting the food supply and human health.

Activity: While electronic nose (EN) technologies have broad applicability, the chemical discrimination ability of such devices is often poor. It is particularly difficult to establish chemical signatures in the multi-sensor response of the EN that correlate well with the presence of those chemicals in the atmosphere. Supported by a series of Congressionally directed projects, the Detection and Food Safety Center at Auburn University has developed innovative software that works in conjunction with electronic nose devices to increase their chemical recognition capability.

Outcomes: By carefully studying and emulating the process used by canines to sniff for chemicals, they have developed new chemical recognition software. That canine olfactory measurement method has been licensed by RedXDefense, Inc. to operate in conjunction with their EN devices for homeland security and food security applications.

2008 Outcomes

Activity: Recent years have seen a dramatic worldwide increase in all allergies, including food allergies. To address this issue two NRI grants (one in 2003 and the other in 2006) were made to the biochemists at the Florida State University with a physician collaborator from California. The objectives of these projects were: To identify and characterize (basic biochemistry) those tree nut proteins in almonds, cashew nuts, pistachios, walnuts and pecans that are responsible for causing allergic reactions in patients, and to develop monoclonal antibodies for detection of allergens, followed by development of kits for detection of the allergenic proteins in the food chain. These projects addressed the current issue of deadly allergies and detection of these allergens in foods.

Outputs: The investigators established the nature of the allergenic proteins in the tree nuts, developed cDNA libraries, and published over a dozen peer-reviewed journal articles. Close to half-a-dozen graduate degrees were offered in this emerging area.

Outcomes: Using the basic knowledge developed the investigators developed monoclonal antibodies (antibodies specific to the allergens) for the detection of

minute quantities of the presence of allergens in the food. It is anticipated that the methodology will be used for the development of commercial kits for routine use.

Activity: Agricultural crops are grown on more than 40,000 farms and 400 million acres of land in Virginia, and make a major contribution to Virginia's economic vitality. Timely and effective pest management of insects, diseases, and weeds is critical to the successful production of most of the important crops such as corn, soybeans, cotton, small grains, peanuts, potatoes, and vegetables. Rapid and direct delivery of real time pest information is a key but challenging element of IPM.

Outputs: Under 2007 Hatch formula, Evans-Allen, and cooperative Extension funds, Virginia Polytechnic Institute and State University (an 1862 land grant university) along with the Virginia State University (an 1890 land grant university) and in cooperation with the Southern Region IPM Center, developed the Virginia Ag Pest Advisory (http://www.sripmc.org/virginia/). This is a database driven website that compiles pest updates from Virginia Commonwealth Extension Specialists. Weekly e-mails go to agents, growers, and crop consultants across the state. In 2007, the Advisory was discovered by AgFax Media, Brandon, MS, which routes information throughout the eastern U.S. through three electronic newsletters PeanutFax, Ag Southern Grain, and Southeast Cotton Report. IPM information was also included in the pesticide safety education curriculum statewide. The pesticide regulatory program works closely with the Southern IPM Center to communicate critical issues to the public and to decision-makers.

Outcome: In 2007, the number of local e-mail recipients, by request, grew to over 400, the number of pest alerts posted increased from 119 in 2006 to 134, and the number of web hits increased from 8,562 to 12,761. AgFax Media quoted or referenced Virginia cotton IPM information 7,600 times, peanut IPM information 4,000 times, and grains IPM information 1,200 times. A recent survey of the advisory recipients indicated that 87% of respondents accessed the Virginia Ag Pest Advisory. Virtually all of them found it useful and educational, and most stated that it favorably impacted their agricultural production. Extension agents reported that 6,814 individuals gained knowledge on IPM through pesticide safety education programs. Ten applicators were recertified as pesticide applicators.

Activity: Rapid and sensitive detection of chemical residues, microbial toxins, and allergens in the food chain is essential for setting safe levels (in case of chemical residues) and fast response to contamination. Research funded at Cornell University by Hatch Formula funds focused on the development of sensitive and specific bioanalytical assays based on liposomal amplification strategies. The assay platforms fall primarily under two formats: (1) automated, computer-controlled Flow-Injection Liposome ImmunoAnalysis (FILIA) or Nucleic-acid Analysis (FILNA) systems and (2) rapid, simple lateral flow assays (LFA). Assays have been completed for the determination of the herbicides imazethapyr and alachlor, the pathogens Escherichia coli and Listeria monocytogenes, and the mycotoxin fumonisin B1. With the LFA approach, assays have been completed for the detection of the pathogens Escherichia coli, Cryptosporidium

parvum, Salmonella spp. and Listeria monocytogenes, for the pesticide alachlor, for the natural glycoalkaloidal toxins solanine and chaconine, for Shiga toxins I and II, and for the peanut allergen Ara h1. Also, extremely sensitive and specific assays have been developed for cholera and botulinum toxins using a hybrid recognition LFA approach. Finally, several projects have been completed: the detection of the principal peanut allergen, Ara h1 in chocolate; E. coli using 'universal' immunoliposomes prepared with protein G conjugated to the liposome surface; a nucleic-acid LFA for Streptococcus pyogenes; a LFA based on nucleic-acid detection of C. parvum and an antibody immunoassay for Erwinia amylovora, the organism causing fire blight in fruit.

Outputs: The investigators published 3 peer reviewed journal articles and developed prototypes for both the methods for testing a variety of toxins, allergens and microbes. Some companies have collaborated in developing these procedures.

Outcomes: The lateral-flow nucleic-acid based assay for Cryptosporidium parvum is currently undergoing field testing. If these tests are successful, several collaborating companies will be adding new fabrication facilities and personnel for production, commercialization and marketing. Subsequently, several of the other assays are expected to be commercialized using similar technology. These simple, inexpensive, single-use tests will be further developed by the use of microfluidics and should improve food safety, homeland security and environmental quality.

Knowledge Area 712: Protect Food from Contamination by Pathogenic Microorganisms, Parasites, and Naturally Occurring Toxins

KA 712 Introduction:

This knowledge area addresses the prevalence, occurrence, ecology, physiology, pathogenicity, and mechanism of pathogenicity of microorganisms causing food borne illness. Intervention strategies to prevent and reduce contamination the of food chain by pathogens are the central theme of this knowledge area. Approaches taken include funding research, education and extension and integrated activities covering epidemiology of food borne pathogens and antimicrobial resistance, development of novel risk models to reduce microbial loads in food chain, integration of research and outreach, and education of the stakeholders (consumers and food producers). In addition to pathogenic microorganisms, microbial toxins, parasites, and naturally occurring toxins are also covered.

Areas of work include but are not limited to:

- Production of food animals and crops free of pathogenic microorganisms, parasites, natural toxins, or other biological agents harmful to humans.
- Evaluation and prevention of transmission of pathogenic microorganisms and parasites between human carriers, livestock, wildlife, the environment and food systems.
- Maintenance of food security during handling, processing, packaging, and distributing food products. Improved methods for food handling, processing, storage, and preparation for greater food security.
- Methods for preventing or eliminating microbial pathogens and mycotoxins in peanuts and other specialty field crops
- Methods for preventing, removing, or controlling naturally occurring and induced toxins and allergens in agricultural products.
- Assessing risk to human health from pathogenic microorganisms and natural toxins in food animals, crops and associated products.
- Determining consumer attitudes and developing techniques to communicate relative risks of pathogenic microorganisms and natural toxins.
- Basic work on growth and mechanisms of pathogenesis of foodborne microbial pathogens
- Education on safe food handling and preparation.

NIFA KA 712 Food Safety Logic Model

Situation	Inputs	Activities	Outputs	Outcomes		
				Knowledge	Actions	Conditions
Situation: Food safety needs to be enhanced through research, education and extension programs. Contamination of food products by pathogenic microorganisms, , and their toxins. Actions are needed toward improving public health by improving the safety of food, e.g., safe food handling practices, antimicrobial resistance, epidemiology, use of kill steps, etc.	**Funding Sources:** - Federal - NIFA (NRI, NIFSI, SBIR, Special Grants) - other (ARS and ERS through collaboration) - State-matching from Hatch Formula **Human Capital:** - NIFA NPLs - Administrative Support - Grantees (Researchers, educators, and extension specialists) - Para-professionals - Stakeholders (Industry, etc.) - Volunteers - End Users - Consumers	Related to Research, Extension, Education: - Development of new knowledge and methods to test the presence of ruminant tissue in livestock feed. Development of a high resolution microscope - Testing the efficiency of irradiation on *E. coli* in spinach and lettuce Development of food safety technologies	Publications and patents generated, prototypes developed - Publications, extension brochures	**Changes in knowledge, attitudes, skills, motivations, decisions of users, demands on producers and processors regarding**: - Basic principles for the testing of ruminant tissue and a new powerful optical microscope developed. - Irradiation at low doses kills E. coli in spinach and lettuce without compromising the quality and safety of the produce. -X-ray application at very low doses eliminates E. coli on spinach and lettuce -Electrolyzed ater is an efficient and safe sanitizer	**Changes in behavioral practices, management uses or input that**: - New test kits Market tested. - Several produce organizations petitioned FDA for approval of irradiation of spinach and lettuce. FDA approved the petition to allow up to 4 kilo grays of irradiation in August 2008 Pilot testing on X-ray application to spinach completed Pilot studies in processing plants completed	National needs met: - Test kits for the detection of ruminant tissue in livestock feed are currently sold in the market. Since ruminant tissue is the only source of prions (causing BSE-Mad Cow disease), the spread of the disease can be prevented by routine testing of livestock feed. - If adopted by the industry, irradiation will eliminate/reduce the presence of E. coli in spinach and lettuce and make this produce safe for consumption. Commercial companies are exploring the possibilities of on line systems Currently Electrolyzed water is used in poultry processing industry.

Assumptions - NIFA has the funds, personnel and facilities to accomplish this objective. There is a need to collaborate with lateral partner organizations and agencies	External factors - A number of these factors could have a significant impact on programs. A non exhaustive list of changes that might occur is provided below: funding; priorities, attitudes; food production, distribution and preparation habits; average lifespan & number of immune-compromised individuals; emergence & virulence of new pathogens; food safety issues requiring new management strategies & regulatory framework; trends in food contamination & hazard survivability and risk assessment; biosecurity issues; natural disasters; economic conditions; coordination & cooperation with other government entities.

KA 712 Key Activities, Outputs and Outcomes

Selected examples of key activities, outputs and outcomes are provided below.

Activity: In the year 1997, a small Hatch grant at the University of Georgia (UGA) supported a novel approach to sanitizing the food processing facilities and reducing microbial loads in foods without using heat. The process involved the use of electrolyzed (EO) water produced by passing electricity through water containing table salt. Proof of concept resulting from this grant has resulted in a series of grants from the Hatch Formula funds (primarily through Multi-State Research Funding projects), National Research Initiative, National Integrated Food Safety Initiative, and Special grants to further research in applied areas on subjects ranging from killing microbes in food and food environment to protecting plants form diseases by using electrolyzed water. Other source of funding included FDA, and Georgia Food Processing Advisory Council. UGA and other institutions (NC State in poultry, Oklahoma State in Beef, Penn State in Dairy, Auburn in Aquaculture, Oregon State in Fresh-cut produce) including Agricultural Research Service are continuing to advance knowledge in this area.

Outputs: There are multiple outputs from the research and outreach activities related to the antimicrobial activity of Acidic EO water.

- UGA scientists under the leadership of Yen Con Hung have discovered that acidic EO water can kill foodborne pathogens instantly. They found that acidic EO water could successfully achieve 99.9 to 99.99% reductions of microbial populations on lettuce, alfalfa seeds and sprouts, shell eggs and seafood. Acidic EO water was shown to inactivate *Campylobacter jejuni* during poultry washing.

- Research has revealed that acidic EO water is less stable than commonly used chlorine water (bleach) and hence is an environment-friendly alternative to chlorine and other chemical sanitizers. It is also non-corrosive and safe to use for cleaning and sanitizing food processing equipment. Based on the research findings to enhance the properties and control the stability of acidic EO water, UGA filed an international patent application in 2003 and a U.S. patent application in 2004.

- Results of research at UGA have shown that acidic EO water can inactivate biofilms pathogens for preventing cross-contamination in a processing environment. Acidic EO water eliminated biofilms on stainless steel without corrosive effects on the treated surfaces.

- In addition to food applications, UGA scientists evaluated the effectiveness of acidic EO water for inactivating plant pathogens. This research was funded by Hatch Formula funds, the Gloeckner Foundation and the USDA Pest Management Alternative Program. The research has demonstrated that acidic EO water has strong fungicidal activity and can be used to replace fungicides to control foliar diseases on bedding plants, eliminate powdery mildew, and enhance the shelf life of cut flowers.

- Research led by UGA scientists has been featured in scientific societies like the American Chemical Society and American Institute of Physics. ABC, CNN, CBS health watch, environmental news network, health scout and many other local and regional newspapers have highlighted on the Internet. Because of the potential application of EO water to food and non-food sanitation, research has also appeared in *Science News* and *Popular Science* magazines. Many food-related magazines (*Poultry*, *Food Quality*, *Produce News*, etc.) have also reported Dr. Hung's EO water research findings.

Outcome: In 2004, *POULTRY* magazine featured a report on the success of Murray's Chickens for adopting the EO water technology for pathogen reduction during processing and received *POULTRY*'s 2004 industry innovator award. Several major poultry processors plan to incorporate EO water into their processing operations to help them enhance poultry safety. This technology has since been licensed for commercialization.

Because of these findings, the technology developed at UGA has also been sub-licensed to a company for agricultural applications in South and Central America for fungus control in plants. Recent research and outreach grants from NIFA in this area includes grants form: Hatch Formula funds, National Integrated Food Safety Initiative, and Congressional line items

Activity: Food irradiation is a century-old technology for ensuring the microbial safety of food microbial. However, proliferation of this technology has been very slow due to problems with consumer acceptance. Recent outbreaks associated with fresh produce have proven that commercial washing of leafy greens in water containing chemical sanitizers cannot assure the microbiological safety of the end product. We believe that low-energy X-ray technology, which was not explored previously, offers great potential for resolving the above food safety issues.

Scientists at Michigan State University, under the aegis of a grant from USDA-NIFA National Integrated Food Safety Initiative (Sub award to MSU, NIFSI), "A systems approach to minimize *Escherichia coli* O157:H7 food safety hazards associated with fresh- and fresh-cut leafy greens", studied the effect of low energy X-Rays on the survival of E. coli on lettuce and spinach leaves. They were able to leverage funding from International Life Science Institute-North America (ILSI-NA and Michigan Initiative for Innovation & Entrepreneurship (MIIE) to supplement this grant from NIFA.

They have used low-energy X-Ray radiation as a microbial inactivation strategy for a wide range of products, including lettuce, spinach, parsley, almonds, walnuts and ground beef. In this work, the food sample is inoculated with the target pathogen (*Escherichia coli* O157:H7, *Salmonella* or *Listeria monocytogenes*) and then exposed to low-energy X-ray irradiation in a newly developed pilot-scale food irradiator to quantify the microbial efficacy in terms of the radiation D_{10}-value (i.e., radiation dose to decrease the target pathogen 10-fold). Sensory tests will also be conducted in parallel on non-inoculated, irradiated products to assess quality changes over time.

The multidisciplinary research team involved bioengineers, food microbiologists, food scientists, and economists, combining expertise to meet our project goals.

Outputs:

- Peer-Reviewed Publication:
  Jeong, S., B. P. Marks, E. T. Ryser, and S. R. Moosekian. 2009. Inactivation of *Escherichia coli* O157:H7 on lettuce using low-energy X-ray irradiation. *J. Food Prot.* - submitted (under review).
- Conference Abstracts:
  Four abstracts and one invited presentation
- One M.S. graduate student is expected to graduate in December 2010.

Outcome: When individual lettuce leaves were irradiated, a D_{10}-value of 0.040 kGy was obtained, which is 3.4 times lower than the previously reported value using gamma irradiation. When ten stacked leaves were irradiated from both sides, a dose of 0.2 kGy was achieved at the center of the stack, corresponding to a ~5 log reduction of *E. coli* O157:H7. Based on these findings, low-energy X-ray irradiation appears to be a promising microbial inactivation strategy for leafy greens and potentially other types of fresh produce. This work is expected to have a major impact on the manner in which leafy greens are commercially processed, with this new knowledge leading to a number of carefully targeted intervention strategies. In addition, these findings should help reduce the incidence of *E. coli* O157:H7 on fresh-cut commercially produced leafy greens, with this novel x-ray technology providing a cost-effective means to completely eradicate *E. coli* O157:H7.

Adaption of Technology

Rayfresh Foods Inc. (Ann Arbor, MI), who supplied our current prototype x-ray irradiation unit, is developing a commercial-scale, in-line machine for irradiating ground beef patties. Many requests have been received from the food industry for x-ray irradiation trials on a wide range of other products, including fruits and vegetables, nuts, and other dry food products. After commercial installation of the first in-line x-ray irradiator for continuous treatment of ground beef, x-ray irradiation is likely to become very attractive to the food industry. In order to further simulate commercialization of this novel low-energy x-ray technology, an integrated tool is essential to ascertain economic viability. This integrated model based on the physics, biology, and economics of x-ray, as well as gamma and E-beam, irradiation can then be used by different segments of the food industry to identify the best and most cost-effective irradiation method for specific applications.

Activity: Under the aegis of a NIFSI grant, researchers at Michigan State University are developing a tool and information that will improve thermal process validations and better ensure the safety of ready-to-eat meat and poultry products.

Outputs: The pilot-scale data revealed two significant results. First, variability and uncertainty in Salmonella lethality increases significantly when scaling-up inactivation results from laboratory to pilot-scale, which needs to be considered when computing process lethalities. Secondly, for inoculated whole-muscle roasts cooked to a core temperature of 71.1°C during slow cooking processes that mimicked commercial schedules in the pilot-scale oven, no salmonellae were recovered via standard plate counts, indicating that there was no significant under-processing of those products. However, for slow-cooked roasts cooked to a target computed lethality (e.g., 6.5 log reductions), the results indicate that there is significant risk of not meeting the lethality performance standards.

Impacts: This research showed that particular caution should be exercised for marginally-processed products. This information will be provided to the meat and poultry industry to assist them in establishing thermal processes for their ready to eat meat products.

Activity: Researchers at Ohio State University, Purdue University, and Kentucky State University are working to develop mental models of a select group of individuals including: 1) Growers at high-risk for producing contaminated product (small-scale and minority farmers); 2) Targeted consumer audiences at higher risk for foodborne infection (elderly, rural, low-income, and African-American); 3) Educators; and 4) Retailers. This mental model will be developed through the usage of survey data and confirmed by microbiological exploration of the sources and fate of E. coli O157 on vegetables during processing and packaging.

Outcomes: From these results, differentiated food safety messages can then be developed and evaluated with cooperation of stakeholders to overcome the roadblocks to recommended food safety behaviors at both the pre- and post-harvest steps in the food chain. To date, formal expert elicitation of pathways and prevention of microbial contamination of vegetables was performed by conducting in-depth interviews with commercial small-scale, and minority vegetable producers. Laboratory experiments aimed at determining the factors affecting the survival of pathogen on fresh fruits and vegetables were also conducted. Upon the completion of these activities, a database of baseline- knowledge, skill and behaviors among large scale vegetable producers were ascertained in order to develop a more directed communications targeting specific knowledge gaps which can now be utilized for educational and outreach activities for the targeted audiences.

Impacts: As a result of this project, 3 PhD students and 2 postdoctoral scientists were mentored, several papers were developed which are listed below in addition to several oral presentations at both national and international conferences.
Ilic, S., Odomura, J., and LeJeune, J. (2008) Coliforms and prevalence of generic Escherichia coli and foodborne pathogens on minimally processed spinach in two packing plants. J Food Protect. 71:2398-2403.

Wilson, R., Tucker, M., Hooker, N., LeJeune, J., and Doohan, D. (2008) Perceptions and beliefs about weed management: Perspectives of Ohio grain and produce farmers. Weed Technology 22:339-350.

Aruscavage, D., Miller, S., Lewis-Ivey, M., Lee, K. and LeJeune, J. (2008) Survival and dissemination of Escherichia coli O157:H7 on physically and biologically damaged lettuce plants. J Food Protect. 71:2384-2388.

Activity: Researchers at the University of Florida, University of Rhode Island, University of Delaware, and University of Connecticut are working to increase the ability of consumers to balance the important benefits and risks of seafood consumption by providing them with a consistent message and relevant information delivered through a variety of readily available materials. An advisory board made up of medical doctors, nutritionists, researchers and federal agency administrators was established. The role of the Advisory Board is to oversee project activity on an annual basis and give advice to goals and objectives as they are implemented. A second major activity over this past year was to implement a needs assessment on-line survey of healthcare providers. The survey was developed using a content validity methodology supported through literature and reviewed by a cross-sectional expert panel. The core management team for the survey consists of Lori Pivarnik (University of Rhode Island), Doris Hicks (University of Delaware), and Robert Gable (University of Connecticut), an evaluation expert. Prior to implementation of the survey, an expert panel including the Advisory Board, consisting of the project personnel, healthcare providers/practitioners, Land Grant Food Safety Experts and/or Sea Grant Seafood Specialists reviewed the survey content and made recommendations of survey length and content.

Outcome: The needs assessment survey was implemented in September 2008 and ran through December 2008 using an online service.

Impact: Once the results from the needs assessments survey are evaluated they will be used to develop appropriate educational pieces for healthcare providers. All materials developed based on the needs assessment survey will be evaluated such that their ability to change knowledge, behaviors, and actions can be determined.

Activity: Capacity Building Grants (CBGs) at North Carolina A&T State University (NCA&TSU), an 1890 Land Grant University, positively impacted the institutional competitiveness of the university in Food Safety. The university researchers engaged in an active role in partnerships with other research and teaching institutions and industries to help in the national effort to provide consumers with safer and better quality foods. The CBGs also helped in developing experiential learning activities that promote healthy eating, food safety practices and processes, and the latest analytical methods in food and nutritional sciences; enhancing the ties between research and experiential learning through integration and enhancement of different academic programs (food/nutrition, child development, animal science, etc.) and strengthening outreach to the community at large. CBG funds were also leveraged by faculty to attract other funding sources such as USDA NRI, SARE, and other federal programs. Currently, the Food and Nutritional

Science Program at NCA&TSU has four fully equipped labs, including Food Microbiology and Toxicology, Food Chemistry, Cell Culture, and Sensory Evaluation.

Research activities included the development of effective natural methods to control pathogens in fresh produce, development of biosensors to rapidly detect foodborne pathogens in foods, experiential learning for preschool children/parents to increase their consumption of fruits and vegetables, food safety outreach to low income consumers and small producers, educational and survey techniques for community outreach, etc. Furthermore, CBGs helped advance the knowledge and research capacity of faculty, staff, graduate students, and undergraduate students by exposing them to new research approaches, including novel ways to ensure the safety of fresh produce and other food products using state of the art technologies.

These projects also enhanced the performance of the NCA&T basic and applied food safety program and were used for recruiting students to the Food Science and Nutrition's Undergraduate and Graduate programs. The students acquired hands-on laboratory experience and they had opportunities to present their research findings at local, national, and international meetings which helped improve their networking abilities and communication skills. Other examples of outcomes include:

1. Created new opportunities for synergies with other institutions such as the USDA/ARS food safety and Human Nutrition groups and multiple institutions at the NC Research Campus in Kannapolis. The latter is a multi-institutional campus focused on safety and health aspects of fruits and vegetables.
2. Enhanced departmental research and testing capabilities with unique facilities that attract the private sector for collaborative work and/or R&D services
3. Equipping of a new computerized Sensory Evaluation lab for use in teaching, student/community experiential learning, and research
4. Purchase of laptops with commuter modules that allow remote collection of data in participating schools and community centers
5. Research Assistantships for 7 African American students working toward completion of their Masters degrees in Food and Nutritional Sciences (these on current projects only)
6. Graduation of minority students with graduate degrees in Food and Nutrition
7. Funding for PIs and students to attend professional meetings for professional development
8. Development and testing of educational intervention tools and materials tailored to pre-schoolers, especially in underserved areas where minorities tend to concentrate
9. Strengthen the Food and Nutritional Sciences curriculum through development of an interdisciplinary and modular course in Food Science and nutrition, and child development
10. Generation of a large amount of data for future publications and presentations at national meetings

Activity: Starting in year 2000, CSREES awarded a series of grants in the area of food irradiation. Notable areas emphasized were consumer food safety and education, irradiation of complex and irregularly shaped foods such as fruits and vegetables, and irradiation of green leafy vegetables. The awards were made to Iowa State University, Texas A&M University, Chapman University, Colorado State University and University of California, Davis. The source of funds included the National Integrated Food Safety Initiative, National Research Initiative, Special Research Grant, and Hatch Formula funding (including the participation of the multistate group S 1033), notwithstanding many extension activities by the partners. The funding for this activity was around $ 1.5 million.

Outputs: Enhanced education of the consumer about the safety of irradiated fresh fruits and vegetable including green leafy vegetables; models for irradiating irregularly shaped foods, establishment of effective irradiation dose for reduction of pathogenic microorganisms, especially in green leafy vegetables without compromising the quality; and several journal article publications, and extension bulletins.

Outcome: United Fresh, Food Products Association and other parties used the outputs of this activity, along with those resulting from ARS research, in support of their petition to FDA for approval of irradiation of fruits and vegetables. FDA analyzed existing and new data on the safety and on August 21, 2008 approved the irradiation of fresh iceberg lettuce and fresh spinach at a dose level of up to 4.0 KiloGrays. The anticipated outcome is use of this technology for reducing pathogens (such as E. coli and Salmonella) and increase the shelf life of iceberg lettuce and spinach

Activity: In food processing plants formation of Listeria biofilms has been a problem leading to long term persistence and a mechanism for the organism to protect itself from sanitizers. An NRI grant made to Sterilex Corporation addresses this issue both from the stand point of food safety and environmental safety by killing all the organisms before the wash water and sanitizers are dumped. For any new sanitizer developed, protocol development and validation is critical to the establishment of standards for registration of EPA biofilm claims for use in food processing.

Outputs: The researchers developed an optimized formulation of a disinfectant to treat meat and poultry food processing equipment that is used to produce ready to eat meats. The formulation kills all the Listeria in biofilms. Four journal articles were published and several abstracts were presented at scientific meetings. Funds were leveraged by the investment of $ 75,000 from the Sterilex Company in professional time after one of the key PIs from another laboratory resigned from the project.

Outcome (Expected): Sterilex will be conducting additional laboratory and field studies on the optimized formulations, and will then proceed to EPA registration of the products for the control of *L. monocytogenes* biofilms in food plants, food service, and animal health facilities. In addition, Sterilex has demonstrated the efficacy of the

AP-PT platform as a basis for the development of a family of formulations for future development.

Activity: A series of special research grants entitled "Detection and Food Safety" funded at Auburn University, Auburn, AL (PI Bryan Chin), have addressed the development of several food safety related technologies.

Outputs: During the past 6 years of these projects, the investigators have leveraged USDA funds with other funding sources to support 102 post-baccalaureate degrees (48 MS and 54 PhD), published 280 refereed journal articles, and filed disclosures for 113 patents, received 19 patents, and commercialized six technologies. The series of projects funded by USDA has demonstrated the superior capability of filamentous phage in biosensors (versus antibodies) for microbial detection. Theoretic detection limits of one cell per 100ml of solution are possible. They have also demonstrated that it is possible to detect Salmonella bacteria on the surface of spinach leaves (no solution medium required).

Outcome: The investigators not only have advanced the science of rapid detection of tissues of ruminant origin (Only source of prions of bovine spongiform encephalopathy) in live stock feed, but have also taken it to the level of commercialization; test kits are now being sold by Neogen and the farmers can test the livestock feed before feeding. They have also developed a very high-powered optical microscope that can provide resolution down to 100 nanometers for live organisms. With this scope scientists can watch food pathogens such as salmonella in action. This work has resulted in the establishment of a new company (Cyto Viva) which now routinely sells the microscope for use by many scientists in microbiological and other laboratories. In addition, there were spin-off technologies that resulted in commercialization of detection devices (Test Kits for detecting the adulteration of meat from one animal with meats from other animals and a device tracking time-temperatures during shipments).

Section III: Secondary Knowledge Areas

KA 501 - New and Improved Food Processing Technologies

KA 501 Introduction:
Work in this area focuses on development or improvement of methods, techniques, or processes to maintain or improve quality or functionality, stabilize or preserve foods, or prepare foods for further processing.

Areas of work include but are not limited to:

- Food physical processes (i.e., thermal and non-thermal pasteurization/ preservation, size reduction, separation, concentration)
- Food bioprocesses (i.e., enzyme and microbial applications, fermentation, genetic engineering of foods and food ingredients)
- Food chemical processes (i.e., salt, sugar, acid, preservatives, colorants, antioxidants, chemical modification)
- Food processing efficiencies (i.e., management of energy, water, wastes)
- Improved or new food packaging technologies
- Food process modeling, automation, and sensors
- Processing technologies for new food uses of agricultural products
- Food bioengineering and food process engineering
- Maintaining or enhancing bioactive components in food and food ingredients.

2009 Outcome

Ricin is an easily available toxin which can be used as a bio-terror agent. It is simple to make from the beans of the caster plant and is easy to add to our food supply. Fast and inexpensive methods for its detection in food samples are needed. Dr. **Ian Kennedy** and his colleagues at **University of California, Davis** has developed a novel fluorescent biosensor for ricin using magnetic-luminescent nanoparticles as carriers in a very small capillary tube. Antibodies are used to capture the ricin that is present in a food sample. An alternating magnetic field is used to speed up mixing of the particles with the target molecules in the miniature device. An automated system of electromagnets provided the alternating field as well as magnetic manipulation of the particles prior to detection. The total analysis time was reduced to about 10 minutes which is about 8-10 fold improvement in comparison with conventional methods. The sensitivity of the assay was sufficient to detect ricin in a variety of foods at levels at which harm to humans is not expected. This device and method can be manufactured cheaply and simply enough to permit wide-scale screening of our food supply for other bio-terror agents. **A startup company** has been formed in Davis based on this work. It aims to commercialize a test for pesticides in the raw materials for food flavorings and for infectious diseases. Significant funding has been obtained from multi-national sources.

2008 Outcome

An NRI grant jointly awarded in 2007 to Innovative Biotechnologies International Inc., NY (Richard Montagna) and Cornell University (Herald Craighead), is developing a highly specific and ultra sensitive nanobiosensor for the direct detection of prions in the blood of cows with mad cow disease prior to slaughter. Current evaluation of cows for Bovine Spongiform Encephalopathy (BSE) relies upon post mortem testing of suspicious animals. The ability to directly detect infectious prions in the blood of all cows prior to slaughter will dramatically improve the safety of the human food supply. Construction modified Resonating Mechanical nano-Biosensors (RMBs), the investigators increased the sensitivity of detection by five orders of magnitude (X100, 000), to a point where 200 picograms of prions /ml of serum can be detected. Currently efforts are underway to achieve sensitivity by another two orders of magnitude. One paper has been published in Analytical Chemistry and another manuscript is in preparation at this writing. This proposal is an excellent example of integration of the disciplines of biology and physics to solve a real world problem.

KA 903 - Communication, Education, and Information Delivery

KA 903: Introduction:
This area of work focuses on educational processes, needs, and methods to achieve educational goals. Work includes development, use, and assessment of communication, information delivery, and technology transfer methods and systems. List topic or discipline-specific education under the appropriate KA.

Areas of work include but are not limited to:

- Techniques, procedures, and processes of education
- The science of teaching, learning, and cognition
- Curriculum design and educational instrumentation (applications of technology and media in teaching and learning)
- Teacher preparation and improvement
- Communication and information systems and delivery, including electronic networks and distance education
- Technology transfer
- Educational psychology and human motivation.

Activity: A renewed recognition of the need to strengthen the content of food safety research-based content in agricultural education curricula at secondary and postsecondary levels led to the 2009 Secondary Postsecondary Agriculture Education Challenge Grants Program award of $32,868 to University of Delaware (2 years) to integrate food safety investigations into science curricula for secondary education to increase understanding of food safety principles, increase awareness of the scientific rigor of food science and career opportunities related to food science, and to help students prepare for careers in food science.

Activity: The International Science and Education (ISE) Grants Program advances the need for increasing global competence by graduates from U.S. academic institutions. The import of global dimensions in the food systems domain, is increasingly more critical to food safety and quality. A 2009 ISE award ($106,400) to West Texas International Program (WTIP) will facilitate international experiences and collaboration between students at West Texas A&M University and students in Nigeria and Azerbaijan. Students will focus on solving problems in agriculture and environmental science using systems methods.

Activity: In 2006, Riverside Community College (RCC) received $294,000 from the HSI Education Grants Program for a 3-year project to collaborate with University of California (UC), Riverside. This pairs a research grant (UC, Riverside) and an education grant (RCC) in a unique partnership to educate and increase interest among minority students at community colleges about food safety issues. The collaboration would provide RCC students an experiential learning opportunity in cutting-edge water quality research and exposure to a 4-year college experience at UC Riverside. The partnership aims to motivate students to graduate from RCC and transfer to a 4-year university to

pursue careers in science and engineering. The investigators of NRI grants made to the ARS-USDA Salinity Laboratory, UC, Riverside, University of Vermont and University of Utah studied the transport behavior of E. coli and *Cryptosporidium* in soil. UC Riverside took the lead in training the minority students. The topic was on the migration and persistence of food pathogens (E. coli) in soil.

Outcome: Six Hispanic students who went to RCC entered B.S. programs at UC, Riverdale to pursue training in food safety. The program's success has garnered interest among students at RCC. Hundreds of students and faculty have shown interest by participating in the program's seminar series at RCC, and an enhanced interest in science and engineering fields has been observed through programmatic assessment.

Section IV: Portfolio External Panel Recommendations

Relevance

Scope:
There was a need to have more quantitative data on the outputs of the funded research projects. The criteria for assessment should be developed within NIFA leadership and used to objectively evaluate the research outputs from the portfolio; foods other than animal-based food products and infectious agents should be fully demonstrated in the portfolio, specifically produce and non-meat foods need to be better represented in the portfolio; NPLs and scientific staff in the food safety program in NIFA could increase and improve communication between the competitive grants programs and the state agriculture experiment stations and extension. Communication about NIFA programs and about what states are doing are areas of concentration; program staff should consider current geographic needs in food safety, specifically considering the needs of rural communities in the US and developing nations; NIFA food safety staff should be involved at some level at other Agency programs, and obtain additional funding for research, education and extension activities concerning food security.

- Portfolio Response for 2009:

  We continue to make earnest efforts to improve its data collection and reporting, e.g. the One Solution project improving the CRIS system; redesigned Plan of Work with new designs to make it possible for projects to report on progress, outcomes, etc., with the deadline of April 2008 for annual reports. NPLs were provided with the Administrative Dashboard to enable their quantitative data collection for project outputs and outcomes, and many NPLs are using the Dashboard to track their progress. NPLs are now assigned the responsibility as state liaisons to, among other things, improve communications with partners. This effort has served to provide greater detailed information to the Land Grant Universities, Tribal Colleges and State Experiment Station Directors relative to competitive grant programs and other NIFA activities and initiatives. Additionally, information from these institutions has aided NPLs and NIFA in communicating advances to the public. The NRI Food Safety program included priorities for safety of fresh produce and seafood beginning in FY 2007. The NRI Project Directors' Workshops held in 2007 in conjunction with the IAFP Annual Meeting is an example of communication of project results with members of professional societies. The National Integrated Food Safety Initiative has included priorities for the safety of fresh and fresh-cut fruits and vegetables since 2006, and regularly reports on related research results at national meetings, and at NIFA-specific stakeholder planning meetings with sister food safety agencies.

Focus:
Additional funding is needed for work on viruses based on the proportion of food borne illnesses caused by viral agents. Data from 1997 to 2006 on reported causes of food borne illness from the Centers for Disease Control and Prevention show that Norovirus-borne outbreaks increased by more than 600%. This increase may be, in part, due to improved

methodologies in the detection of viruses It should be noted that norovirus outbreaks are more related to worker hygiene rather than the entire food system as is the case with many food borne illnesses.

- Portfolio Response for 2009:

  The portfolio continues to communicate and consult other USDA agencies, particularly ARS, and external agencies, such as FDA, CDC, etc. involved in food safety activities. NIFA NPLs now meet annually with sister Federal food safety agencies during the ARS/FSIS Annual Research Planning Conference to help define interagency program priorities. NIFA will play a major role in the planning for the next upcoming conference in 2010. The portfolio continues to focus on all important issues of food borne illnesses within the allocated funding. The focusing of program priorities within the NRI-based Food Safety programs was necessitated by several cycles of flat funding accompanied by increases in research costs. Because researchers and reviewers invest large amounts of time in preparing and reviewing proposals, it is not efficient to run granting programs that can only fund 10-15% of proposals submitted. Therefore, NIFA has chosen to focus resources on a few critical areas, based on advice from stakeholders. This change in funding philosophy has led to emphasis and enhancement in the most critical areas; however, other areas of importance within the food safety realm do not receive needed research funding as a result. Research funding for work on enteric viruses, including caliciviruses, has increased substantially since the external review analysis. These include efforts in both pre- and post- harvest research to track source and point of contamination during production and processing of fresh produce.

Emerging Issues:
NIFA staff should be more involved with National Advisory Committees for Microbiological Criteria in Foods (NACMCF); even if NIFA staffers are not members of boards, they should attend meetings and seek interactions with other advisory committees, and NIFA needs to define and clarify what emerging issues represent in order for the category to be evaluated properly.

- Portfolio Response for 2009:

  Members on the National Advisory Committee are appointed and, currently, no NPLS in NIFA have been appointed directly to the Committee. However, NPLs have attended open Committee meetings and have shared proceedings with other agency contacts. In addition, NIFA NPLs meet regularly with colleagues in sister federal food safety agencies to identify program priorities, highlight knowledge gaps, and ensure that programs are not duplicative. The portfolio continues to improve upon its ability to put emphasis on national emerging issues. Competitive grants programs in food safety continue to reflect the evolution of food-borne illness issues and priority setting is based upon statistical analysis of ongoing and emerging issues.

NACMCF respects NPL's knowledge, expertise, and vision of merging issues. The committee solicits the inputs from the NPLs at regular basis. For example, the NPL of nanotechnology was asked to give a brief on nanotechnology applications in food safety at one of the quarterly meeting.

Integration:
NIFA should further develop partnerships with ARS and State Agricultural Experiment Stations and host discussions between these various entities through regular workshops.

- Portfolio Response for 2009:

  The portfolio continues to improve in this area. National Program Staff from ARS have been involved in stakeholder listening sessions hosted by CSREES Food Safety NPLs and ongoing informal discussions have increased to maintain a knowledge sharing pathway. Recent teleconferences were held with ARS food safety program leaders to discuss joint CSREES/ARS program priorities. ARS NPLs have also attended competitive grants program proposal reviews to gain greater understanding of the process of awarding research funding. In a similar vein, ARS NPLs have shared their annual reports detailing ARS activities in food safety research. ARS scientists are eligible for funding from the NRI and do submit proposals and receive NRI grants. They also participate on NRI and NIFSI peer review panels.

  Regularly scheduled conference calls with Land Grant University personnel, including Deans, Experiment Station Directors, Research Directors and NASULGC representatives, have fostered greater interaction and information exchange between all parties. In addition, program updates and briefings have been held for stakeholder groups such as the Agriculture and Natural Resource Leaders, Southern Regional Program Leaders, Veterinary Research Deans, the Council of Food Science Administrators, and Nutrition Department Heads. More integrated proposals have been received in integrated programs, including NIFSI.

  Even though the NRI water program is offered as a research program, recent research such as Rob Atwill at UC Davis on water borne pathogens was immediately moved into extension outreach during the spinach E. coli outbreak in California to share latest research on setbacks of livestock from irrigation streams and fields with fresh produce at numerous public meetings and fact sheets.

Multidisciplinary:
Increase the number of coordinated agricultural projects (CAPs) in food safety; gather more quantitative data to evaluate the effectiveness of the interdisciplinary programs; encourage other disciplines, including the psycho-social sciences, to be a part of interdisciplinary work.

Many water pathogens relating to irrigation for food production and processing studies use multiple expertise of microbiologists, veterinarians, engineers, modelers, animal scientists and horticulture specialists.

- Portfolio Response for 2009:

The portfolio continues to improve in multidisciplinary balance. Flat funding for 2008 did not support the creation of new CAPs grants, but the existing CAPs grant continued to demonstrate success. One hundred percent of the 34 NIFSI grants funded in 2008 were multi-state, multi-institutional, multidisciplinary grant projects. These awards represent the application of non-traditional disciplines to food safety and the interaction of scientists from more than one discipline in each project working to solve complex problems. Nevertheless, the increase in multidisciplinary grants was not for the entire portfolio. Food safety priority area of NRI 75.0 Nanotechnology program has typically supported multidisciplinary research projects involving physical, chemical, biological, materials, and food scientists.

Quality

Significance:
Increase linkages of specific programs to improvements in public health. RFAs should request the development of novel and innovative approaches to increase these linkages.

- Portfolio Response for 2009:

  This remains a problem across the entire food safety community. Over the past decade the overall incidence of foodborne illness has decreased, but no single food safety agency, or single food safety effort is able to demonstrate that the decrease is directly attributable to specific variables. Attribution of research, education, and extension efforts to reflect a decline in the number of food-borne illnesses or the number or magnitude of product recalls requires the interplay of multiple variables in production, processing, quality assurance and even consumer behavior to be accurate. NIFA continues to interact with others in the food safety community to investigate methods that will promote reliable attribution studies. NIFA NPLs are active on the planning team for the 2010 Food Safety Education Conference, where a major session during the meeting will focus on attribution studies. Additionally, grant recipients are reminded at least twice per year to acknowledge NIFA funding in presentations and publications and compliance with this requirement has improved since these reminders began being sent by email. In times of scarce resources, it is more appropriate to focus funding on continuing efforts to improve the safety of food while avoiding overlap with other agencies, rather than on overt concern over who takes credit for improvements.

  Critical food safety biosecurity measures have been developed since September 11 to prevent food terrorism, including surveillance, testing, training of producers and processors. Documented cases of attempted intentional food contamination and intervention have been documented, and training to avoid future events has been implemented.

Stakeholder:
Clarify who the key stakeholders are, specifically those who should have input in the portfolio. NPLs should attend committee meetings such as the NACMCF and offer advice to these groups; NPLs should seek opportunities to enhance the involvement of end-users (stakeholders, NGOs, industry, Congress, Project Directors, etc.) in all aspects of the portfolio.

- Portfolio Response for 2009:

  The 2008 team felt that the portfolio has made an effort to solicit information from the end-users, and has processed unsolicited information, as well. This information has helped reduced duplication of work in Food Safety. Further, all Request for Applications posted by the Agency ask all interested parties to provide input into the competitive grants process, including providing contact information to facilitate this input. Stakeholder updates and discussions have been held with ARS, FDA, Agriculture and Natural Resource Leaders, Southern Region Program Leaders, Veterinary Research Deans, and others who interact directly with end-users. NIFA offered joint funding priorities with FDA in the AFRI RFA in FY 2009. This came about as a direct result of a meeting between CSREES and FDA staff in 2008. These meetings will continue in 2009.

Alignment:
If necessary, allow NRI programs to take a more integrative approach; develop a mechanism to gather data on Extension programs in food safety and a system for gathering these data on a continuing basis; NPLs should sit on food security committees if NIFA elects or is directed to fund research and education in this direction; if funding for food defense issues becomes available then the Agency should seek to develop joint programs with other federal agencies using the successful NSF-NRI genome program as a model.

- Portfolio Response for 2009:

  The 2008 team felt that the portfolio continues to do an excellent job in aligning its work with current state of science. To avoid program duplication, NIFSI has funded the lion's share of integrated food safety research and NRI has funded basic research. The agency One Solution effort continues to focus specifically on collecting data on extension program impacts. Data from state Annual Reports can also provide additional information about the impacts of extension programming in food safety. Additional funding for food defense has not been forthcoming and NIFA does not need to duplicate the efforts of other agencies (e.g. DOD, HS)

Methodology:
Provide a consistent set of instructions and guidelines on how to evaluate and rank proposals for grants review panel members; the portfolio and/or Agency should consider a grant proposal triage procedure similar to the one used by NIH.

- Portfolio Response for 2009:

  External reviewers have assessed the portfolio as having routinely utilized appropriate review methodologies. Panelists have consistently praised agency NPLs for clarity and direction during panel orientations preceding competitive review panel deliberations. Proposal triage procedures were adopted and revised by NIFSI in 2007 through 2008, and by NRI in 2004. The NRI (soon to be AFRI) has drafted a procedures manual for NPLs to follow, which is expected to be released in early FY 09. Competitive review processes assure the project with best science being supported. Nanoscale science, engineering and technology are the new frontier of scientific research and discovery. Nanotechnology is a cutting edge research area in food safety area.

Performance

Productivity:
Consider measures of productivity and establish linkages to milestones; increase the amount of quantitative data to provide evidence of productivity particularly for formula funds and extension.

- Portfolio Response for 2009:

  The agency One Solution effort continues to focus specifically on collecting data an extension program impacts. Data from state Annual Reports can also provide additional information about the impacts of extension programming and formula grants research in food safety. The USDA/HHS Healthy People 2010 milestones for incidence of food-borne illness continue to serve as the gold standard for agency food safety programs; preparation of milestones for Healthy People 2020 is underway. New programs or emphases were added during this period (2003-2008) include nanotechnology and water programs.

  For the amount of federal funds received by NIFA, very high quality projects are being funded. Some are cutting edge such as new models and measurements to understand how pathogens survive and move in soil and water and onto food to develop intervention methods.

Comprehensiveness:
Possibly generate funds that will allow programs to be comprehensive, focused and responsive.

- Portfolio Response for 2009:

  Additional funding to bolster the portfolio was not forthcoming in 2008. In an effort to focus on high priority and emerging areas of food safety, focus has been placed on what the agency has determined through stakeholder input to be the most critical aspects of the food safety spectrum.

For the amount of federal funds received, NIFA covers a broad spectrum of professional course development, training and research in epidemiology, pesticide residue reduction, food bioterror, meat, dairy, eggs, vegetables, water irrigation, restaurant training, home consumer training, and volunteer training in soup kitchens and charity suppers. It covers prevention, intervention, and final consumer endpoints

Timeliness:
The panel was pleased that most projects are completed. The panel did, however, believe that there should be a change in expectations around no cost extensions and that more realistic timeframes be requested by investigators in their proposals.

- Portfolio Response for 2009:

  Legislative requirements for project closure in 5 years remained in place for NIFSI in 2008. However, this has been extended to 10 years for AFRI beginning in 2009. The team felt that the portfolio continued to have most projects achieve closure on time. Under the Federal Demonstration Partnership, the first no-cost extension can be granted by the Project Director's institution and this is therefore not under NIFA's control. Requests for a second no-cost extension must be approved both by the NPL and the Office of Extramural Programs, and justification for the extension must be provided (e.g. loss of staff, relocation of the PD to a new institution).

Agency Guidance:
The panel felt that the food safety staff was (are) working hard and demonstrate significant leadership. The panel was impressed with the qualifications of the NPLs. As a group, the NPLs have improved considerably in the last ten years. NPLs appear to be up to date and authoritative scientists in their respective fields (for example, they write books, articles, serve on professional society committees, etc.); they are on the cutting edge. The NPLs are led by an administration that is open to new directions and that allows the NPLs to do their jobs in a mostly unencumbered way. The panel observed that the food safety program NPLs are among the best in NIFA.

- Portfolio Response for 2009:

  NPLs continue to strive toward improved management, leadership, and program planning.

Accountability:
NIFA is urged to identify ways to improve this system to allow for better and more comprehensive data. The panel recognizes that the quality of the data in CRIS is dependent on what is entered into the system by the scientists. NIFA staff should work with experiment station directors to improve this process.

- Portfolio Response for 2009:

As stated elsewhere in this report, the agency continues to make earnest efforts to improve its data collection and reporting, e.g. the One Solution project improving the CRIS system; redesigned Plan of Work with new designs to make it possible for projects to report on progress, outcomes, etc., with the deadline of April 2008 for annual reports. NPLs were provided with the Administrative Dashboard to enable their quantitative data collection for project outputs and outcomes, and many NPLs are using the Dashboard to track their progress. NPLs are now assigned the responsibility as state liaisons to, among other things, improve communications with partners. This effort has served to provide greater detailed information to the Land Grant Universities, Tribal Colleges and State Experiment Station Directors relative to competitive grant programs and other NIFA activities and initiatives. Additionally, information from these institutions has aided NPLs and the Agency in communicating advances to the public. Modifications to the CRIS system are expected to further enhance the quality of information provided. Grantees' meetings enhanced the sense of accountability among grant recipients.

Projects are completing thorough reports on a timely basis and making wise use of scarce funding. They are linking USDA projects to other funding to expand the impacts.

Section V: Self-Assessment

Portfolio Scoring:

Criteria	Panel Score	2006 Score	2007 Score	2008 Score	2009 Score
Relevance					
1. Scope	3	3	3	3	3
2. Focus	3	3	3	3	3
3. Contemporary and/or Emerging Issues	2	3	3	3	3
4. Integration	2	2	2.5	3	3
5. Multi-disciplinary Balance	2	2.5	2.5	3	3
Quality					
1. Significance of Findings	2	2	2	2.5	2.5
2. Stakeholder/Constituent Inputs	2	2	3	3	3
3. Alignment with Current State of Science	3	3	3	3	3
4. Appropriate and/or Cutting Edge Methodology	3	3	3	3	3
					Performance
1. Portfolio Productivity	2	2	2.5	3	3
2. Portfolio Comprehensiveness	2	2	2	2.5	2.5
3. Portfolio Timeliness	3	3	3	3	3
4. Agency guidance	3	3	3	3	3
5. Portfolio Accountability	2	2	2	2.5	2.5
Overall score*	*83*	*86*	*91*	*97*	*97*

* The overall score is based on weighted calculations

2009 Portfolio Score Discussion

Relevance

Scope: Remained unchanged at 3.0
The portfolio assessment team voted to maintain the score of 3.0 for the area of scope. The funding increased for fiscal year 2008 played as large role in this portfolio's ability to maintain this score. For example in 2008, the Specialty Corps Initiative had a significant increase in funding and thus allowed for an increase in the number of proposal with outstanding coverage of Food Safety projects.

Focus: Remained unchanged at 3.0
This portfolio's focus is largely determined by legislative mandates. The Food Safety program while working within these mandates is highly focused on the critical needs of

the nation. There is a degree of flexibility with National Integrated Food Safety Initiative (NIFSI) and AFRI competitive programs grants.

Contemporary and/or Emerging Issues: Remained unchanged at 3.0
This portfolio is at the forefront of addressing emerging Food Safety issues. For example, we identified Quantitative Assessment of Food Safety Intervention Technologies in Risk Management as a special emphasis area in 2009 NIFSI RFA in response to stakeholder input on the need for risk-based approach for reducing microbial loads in foods.

A second example is the Office of Science and Technology Policy (OSTP) call for the submission of 6 nanotechnology initiatives of which one is Food Safety. In consultation with NIFA administrators, we responded by submitting a white paper on the role and utilization of nanotechnology in food safety area to the OSTP.

Integration: Remained unchanged at 3.0
The Food Safety program is highly integrated. The Specialty Crops, NIFSI, AFRI food safety practical approaches, and SBIR grants are integrated.

Multi-disciplinary Balance: Remained unchanged at 3.0
The Specialty Crops Initiative has expanded the scope on the multi-disciplinary balance of Food Safety programs, to include such areas as sociology and economics. There has also been significant improvement in the education aspect of NIFSI portfolio.

Quality

Significance of Findings: Remained unchanged at 2.5
The improvement of Request for Applications (RFAs) resulted in increased linkage between NIFA Food Safety programs other agencies. External panel recommended to work toward increased linkages to for this dimension.

Stakeholder: Remained unchanged at 3.0
This portfolio has excellent collaboration with other agencies and private organizations.

Alignment with Current State of Science: Remained unchanged at 3.0
The portfolio team agreed upon this portfolio's high degree of alignment with issues and new technology techniques.

Appropriate and/or Cutting Edge Methodology: Remained unchanged at 3.0
Peer review is the hall mark of competitive programs. One of the criteria for awarding proposals is the use of state of the art methodologies in carrying out research.

Performance

Portfolio Productivity: Remained unchanged at 3.0

This is a highly productive portfolio. As measured by publications, patents, and outcomes, productivity by the food safety grantees is very high.

However, we can capture the outcomes/impact better, if CRIS and The Research, Economics, and Education Information System (REEIS) could make improvements in collecting information from grantees. The grantees need to do a better job at presenting their information in REEIS and CRIS.

Portfolio Comprehensiveness: Remained unchanged at 2.5
Given the resources, the portfolio is comprehensive as for reducing the microbial loads in food chain. However, we would benefit from including making connections with public health.

Portfolio Timeliness: Remained unchanged at 3.0
No comments were made by the portfolio team on this dimension during scoring session.

Agency Guidance: Remained unchanged at 3.0
No comments were made by the portfolio team on this dimension during scoring session.

Portfolio Accountability: Remained unchanged at 3.0
No comments were made by the portfolio team on this dimension during scoring session. There are concerns about the Current Research Information System (CRIS) and its ability to provide quality outcomes.

Appendix A – External Panel Recommendations to the Agency:

In response to directives from the Office of Management and Budget (OMB) of the President, NIFA implemented the Portfolio Review Expert Panel (PREP) process to systematically review its progress in achieving its mission. Since this process began in 2003, 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 NIFA is addressing the expert panel's recommendations. These internal reports are crafted to specifically address the issues raised for a particular portfolio; however, despite the fact that 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 NIFA 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 NIFA often do not highlight the contributions made by NIFA.
Multiple panel reports suggested NIFA better monitor reports of its funding and ensure that the agency is properly credited. Many panelists were unaware of the breadth of NIFA activities and believe their lack of knowledge is partly a result of NIFA not receiving credit in publications and other material made possible by NIFA funding.

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

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

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 NIFA material on the web. In addition, the new AREERA Plan of Work (POW) and Annual Report (AR) are fully functional. The agency requires a POW and AR on the four major research and extension formula funds; Hatch, Evans-Allen, Smith-Lever 3b&c, and 1890 Extension Programs. The reporting format and means of submission were substantially revised, they were restructured using an outcome-based, logic model design. They are collecting reports electronically via the internet using a database system. The purpose of this revision was not only to reduce the burden imposed on collecting the Plan of Work (POW) and Annual Report of Accomplishments (AR), but to make the information collected usable for NIFA program leadership and portfolio evaluation. Additional

benefits were realized, the information collected can be easily analyzed and assembled into a national report on the POW and AR for these formula funded programs.

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. Questions revolving around long-term planning between the entities were common as were ones that asked how the NIFA mission and goals were being supported through its partnership with universities and vice versa.

Issue 2: Agency Response:
NIFA has taken several steps to strengthen its relationship with university partners. First, to the extent possible, implementing partners will be attending the NIFA strategic development exercise which is intended to help partners and NIFA fully align what is done at the local level. Second, NIFA has realigned the state assignments for its National Program Leaders (NPLs). Each state is now assigned to one specific NPL. By reducing the number of states on which any individual NPL is asked to concentrate and assigning and training NPLs for this duty, better communication between state and NPLs should occur.

Finally, several trainings that focused on the POW were conducted by NIFA in geographic regions throughout the country. A major goal of this training was to better communicate NIFA goals to state leaders which will facilitate better planning between the universities and NIFA.

Issue 3: National Program Leaders
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. Understanding the specific job functions of NPLs was something that helped panelists in the review process. 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:
NIFA 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 NIFA requires of its NPLs, quick hires are not always possible. Often, NIFA is unable to meet the salary demands of those it wishes to hire. It is essential that position gaps be 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.

Issue 4: Integration

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. NIFA has recognized the need for these approaches and has undertaken steps to remedy this situation. NIFA has recently mandated that up to twenty 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. Finally, integration is advanced through the portfolio process which requires cooperation across units and programmatic areas.

Issue 5: Extension

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:

Outcomes that come about as a result of extension are, by the very nature of the work, more difficult to document than the outcomes of a research project. NIFA has recently shuffled its strategy of assigning NPLs to serve as liaisons for states. In the past, one NPL might serve as a liaison to several states or a region comprised of states. Each state will be assigned a specific NPL and no NPL will serve as the lead representative to more than one state. This will ensure more attention is paid to extension activities.

In addition NIFA also has been in discussion with partners and they have pledged to do their best to address this issue. The new POW will make extension-based results and reporting a priority. Placing heavy emphasis on logic models by NIFA will have the effect of necessitating the inclusion of extension activities into the state's POWs. This, in turn, will require more reporting on extension activities and allow for improved documentation of extension impact.

Issue 6: Program Evaluation

Panelists were complimentary in that they saw the creation of the Office of Planning and Accountability 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 firsthand that NIFA 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 NIFA 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 Planning and Accountability unit 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 NIFA 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 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 NIFA has begun to embrace program evaluation and over the coming years NIFA 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.

In addition to process developed within the Office of Planning and Accountability, NPLs have discussed methods for improved post award management and reporting. Many Agency Requests for Applications (RFAs) are now encouraging program evaluation and post award reporting of outcomes and impacts of funded activities. Steps are being taken to providing an electronic database that will make it easier to report outcomes and impacts of NIFA funded activities anytime after Agency funding for the project has ended.

Issue 7: Logic Models

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 NIFA 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 NIFA and we have been proactive in promoting the use of logic models to its state partners. Recent NIFA-wide 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

The system is now operational and states were required to begin using it by June of 2006. By requiring the inclusion of the data components listed above states are in essence, creating a logic model that NIFA believes will help improve both program management and outcome reporting.

OPA conducted a recent training seminar regarding logic model concerns. In October and November of 2005 four separate training sessions were held in Monterrey, California, Lincoln, Nebraska, Washington D.C. and Charleston, South Carolina. More than 200 people representing land-grant universities attended these sessions where they were given training in logic model creation, program planning, and evaluation. In addition, two training sessions were provided to NPLs in December 2005 and January 2006 to further familiarize them with the logic model process. Ultimately it is hoped these representatives will pass on to others in the Land-Grant system what they learned about logic models thus creating a network of individuals utilizing the same general approach to strategic planning. These materials also have been made available to the public on the NIFA website.

As a result of OPAs efforts to inform and educate NIFA staff about the logic model, NPLs have started implementing logic model use in RFAs, particularly in AFRI. These logic models are used as a planning tool for agency funded projects. RFA applicants, reviewers and awarders are able to grasp the progression of a proposed activity and define expected outputs, outcomes and impacts.

Appendix B - Detailed Funding Tables for Primary KAs – NIFA Funding:

NIFA Only Funding tables provide details of agency specific funding for a five fiscal year span for primary KA activities. The funding sources are agency ONLY funding sources. The grand total of these funding sources equals NIFA ADMIN funding that is included in the Overall Funding tables. Below are definitions for NIFA funding sources identified in the following funding tables.

- Hatch (HATCH) formula funds are allocated to the States, for the purpose of conducting agricultural research by the State Agricultural Experiment Stations. Hatch dollars are reported as expenditures in the following funding tables.

- McIntire-Stennis (MC-STN) are funds allocated to the States, for the purpose of conducting forestry research by schools of forestry, land-grant colleges, and State Agricultural Experiment Stations. McIntire-Stennis dollars are reported as expenditures in the following funding tables.

- Evans-Allen funds are allocated to the eligible institutions for support of agricultural research by the 1890 Colleges and Tuskegee University. These dollars are reported as expenditures to the Current Research Information System.

- Animal Health and Disease Program formula funds are allocated to eligible institutions for support of livestock and poultry disease research. These dollars are reported as expenditures to the Current Research Information System.

- Special Research Grants funds are awarded to eligible institutions for the purpose of conducting research to facilitate or expand food and agricultural research programs. These dollars are obligated funds reported in the Current Research Information System.

- National Research Initiative (NRI) Competitive Grants awarded to the eligible institutions for the purpose of conducting research emphasizing natural resources and the environment; nutrition, food quality, and health; plant systems; animal system; rural development, markets, and trade; and processing for value-added products. These dollars are obligated funds reported in the Current Research Information System. These dollars are obligated funds reported in the Current Research Information System.

- Small Business Innovation Research (SBIR) Program grants awarded to eligible institutions for the purpose of supporting high quality research proposals containing advanced concepts related to research on forests and related resources; plant production and protection; animal production and protection; air, water and soils; food science and nutrition; rural and community development; aquaculture; and industrial applications. These dollars are obligated funds reported in the Current Research Information System.

- OTHER NIFA funds are NIFA Administered funding programs not included in Hatch, McIntire-Stennis, Evans-Allen, Animal Health and Disease, Special Research Grants, National Research Initiative, or Small Business Innovation Research funding programs. These include cooperative agreements, and all other agency administered research grants awarded either competitively or non-competitively. These dollars are obligated funds reported in the Current Research Information System.

- Smith Lever 3(d) provides the opportunity for 1862 and 1890 Land-Grant Institutions, including Tuskegee University and West Virginia State University, and the University of the District of Columbia to compete for and receive extension funds. Smith Lever 3(d) funds became competitive in 2008, prior to that it was a non-competitive extension funding source for the previously mentioned institutions. These dollars are obligated funds reported in the Current Research Information System.

- Smith Lever 3(b) and (c) funds provide funding for agricultural extension programs at 1862 Land-grant universities. These dollars are reported as expenditures in the Plan of Work Annual Report.

- 1890 funds provide funding for agricultural extension programs at 1890 Land-grant universities. These dollars are reported as expenditures in the Plan of Work Annual Report.

KA 711: Ensure Food Products Free of Harmful Chemicals, Including Residues from Agricultural and Other Sources NIFA Funding						
Combined Research and Extension Dollars						
Formula-Expenditures/Grant-Obligations in Thousands						
Funding Source	**FY 2004**	**FY 2005**	**FY 2006**	**FY 2007**	**FY 2008**	**Total**
Hatch	890	849	774	872	1,034	4,419
McIntire-Stennis	0	0	0	0	0	0
Evans Allen	110	106	165	175	0	556
Animal Health	4	15	1	25	31	76
Special Grants	2,529	3,240	2,796	2,198	2,088	12,851
NRI Grants	667	665	404	297	339	2,372
SBIR Grants	0	296	184	394	120	994
Other CSREES	764	1,113	1,537	1,573	1,420	6,407
Smith-Lever 3(d)	n/a	n/a	n/a	0	0	0
Total Reported in CRIS	4,964	6,284	5,859	5,534	5,032	27,673
Smith-Lever 3(b) and (c)	n/a	n/a	n/a	1,149	1,103	2,252
1890 Extension	n/a	n/a	n/a	119	50	169
Total Extension Reported in POW-AR	n/a	n/a	n/a	1,268	1,153	2,421
Total (NIFA Admin)	4,964	6,284	5,859	6,802	6,184	30,094

*n/a = Funding data are not available for that fiscal year

KA 712: Protect Food from Contamination by Pathogenic Microorganisms, Parasites, and Naturally Occurring Toxins NIFA Funding						
Combined Research and Extension Dollars						
Formula-Expenditures/Grant-Obligations in Thousands						
Funding Source	**FY 2004**	**FY 2005**	**FY 2006**	**FY 2007**	**FY 2008**	**Total**
Hatch	3,076	3,196	3,124	4,043	5,594	19,033
McIntire-Stennis	0	0	0	0	0	0
Evans Allen	1,757	947	873	886	555	5,018
Animal Health	117	239	90	147	125	718
Special Grants	6,977	7,483	6,929	0	6,211	27,600
NRI Grants	6,195	11,970	8,604	7,086	9,096	42,951
SBIR Grants	305	555	579	849	410	2,698
Other CSREES	11,274	11,208	9,765	9,515	14,762	56,524
Smith-Lever 3(d)	n/a	n/a	n/a	0	0	0
Total Reported in CRIS	4,950	35,598	29,964	22,526	36,753	129,791
Smith-Lever 3(b) and (c)	n/a	n/a	n/a	4,213	4,870	9,084
1890 Extension	n/a	n/a	n/a	479	488	968
Total Extension Reported in POW-AR	n/a	n/a	n/a	4,693	5,359	10,051
Total (NIFA Admin)	29,701	35,598	29,964	27,219	42,112	164,594

*n/a = Funding data are not available for that fiscal year

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

Overall Funding tables provide financial information regarding outside funding sources and their contribution to agency activities, for a five fiscal year span. The grand total of these funding sources amounts to the total funding for agency activities, including internal and external funding.

- NIFA ADMIN funds are expenditures of formula grant and other grant funding administered by NIFA and distributed to the State Agricultural Experiment Stations (SAES) and Other Cooperating Institutions (OCI). The programs included are Hatch, McIntire Stennis, Evans Allen, Animal Health, Special Grants, Competitive Grants, Small Business Innovation Research Grants, Other NIFA grant, Smith-Lever 3(d), Smith-Lever 3(b) and (c), and 1890 Extension programs.

- Other USDA funds are expenditures of funds received by the SAES and other cooperating institutions from contracts, grants, or cooperative agreements, with one of the USDA research agencies other than NIFA.

- Other Federal (FED) funds are expenditures of funds by USDA agencies, the SAES and other cooperating institutions received from federal sources, outside of USDA, through contracts, grants, and cooperative agreements directly with other federal agencies.

- State Appropriations (APPR) funds are expenditures of funds by the SAES and other cooperating institutions received from sources outside of the federal government. Direct appropriations from individual state governments.

- OTHER NON-Federal (FED) funds are expenditures of funds by USDA agencies, the SAES and other cooperating institutions received from sources outside of the federal government. Sources include the sale of products (self generated), industry grants, and miscellaneous non federal sources.

KA 711: Ensure Food Products Free of Harmful Chemicals, Including Residues from Agricultural and Other Sources Overall Funding						
Combined Research and Extension Dollars						
$ in the thousands						
Funding Source	**FY 2004**	**FY 2005**	**FY 2006**	**FY 2007**	**FY 2008**	**Total**
NIFA Admin	4,965	6,284	5,859	6,802	6,184	30,094
Other USDA	403	356	604	707	522	2,592
Other Federal	1,692	1,635	1,441	1,776	2,617	9,161
State Appr.	5,411	5,023	5,601	5,852	4,808	26,695
Other Non-Fed	2,591	3,621	3,238	3,789	2,481	15,720
Total	15,985	16,918	20,283	17,658	16,612	87,456

KA 712: Protect Food from Contamination by Pathogenic Microorganisms, Parasites, and Naturally Occurring Toxins Overall Funding						
Combined Research and Extension Dollars						
$ in the thousands						
Funding Source	**FY 2004**	**FY 2005**	**FY 2006**	**FY2007**	**FY 2008**	**Total**
NIFA Admin	29,701	35,598	29,964	27,219	42,112	164,594
Other USDA	3,937	2,563	2,486	1,798	2,664	13,448
Other Federal	5,745	7,620	7,942	6,011	7,492	34,810
State Appr.	22,470	20,406	20,538	21,457	25,954	110,825
Other Non-Fed	8,076	7,158	6,992	7,891	11,085	41,202
Total	69,929	73,344	67,922	59,683	89,307	360,185

Appendix D - List of Supporting Programs:

Since food safety is an issue cutting across the agriculture system (from soil/water to food ready for consumption) several NIFA programs cross cut with food safety. The cross cutting areas support food safety portfolio,

Name of Program	Description of Program
Agriculture and Food Research Initiative (AFRI)	AFRI Food Safety Program supports research to enhance the knowledge of mechanisms of pathogenesis in food borne illness eventually aimed at risk mitigation measures. AFRI Food Safety Program also supports an integrated approach to enhance epidemiological methods available for the study of food-borne diseases and antibiotic resistance,
National Integrated Food Safety Initiative (NIFSI)	This program supports food safety grants that integrate research, education and extension to solve problems in applied food safety issues driven by stakeholders from farm to fork.
HATCH Formula Funds	Hatch Act funds are provided for agricultural research on an annual basis to the State Agricultural Experiment Stations (SAES's). A quarter of these funds are allocated for the Multistate Research Fund which provides funds for cooperative research employing multidisciplinary approaches conducted by the SAES. For fiscal year 2008, the Hatch formula funds expended/obligated in food safety area were $ 6.6 million and the contribution of the State for this period was at $ 25.9 million.
Evans-Allen Formula grants	Evans-Allen formula grants support agricultural research at the 1890 land grant institutions. The scope includes all agricultural areas with food safety being one of them and the priorities originate from the States. Evan-Allen funds expended/obligated in food safety area in year 2008 were $ 0.55 million.
Smith-Lever Funds	These funds are appropriated on a n yearly basis for to cover the entire area of agriculture. Like other formula funds the priorities originate from the States. The amounts expended/obligated for food safety in 2008 was approximately $ 6.0 million.
Animal Health	This program supports the health of livestock, poultry, horses, fish, and other agriculturally important commodities through research, education, and extension activities.
Animal & Plant Biosecurity	This program assists in monitoring and preventing intentional disease outbreaks, as

	well as, working with its partner institutions to focus on disease transmission and detection; plant and animal disease diagnosis; the extension of disease information to producers, and information outreach to the public.
Animal Manure Management	Animal manure is the prime source of food borne pathogens. Composting of manures cuts across the food safety.
Aquaculture	This program provides leadership and funding for aquaculture research, technology development, and extension programs. Seafood and fresh water fish are number two in causing food borne illness
Education, International Science	This program supports res activities to enhance the capabilities of American colleges and universities to conduct international collaborative research, extension and teaching programs.
Higher Education	Supports the training of under graduate and graduate students in food safety.
Improving Food Quality and Value/Nanotechnology	Develops new technologies and in processing, packaging, and retail distribution. FDA and FSIS require that all new technologies meet minimum food safety requirements.
Integrated Pest Management	This program provides leadership for a broad portfolio of Integrated Pest Management (IPM) programs. The goals of the program map to the National IPM Roadmap and are: 1) to improve the economic benefits related to the adoption of IPM practices, 2) to reduce potential human health risks from pests and the use of pest management practices, and 3) to reduce unreasonable adverse environmental effects from pests and the use of pest management practices.
Nanotechnology Scale Science and Engineering	NIFA manages four grant programs that fund nanotechnology research projects. It also participates on the Nanoscale Science, Engineering, and Technology Subcommittee of the White House National Science and Technology Council and the National Nanotechnology Initiative.
Water Quality	This program seeks to improve the quality of our Nation's surface water and groundwater resources through research, education, and extension activities.
Water and Watersheds	This AFRI program aims to protect and enhance the natural resource base and the environment by improving and maintaining healthy watershed habitat and water supply protection and to improve the quality of life in rural America through clean

	irrigation and livestock drinking water supplies.
Specialty Crops Research Initiative (SCRI)	The Initiative has five focus areas: research in plant breeding, genetics, and genomics to improve crop characteristics; efforts to identify and address threats from pests and diseases, including threats to specialty crop pollinators; efforts to improve production efficiency, productivity, and profitability over the long term; new innovations and technology, including improved mechanization and technologies that delay or inhibit ripening; and methods to prevent, detect, monitor, control, and respond to potential food safety hazards in the production and processing of specialty crops.
1890 Capacity Building Program	This program strengthens teaching and research programs in the food and agricultural sciences by building the institutional capacities of the 1890 Land-Grant Institutions, Tuskegee University and West Virginia State University.

Appendix E - Partnering Agencies and Other Organizations:

Food Safety Portfolio - Partnering Agencies and Organizations		
USDA Agencies	**Non-USDA Federal Agencies**	**External Organizations**
ARS: Collaborated in prioritizing research, education and extension activities FSIS: Collaborated in prioritizing research, education and extension activities in meats, poultry and egg products.	FDA: provided direct support to a priority in 2009 in AFRI Food Safety. Also provided input for priorities for specialty crops and NIFSI programs in the safety of fresh produce.	Various institutions and international entities provided input on the status of antimicrobial resistance in food chain and recommendations for future direction.

Appendix F - Program Evaluations:

Portfolio Program Evaluations

1. For special Emphasis Research Grant made to a consortium of four Universities led by the University of Georgia, NPLs have participated in quarterly teleconferences and participated in the face-face meeting of the technical/advisory committee on August 7, 2008 held in conjunction with the Annual Meeting of the International Association of Food Protection (IAFP) in Columbus, OH, to assess the progress of the grant made in 2007 under the NIFSI program. In general, the progress was very good. The following recommendations were provided by the committee and the NPL.

- Drop the bacterial phage experiment to control the E. coli on the surface of manure composts, since the preliminary results were not encouraging. The project director and other PIs felt that this was a good recommendation and indicated that they would drop the experiment and redirect the resources to other experiments within the manure compost area.

- While the internalization of E. coli by lettuce leaves was demonstrated in the laboratory experiment, the committees raised a number of questions in order to steer the experiment reflect field conditions, while appreciating the difficulties involved.

- In addition to the meeting above, a Special Session of a Round Table on Leafy Greens: An Integrated Risk Management Approach was held by the grantees under the aegis of this grant.

2. At the same IAFP meetings (see above), The PI of a special research grant at Cornell was asked by the NPL to organize a stakeholder input meeting in order gain a better insight into the direction of the research and outreach. The PI contacted several potential stakeholders including, CDC, Industry, Universities, and FDA. Representatives from all the entities were represented at the IAFP Meeting.

- There were a variety of suggestions to improve the project but the one that stood out was an increased collaboration with CDC to enhance attribution in the area of food borne illness, especially in the area of molecular epidemiology.

  We continued to evaluate this program in 2009. More specifically, we convened a workshop of all the sub-projects within this project at the International Association of Food Protection in August of 2009. In addition, at this meeting we met several PDs form different grants in food safety and had informal talks on the progress.

3. An on-site review was conducted by the NPL for a grant provided to the University of Minnesota in Food Defense area in 2006 under the NIFSI program. The goal of this grant was to evaluate the usefulness of the Association of Food and Drug Officials (AFDO) web-based system to provide timely access to information and identify specific gaps in

threat prevention activities, identify and meet educational needs of food regulatory personnel, and enhance the ability of the National Environmental Health Association (NEHA) and the Extension Service to provide food protection and defense outreach activities to their stakeholders.

- The investigators were making excellent progress and no suggestions were made to change the course. As per the 2007/08 progress report, they have built a "food shield" -a web-based platform that is creating community between the varied entities that make up our national food and agricultural sectors. Secure, integrated resources give state departments of agriculture and health and their affiliated laboratories the ability to communicate and coordinate with their peers in other states.

4. During routine review of the Food Science and Technology programs at Land Grant Universities, projects funded by the Food Safety Portfolio program were also part of the broader cursory review. These institutions included: North Carolina State University, University of Idaho, University of Nebraska, Purdue University, Rutgers University, University of Wisconsin, Iowa State University, and Oregon State University.

5. In April of 2009, along with the Ohio State University, we co-sponsored a Conference on the Antimicrobial Resistance in the Food Chain in Washington DC. The conference involved scientists from Land Grant Universities, ARS and International Organizations. The conference was inaugurated by the Administrator of CSREES.

- The main outcome of this Conference was a set of recommendations for future research, education and extension activities. We have carefully considered these recommendations and in collaboration with ARS NPL, we were able to craft the language for the 2010 NIFSI RFA to include antimicrobial resistance a s a priority item.

Appendix G – List of Stakeholder Groups Consulted:

Stakeholder Groups	Year Consulted
Veterinary Deans of Research	2009
Council of Food Science Administrators	2009
Institute of Food Technologist - Project Directors	2009
International Association for Food Protection – Project Directors	2009
Peer Review Panel/Panel Manager's Report	2008
Industry/Producers/Processors	2008
Federal Agencies: *Food and Drug Administration*	
Food Safety and Inspection Service	
Agricultural Research Service	

Appendix H - Documentation of Previous Score Changes:

2008 Portfolio Score Change Discussion

In the area of Integration (1.4), the portfolio self assessment team decided to raise the score from 2.5 to 3.0. The rationale for the increase is from several angles. First, both the quality and the quantity of the integrated proposals funded increased from fiscal year 2006 to 2007. For example in 2007, the National Integrated Food Safety program awarded two large special emphasis grants in the amounts of $ 2.5 million each for addressing the spinach and lettuce E. coli contamination issue in a highly integrated manner involving stakeholders who participated in the beginning of the proposal writing and are currently serving on the advisory committees for the projects. These projects are integrated for both outreach and research to draw up on the success of each other. In a short period of time, these projects are already yielding encouraging outputs which are very likely to lead a solution to the issue. Second, in the same vein, epidemiological approach to food safety program, which typically made research grants previously, has awarded grants with research and outreach components addressing the safety of fresh fruits and vegetables. Third, even though the NRI water program is offered as a research program, recent research funded at UC Davis on water borne pathogens was immediately moved into extension outreach during the spinach E. coli outbreak in California to share latest research on setbacks of livestock from irrigation streams and fields with fresh produce at numerous public meetings and fact sheets.

The team also increased the score for Multidisciplinary Balance (1.5) from 2.5 to 3.0. A large majority of the grants made in 2007 were not only multidisciplinary but also multi-institutional, multistate and multifunctional. This is especially apparent in the epidemiology and NIFSI grants. Selected examples are: 1) an integrated NIFSI grant made to the University of Georgia as the lead institute, included Illinois Institute of Technology, Clemson University, Michigan State University and National Center for Food Safety and Technology (FDA). The disciplines represented in this project are: microbiology, biochemistry, statistics, food technology, animal waste utilization, plant science, and extension. 2) Food safety priority area of NRI 75.0 Nanotechnology program has typically supported multidisciplinary research projects involving physical, chemical, biological, materials, and food scientists to develop nano-based sensors for monitoring safety and quality of foods, especially in real time. 3). Many water pathogens relating to irrigation for food production and processing studies use multiple expertise of microbiologists, veterinarians, engineers, modelers, animal scientists and horticulture specialists.

During the discussion, the team members brought up compelling reasons for increasing the score of Significance of Findings (2.1) from 2.0 to 2.5. Primary reason was the outputs that came from grantees in food security area. Critical food safety biosecurity measures have been developed since September 11 to prevent food terrorism, including surveillance, testing, training of producers and processors. Documented cases of attempted intentional food contamination and intervention have been addressed, and training to avoid future events has been implemented. A classical example is the results

obtained by the University of Minnesota investigators in successfully developing the contents of the FoodShield, a web-based interactive networking for food professionals and regulators. We are confident that we would be using the outcomes of the project in the near future.

Likewise, the team increased the Portfolio Productivity score from 2.5 to 3.0. A significant addition this year is the capturing of extension funds expended on the food safety activities. In 2007, approximately $6.0 million were spent in food safety outreach activities. Significant activities are reflected in the document under portfolio activities, outputs and outcomes. Also in 2008, NRI nanotechnology program funded in excess of $1.0 million for development of nanotechnology based sensors for detecting intentional and unintentional contamination of foods. Development of a nano method to detect prions in the blood of cattle with mad cow disease is cited in the document.
Scores for Portfolio Comprehensiveness (3.2) and accountability (3.5) were also increased from 2.0 to 2.5. The grantees continued to leverage other resources using NIFA as base. In spite of a decrease in the NIFA funding for the portfolio, the leveraged money from non-NIFA sources remained about the same (Table 1). Thus, even though the amount of NIFA funds was relatively small, the grantees covered a broad spectrum of research, education and extension activities outlined in the document. They are linking USDA projects to other funding to expand the impacts. As for accountability, completed projects are now reviewed through CRIS reports on a timely basis. Further, modifications to the CRIS system are expected to further enhance the quality of information that can be retrieved. Additionally, project directors' meetings are being conducted for each competitive program to measure the progress. Grantees' meetings enhanced the sense of accountability among grant recipients.