North Carolina Agricultural Research Service

Annual Report of Accomplishments and Results

2006

AREERA REPORT

Agricultural Research, Education, and Extension Reform Act

North Carolina Agricultural Research Service
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Introduction and Certification

North Carolina State University is North Carolina's 1862 land-grant university and the only Research I land-grant institution in the state. The North Carolina Agricultural Research Service (NCARS) within the College of Agriculture and Life Sciences serves not only as the college's agricultural, environmental and biological sciences research arm but also provides the research foundation in these areas for educational activities within academics and extension. NCARS is the principal state agency for research in agriculture, life sciences and forestry. Its research projects involve North Carolina State University's colleges of Agriculture and Life Sciences, Forest Resources, Physical and Mathematical Sciences, Engineering, and Veterinary Medicine and the School of Human Environmental Sciences at the University of North Carolina-Greensboro. Within the college, NCARS coordinates research in 18 departments and works in partnership with the North Carolina Cooperative Extension Service and Academic Programs.

The mission of NCARS is to develop the knowledge and technology needed to:

- improve the productivity, profitability and sustainability of industries in agriculture, forestry, and life sciences;
- conserve and improve the state's natural resources and environment; and
- improve the health, well-being and quality of life of all citizens of North Carolina.

In FY 2006 NCARS personnel include 392 tenured and tenure-track research faculty accounting for approximately 191.6 full-time scientist equivalents, most on shared appointments with academics or Extension. Working with these faculty members are over 541.4 research professors, researchers, research assistants, professional support staff and graduate students; 432.6 laboratory or field technicians, and other technical support; and 132 clerical/other staff. These faculty members and support personnel conduct basic and applied research in 627 projects to support more than 70 commodities as well as many related agribusinesses and life science industries.

The following AREERA Annual Report of Accomplishments and Results corresponding to the 2005-2006 Plan of Work Update, highlights accomplishments and impacts of research conducted through the North Carolina Agricultural Research Service and emphasizes the high priority areas in agriculture and life sciences for North Carolina now and in the near future.

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A. Planned Programs

National Goal 1: An Agricultural System that is Highly Competitive in the Global Economy

Overview: Animal and Plant Production Systems

Plant Systems

North Carolina has always had a strong agricultural economy however, it has become more diverse to meet the demands of a changing population and market opportunities. Growers have diversified into many specialty crops including medicinal herbs, specialty melons, heirloom fruits and vegetables, various crops for the state's growing Hispanic and Oriental populations, kenaf, sea oats and grapes for wine and nutraceutical properties. Additionally consumer concern over food quality and nutrition has fostered an increasing demand for organically produced fruits and vegetables. While this diversification has been good for North Carolina growers, it has placed demands on the NCARS to develop sustainable programs for producing, protecting from and managing pests and pathogens, harvesting, storing, and marketing these commodities. The introduction of new pests and the development of pests resistant to commonly used pesticides are also providing NCARS scientists challenges to provide management strategies for them.

The performance goals under the AREERA Goal (1a) plan of work address needs of North Carolina growers which will allow them to remain competitive in a national and global agricultural economy and take advantage of local marketing opportunities through more efficient production practices and diversification to alternative and specialty crops. The target audience for this research is the producers of field and horticultural crops in North Carolina. However, much of the research will have regional, national and international impact. Additionally, North Carolina consumers will benefit through increased diversity of fresh, locally grown produce in the marketplace.

Performance goal 1 focuses on the development of improved pre- and post harvest handling techniques for field, fruit, specialty and vegetable crops.

- Fundamental technologies in cultural practices and sampling methodology have been used to reduce specific off flavors in peanuts. The impact of specific aromatic compounds causing specific off flavors has contributed to understanding of the off flavor and may lead to cheaper methods to identify peanuts with the off flavor. Consumers have been made aware that there is no concern for trans-fats in peanut butter and this will result in enhanced or continued stable markets. Information on descriptive sensory and US and European consumer acceptance of US peanuts constitutes the current most valuable marketing tool for export of US peanuts.

Performance goal 2 addresses improved production management systems for field, fruit, vegetable and specialty crops and includes a wide range of projects that focus on various management practices.

- Systems to improve forecasting disease risk for downy mildew on cucurbits, turf diseases and foliar diseases of peanut are being developed and tested. These models save growers thousands of dollars in reduced sprays and reduced losses as well as being a plus for the environment.

- The Plant Micropropagation Unit in the Department of Plant Pathology is a major source of strawberry propagation material for many strawberry plant producers in North Carolina and Florida producing over a million plants each year.

- Weed management systems have been developed to preclude and or control glyphosate-resistant common ragweed, and common lambsquarter, two of the most common and problematic weed species in North Carolina crop production.

- Multiple applications of foliar insecticides on sweetpotatoes were shown to provide no additional protection against root feeding insects. A procedure was developed for controlling the key root-feeding insect pests using a single properly timed, post-planting soil insecticide treatment. This finding will enable growers to eliminate foliar sprays, which consist primarily of organophosphate, and chlorinated hydrocarbon insecticides currently targeted by EPA under the Food Quality and Protection Act

- Field studies at two locations in eastern and western North Carolina confirmed that a starter fertilizer with additional potassium increased rooting depth by 1-2 inches, root volume by 15%, and grain yield by 22 bu/acre. Statewide yield data indicates that the use of starter fertilizer and increased seeding rates increased state average corn yield by 4 bu acre-1 in 2006 with a farm gate value of $3.1 million.

- The critical period of grass, broadleaf, and grass and broadleaf interference in peanut and the temporal aspects of such interference on crop and weed biology was determined. The critical period of grass and broadleaf weeds in cotton was also determined, as was the critical period of weed interference in cotton as influenced by narrow (15-inch) and wide row (36 and 38- inch), and the temporal aspects on such interference on weed and cotton biology.

- Glyphosate resistance in Palmer amaranth was confirmed in NC, the in-state distribution of resistant biotype was determined, and research was conducted to develop management systems and education programs for growers of cotton and soybean.

- Research conducted over the past three years identified the key components of a corn cropping system based on plant populations over 30,000 plants per acre, banded starter fertilizer, and careful seed placement to achieve uniform plant spacing. This research found that corn growers could increase yield by 22 to 27 bushels per acre using this system compared to previous corn management practices. Given the yield increases experienced by growers in 2006 and a corn price of $3.50 per bushel this research and extension project has produced an economic gain of $3,150,000 in 2006.

- A long-term breeding effort for early blight resistance in tomato has resulted in the release of three varieties, Mountain Supreme, a large-fruited type, and Plum Dandy' and 'Plum Crimson', Roma-types for fresh market. Studies with Mountain Supreme have shown effective control of early blight with a 10-day spray schedule versus the 5-day schedule needed for control of early blight on susceptible varieties in western North Carolina.

- The amount of tomato spotted wilt virus that is spread to susceptible crops in spring was shown to be determined by the number of TSWV infected weeds growing in the vicinity, the abundance of thrips vectors of TSWV dispersing from those weeds, and the age of the crop at the time the infectious thrips disperse. Preliminary evidence indicates that both the thrips populations and the

amount of TSWV spread in winter weeds are determined by winter and spring temperatures and rainfall. These findings indicate that it should be possible to predict TSWV outbreaks based on winter and early spring temperatures and rainfall.

- The fertility parameters which provide sufficient but not excessive growth of the wetland plants *Iris virginica* var. *shrevei* and *Juncus effusus* in nursery production were studied. The results of this study showed that there is no obvious reason to fertilize wetland species at rates above the minimum recommended for the product. This knowledge allows reduced expense for fertilizers and less chance of losses to the surrounding environment.

- A rootworm advisory program that provides sound decision-making principles for southern corn rootworm insecticide use on peanut has been developed and reduced unnecessary insecticide use by 49%. The tomato spotted wilt virus risk index has been validated and presented to growers and the incidence of tomato spotted wilt virus has been 50% lower since the introduction of this index.

- Powdery mildew and leaf rust are foliar diseases that regularly cause significant losses to wheat producers in the eastern U.S. Seed mixtures of resistant, lower-yielding varieties and susceptible, higher-yielding varieties may stabilize yields across diverse environments, better exploit available resources by compensation, and reduce the need for expensive and environmentally unsound pesticide applications. Research over 2 years indicates that wheat variety mixtures can offer a yield advantage in diverse North Carolina environments, especially those in the Coastal Plain. Across 2 years and three test sites, mixtures have significantly outyielded pure stands.

- Brown stink bug can seriously affect the yield and quality of corn and soybean, and perhaps wheat. Since brown stink bug moves in and out of crops throughout the season and has three generations a season, growers must recognize the bug's behavior and requirements in order to efficiently detect and manage the pest. Studies showed that bugs move among differing fields as early fruiting varieties became mature and late fruiting varieties began to develop pods. This knowledge enables growers appropriately manage the bug and improve the sustainability of the farming enterprise.

- Commercial blackberry acreage has more than doubled in North Carolina in one year. In response to this growth in the commercial blackberry industry a budget was developed for the costs associated with growing, harvesting and marketing 10 acres of blackberries. This analysis showed that if growers received a wholesale price of $14.00/flat they would receive a return to land and management of $9,085/acre for the third through tenth years with a marketable yield of 9,000 lb/acre. The annual net cash flow is positive after the planting is established and enough revenues are projected to be generated to cover start-up expenses in the 4th year.

Performance goal 3 focuses on improving the acceptability and quality of field, fruit and vegetable crops.

- Two potential sources of resistance to soybean rust have been identified by performing screenings of germplasm in Argentina, Brazil, NC, and Georgia. Lines derived from the crosses of those resistant sources have been crossed with an adapted high yielding (MG 5.6) soybean cultivar. These new lines will be screened for rust resistance in Argentina in the winter of 2007.

- Eighty independent lines of peanuts with resistance to Tomato Spotted Wilt Virus have been obtained. Also the progenies for T_2 generation for TSWV transgenic plants have been harvested. Resistance of seedlings to TSWV was confirmed, and at least 19 independent lines showed complete resistance. In 2006, the T_3 generation was produced in the greenhouse.

- Biennial bearing, or the production of flowers (and therefore a crop) in every second year, is a common problem on several important fresh market apple varieties suited to the Southeast. Studies to evaluate the potential for various plant growth regulator treatments to promote flower bud formation in the heavy bloom year of a biennial bearing cycle on Fuji, Golden Delicious, Cameo and Mutsu identified several promising treatments.

- Peanut cultivars developed by scientists at NCSU were grown on over 74% of the seed acreage under production in North Carolina in 2005 (an estimate of commercial production in 2006) and on over 73% of the seed acreage in the Virginia-North Carolina Production region. Virginia-type peanut production in South Carolina was almost exclusively NC-V 11, an NCSU release.

- Functional genomic analysis of aflatoxin producing fungi and molecular studies of corn are elucidating novel strategies for resistance to or suppression of aflatoxin in corn.

- A newly registered synthetic cytokinin material (6-BA) continued to show great promise as a post-bloom thinning material on both Gala and Fuji apples; the latter cultivar has been difficult to thin with traditional post-bloom thinning materials.

- Corn lines with good resistance to ear rot caused by the fungus *Fusarium* were found that also tended to have good resistance to ear rot caused by the fungus *Aspergillus*, which makes the mycotoxin aflatoxin.

- Four freezing tolerant oat lines that are significantly hardier than both parents were identified. The freezing tolerance of two of these lines has tentatively been confirmed in the field in international uniform nurseries. This germplasm will eventually allow successful culture of winter oats as far north as Pennsylvania and in regions of the world where oats have never been grown.

- Research on watermelon pollenizers identified several cultivars which can be used to optimize triploid pollenization and fruit set. Individual pollenizers work better than combining pollenizers in most cases. Planting arrangement and pollenizer choice impact watermelon fruit quality by helping to reduce hollow heart.

- North Carolina is a leading state in the production of cantaloupe, and the 'Sprite' melon has been important in specialty markets. A research program was initiated in 2002 to develop new hybrids of the 'Sprite' type for use by North Carolina growers and four new hybrids are now being released: 'NC-Sparta' (medium size fruit), 'NC-Sapphire' (large fruit), 'NC-Star' (small fruit), and 'NC-Stella' (round fruit). They are oriental crisp-flesh melons with white skin, white flesh, and high sugar content. Growers should be able to test the varieties in small areas in 2007, and obtain seeds in larger quantities in 2008.

Performance goal 4 includes research projects that are related to the development of improved production management systems for ornamental and floricultural crops and turfgrass.

- Novel genes were employed to obtain transgenic tall fescue plants highly resistant to the pathogens of two major fungal diseases in turf lawn: brown patch and gray leaf spot. Brown patch is the most important turfgrass disease in the area and gray leaf spot is becoming a more and more severe disease for golf courses nationwide.

- A novel technology to quickly cool harvested sod, with the goal of increasing "shelf life" was developed. This work documents a dramatic and persistent effect on sod temperature, and has generated considerable interest within the NC sod industry.

- In cooperation with the NC Sod Producers Association, the TifSport Growers Association and the NC Turfgrass Foundation, NC State University initiated a study to evaluate eight cultivars of bermudagrass currently being grown for use in the mid-Atlantic region. This study is providing sod producers and end users with information from which to make decisions about what cultivars to use on several thousand acres of new bermudagrass area which are planted each year. Lawn care and landscape maintenance companies use this information to make adjustments in their approaches to disease management and nutritional/pesticide interactions.

- Researchers conducted cultivar studies for 5 years to identify adapted eastern honeydew melon with superior qualities that would result in additional market opportunities for North Carolina growers. At least five honeydew varieties with superior qualities have been identified. These are promising candidates for additional commercialization in the East.

- A variety of slow release nitrogen fertilizer materials which can eliminate or greatly reduce any potential environmental impact by preventing off-site loss was evaluated on turfgrass. Many of these materials have been previously been classified as "secondary" or "alternative" or "waste" products. All turfgrass areas are potential users of these materials which provide an alternative to their conventional disposal.

Performance goal 5 focuses on the development and introduction of superior landscape plants to enhance rural and urban environments. The two projects under this goal focused on the evaluation of plants for the landscape in the Southeastern United States, which is one of the missions of the J.C. Ralston Arboretum at North Carolina State University, and evaluation of trees species for planting in the various regions of North Carolina.

- *Cercis canadensis*, the eastern redbud, is a popular landscape tree. It is a native plant, relatively small in stature, and drought tolerant with considerable genetic diversity. This genetic diversity in redbud has been exploited to develop novel landscape types through habit. These new forms of redbud that are being developed and trialed in the program should be readily accepted in the nursery trade, and provide an economic stimulus for the nursery industry. Development of these new forms will provide consumers with additional landscape options and uses for this versatile native plant.

- Research on selection and development of pest resistant plants has essentially eliminated the need for pesticides to control apple scab, dogwood anthracnose, fire blight, powdery mildew, Japanese beetles and Eastern tent caterpillar on a variety of landscape plants

Animal Systems

Faculty and staff at North Carolina State University have been engaged in a wide array of research and related projects to increase the competitiveness of North Carolina animal agriculture and improve its global economic position. These efforts are very broad in scope, impact, and clientele served. Major concerns include improving animal health, production efficiency, and profitability while at the same time improving overall environmental conditions and ensuring the sustainability of our rural communities. These concerns receive intense effort for integrated animal agriculture as well as for diversified,

alternative, and small independent producers. Projects are conducted within university campus resources and across the state working cooperatively with North Carolina producers, citizens, and other stakeholders.

The North Carolina State University Animal and Poultry Waste Management Center (APWMC) was established to address waste management issues, to find ways to ensure the vitality of the state's important animal and poultry production industries, to seek opportunities for adding value from waste byproducts, while also protecting the environment. North Carolina State University, College of Agriculture and Life Sciences in cooperation with the USDA-Agricultural Research Service has been conducting research and demonstrations of alternative waste treatment systems components for more than 15 years. Two of the these prototype systems were selected as "promising technologies" and funded to be installed as full scale, on-farm demonstrations and evaluations under the Smithfield Foods/NC Attorney General Agreement. Additional studies not under the APWMC umbrella have also been conducted.

- Research efforts to identify and implement "Environmentally Superior Technologies" (EST) were initiated in 2000 by the Attorney General of North Carolina by an agreement with Smithfield Foods and its subsidiaries, and a similar agreement with Premium Standard Farms. A third agreement related to similar EST objectives was established between the Attorney General of North Carolina and Frontline Farmers in 2002. Performance standards defined in the Agreements mandate that successful EST address environmental variables including the discharge of animal waste to surface waters and groundwater; emission of ammonia; emission of odor; release of disease-transmitting vectors and airborne pathogens; and nutrient and heavy metal contamination of soil and groundwater. Comprehensive determinations of economic feasibility are also mandated by the Agreements. Targeted economic variables include projected 10-year annualized cost for each technology; projected revenues from byproduct utilization; available cost-share monies; and the impact that the adoption of the EST may have on the competitiveness of the North Carolina pork industry as compared to the pork industry in other states. One of the processes that met the technical performance criteria developed under the Agreements is the Super Soil System that includes solids separation, nitrification-denitrification, soluble phosphorus removal, and solids processing (composting). However, this system has so far not met the economic feasibility criteria.

- Nutritional programming in chickens for manipulation of dietary components such as Phosphorus provides a mechanism to improve nutrient utilization and reduce the impact of animal agriculture on the environment. Epigenetic manipulation may be useful in many areas of animal nutrition.

- Research to access the impact of antibiotic resistance bacteria and pathogens on animal and human health specially associated with Concentrated Animal Feeding Operations in agricultural areas has resulted in preliminary baselines for both animal and non-animal agriculture (row crop) communities. In addition to identifying bacteria/pathogens present in the agricultural areas and their resistance to antibiotics currently available, potential environmental and economic risks can also be identified.

- Sponsored research conducted on a commercial scale animal waste treatment production operation has resulted in value engineering applications to a nitrification / de-nitrification / phosphorus removal technology. The system is fully operational and has been objectively demonstrated to meet environmental standards involving the nutrients nitrogen and phosphorus and emissions of odor and ammonia. The value engineering application is resulting is lower capital and operational cost of the technology system.

- North Carolina State University has conducted evaluations of on-farm demonstration projects for innovative swine waste treatment. With high public and political interest in swine waste management, and the possibility of much misinformation from self-interest groups and unrealistic expectations from legislators and regulators, it has been very important to accumulate and present factual and unbiased information.

- Trace mineral concentrations can be reduced considerably in nursery and grow-finish swine diets without reducing production. Excretion of zinc and copper in swine waste can be reduced by 30 to 50% as a result of reducing trace mineral supplementation. This will lead to a savings of over one million dollars in feed cost in North Carolina per year and improve the sustainability of swine production by reducing concentrations of zinc and copper in swine waste.

Numerous studies focused on improving animal health were conducted.

- Rearing broilers on traditional floor litter and feeding whole triticale encouraged the growth of a more diverse community of bacterial species with less *Salmonella* colonization whereas the intestinal microbial community of broilers raised in cages was not influenced by the dietary treatments. Moreover, broilers reared on litter and fed finely ground grain diets, regardless of grain type, had lower microbial community diversity but higher *Salmonella* populations than did those fed whole triticale.

- Development of very accurate molecular markers to classify the MHC genotype of chickens from around the world has provided the means to independently genotype birds of unknown origin in remote areas allowing for the rapid identification of genetic associations between innate antibody response and disease resistance.

- North Carolina is one of the leading states in the swine industry. Economically, improving nutritional management and reducing mortality of neonatal piglets have far reaching significance. Knowledge from this research will help us further understanding of fatty acid metabolism in neonatal piglets and exploring the ways and means of improving piglet health and nutrition management of the neonates.

- Feed digestibility directly affects the feed efficiency, the animal growth rate and the economics of animal production. A keratinase enzyme discovered was produced in large quantity. From a series of experiments, the keratinase preparation as feed additive was proved to be effective to improve feed digestibility and chicken growth. A commercial enzyme has been developed that can promote animal growth on the regular diet and maintain the normal growth on a low protein diet. It has the potential to save feed cost $3 billion a year worldwide for poultry and swine production.

- A potentially unique effect of a probiotic on the systemic immune system of the broiler has been identified. Preliminary data suggest that probiotics causes the immune system to use less resting energy in a resting state; however, when challenged by an antigen, the immune system reacts more vigorously than in non-probiotic supplemented birds, causing increased energy utilization and more antibody production.

- Dietary inclusion of whole grain or coarse ground corn at a level of 5% improved feed efficiency and early growth of broilers and turkeys, and also increased resistance to salmonella colonization by favoring the proliferation of symbiotic enteric microflora without the use of antibiotics. This

technology can reduce feed costs by about $.01 per bird, or over $4.5 million per year if applied to all broilers and turkeys produced in North Carolina.

A number of projects involved improving animal production efficiency or profitability. With over 60% of farm gate receipts coming from animal production, this work is very important to the farm economy of North Carolina.

- The progression of the Dairy Records Processing System (DRMS) has resulted in continued growth in the dairy sector, with a monthly presence on 59 percent of North Carolina dairy farms, and a similar penetration in many of the 45 states served by DRMS. This pace has continued even as dairy farm operators are experiencing growing herd sizes, tighter margins, and increased complexity of modern dairy practices.

- Identification of chromosomal regions associated with growth, bone density, breast yield, fatness, as well as many other carcass and metabolic traits has provided the basis for marker assisted selection to improve the growth rate or bone integrity of future poultry stocks.

- Supplementing rumen-protected choline significantly increased milk yield in multiparous early lactation Holstein cows fed methionine-limited diets. Information gained from these studies will be used to develop feeding recommendations to improve growth and health in dairy calves and increase milk yield in cows.

- An NCSU Feed Science and Management program has been developed that will be used to train individuals from North Carolina and the Eastern United States who wish to stay within the state or region and work in the Feed Industry. Companies will save $100,000 per person in training costs and reduce the training period by 2-3 years by hiring individuals with feed manufacturing knowledge gained from this program. In addition to on-campus training for students, the program will provide Distance Education and Extension Workshops through Web-based technology allowing employees to further their education while working in the feed milling or allied feed industries.

- A potential mechanism that may underlie large offspring syndrome (LOS) in cattle has been identified. The expression of genes that normally control fetal growth has been documented. The expression of these genes appears to be greater for LOS fetuses compared to the expression found in normally growing fetuses.

- Byproduct feeds remain an important part of beef cattle feeding programs both in North Carolina and in surrounding states. Development of the ethanol industry and the resulting increase in the price of corn has increased the importance of byproducts to beef producers even more. Dry and wet corn gluten feed are economically viable feed ingredients for use in beef finishing diets. This information has led to increased adoption of those ingredients in cattle diets.

- A recently completed long-term study comparing a new non-toxic infected fescue known as MaxQ to toxic infected fescue and endophyte-free fescue showed that non-toxic infected fescue would provide performance similar to endophyte-free fescue while resulting in stand survival and yield similar to toxic-infected fescue. While toxic infected fescue resulted in dramatically reduced performance in the spring and summer it resulted in similar performance and higher carrying capacity than non-toxic infected or endophyte-free fescue during the winter grazing season. These

results will lead to improved forage systems including non-toxic fescue for spring and early summer grazing and toxic-infected fescue for winter grazing.

- Profitability in the dairy industry is modest and volatile. Feed costs represent over half of the cost of producing milk, which is increasing because of use of corn grain for ethanol production. Controlling feed costs is essential. This depends on precise feeding strategies to supply needed nutrients without wastage, wise use of least-cost feeds including by-products, efficient feeding operations, and diets that support optimum production, health, and reproduction. Dairy producers must devise an optimum feeding program, evaluate feeds and feeding systems, and appraise the performance of the feeding program.

- Reduced diarrhea and improved growth performance have been observed when rotavirus infected pigs are fed plasma protein. Supplemental arginine also stimulates in vitro intestinal protein synthesis in virus-infected pigs while glutamine and alanyl-glutamine supplementations are without effect.

- Data from other crossbreeding studies in the U.S. and elsewhere is evidence that crossbreeding of dairy cattle may have positive effects on traits of economic importance to dairy producers. If crossbred cows increase calf survival, reach puberty earlier, and have improved reproductive success compared to Holsteins, then there should be potential economic advantages for use of a planned crossbreeding program in commercial dairy herds.

FTEs & Program Cost for Goal 1

Program cost is inclusive of federal Hatch funds appropriations, other federal contracts and grants, state appropriations, and other contracts and grant funds.

Federal App.	State App.	Fed G & C	Non Fed Grants	SY	PY	TY	CY
$4,525,867	$33,507,472	$3,753,554	$5,056,389	125.22	335.15	263.64	43.87

Key Themes: Plant Systems

Key Theme: Agricultural Competitiveness

a. Issue: Transgenic rice varieties with the capability of producing proteins that stimulate the immune systems of infants and adults have been developed. These transgenic varieties must be grown in isolation from conventional rice. Although it has been decades since rice was grown commercially in North Carolina, the potential of transgenic rice to produce high value proteins makes this an ideal opportunity for farmers. Unfortunately, there is little information on rice management systems for North Carolina. The goal of this research was to develop rice management systems suited to this environment. A leading company in this field, Ventria Biosciences, agreed to begin production of four transgenic rice lines in North Carolina in 2006 based on research conducted in NC in 2005 and 2006. Currently, three growers are producing rice on 205 acres and it is estimated that in 3 years over 20,000 acres of transgenic rice will be produced in North Carolina.

b. Impact: An acre of transgenic rice can yield over 120 bushels acre^{-1} and produces a net profit of over $800 acre^{-1}. In 2006, the 250 acres of transgenic rice returned over $200,000 to growers. With the anticipated expansion of acreage, it is estimated that rice could be a $16,000,000 crop by 2015.

c. Scope of Impact: State specific but may be Regional.

Key Theme: Diversified/Alternative Agriculture

a. Issue: Medicinal herbs have been studied and discussed for many years as a possible new crop for North Carolina farmers. A 3-year project on Medicinal Herbs for Commerce was initiated to determine if North Carolina farmers can produce the quality and quantity of medicinal herbs required by the industry at a price that is competitive in a global market. By the summer of 2006, there were 40 growers involved in the project, many of them present or former tobacco farmers. Eleven medicinal herb buyers from four states cooperated on the project. The farmers grew one or more of 17 kinds of herbs including California poppy, valerian, Echinacea, dandelion, German chamomile, and skullcap. In addition to assistance in growing and marketing their crops, educational opportunities were presented in the form of workshops, field days, conference calls, newsletters, and websites.

b. Impact: Currently there are over 250 estimated total acres of medicinal herbs in production in NC. Forty-three established medicinal herb farmers are growing 98 different herbs. NC medicinal herbs are high-value crops. Estimated net returns per acre range from $300 to over $25,000, depending on the crop grown. A local economic development organization created three scenarios for the anticipated impact of medicinal herbs in NC. Based on the assumptions presented, the future net value of medicinal herbs in NC ranged from $7.4 million to $62 million and the number of jobs to be created ranged from 1,110 to 9,300.

c. Scope of Impact: State specific but will have Regional Impact.

Key Theme: Plant Production Efficiency

a. Issue: Many corn growers are increasing the number of plants per acre to increase yields. The key components of corn cropping system based on plant populations over 30,000 plants per acre are banded starter fertilizer, and careful seed placement to achieve uniform plant spacing. The goal of this research was to identify high yield corn management systems that would allow growers to grow corn profitably. Three projects were conducted at 9 sites in 2006 to identify and refine the key recommendations of how many seeds to plant, how much starter fertilizer to use, etc.

b. Impact: Yield increases of over 22 bu acre^{-1} were found when the proper combinations of plant population, starter fertilizer and plant spacing were used. Given the yield increases experienced by growers in 2006 and a corn price of $3.50 per bushel this research and extension project produced an economic gain of $3,150,000 in 2006. The impact is projected to be larger in 2007 because based on the success of corn systems over the past four years and the increasing price of corn experts project a 20 to 25% increase in corn acres grown in North Carolina in 2007.

c. Scope of impact: State and Regional

Key Theme: Precision Agriculture

a. Issue: Recent changes in farm legislation associated with the 2002 Farm Bill eliminated the quota system and decreased value of peanut at the farm level from over $600/ton to $500/ton or less. These changes have resulted in decreased profitability of peanut production. Consequently there is a tremendous need to examine all production and pest management strategies in order to develop the most cost effective and sustainable peanut production systems. In doing so, defining risks associated with production and pest management practices is important. Studies were conducted to define agrichemical interactions and to continue developing IPM approaches which potentially may lead to more efficient use of crop protection chemicals. Additional research was conducted to compare subsurface drip and overhead sprinkler irrigation and to determine if pesticide inputs can be reduced in these systems. Results from this applied research demonstrated risks associated with adopting reduced tillage systems for peanut and identified interactions among agrichemicals which will lead to a better understanding of why pest control practices fail in some instances. The findings will help producers use crop protection chemicals more efficiently.

b. Impact: From these and other data a Web-based decision aid has been developed to help peanut producers calculate risks of problems from seven disease, two arthropod, and three nematode species. Risk is categorized as high, moderate, or low depending upon field conditions, field and pest history, and management choices.

c. Scope of Impact: State and Regional

Key Theme: Plant Germplasm

a. Issue: Sweetpotatoes are the most important vegetable crop produced in North Carolina with an average annual market value of $81.8 million during 2002-2004. NC is the leading supplier in the nation producing > 1.5 billion pounds per year or roughly 35-40% of the nation's supply. To remain competitive, NC's growers need new varieties that are adapted to NC, high yielding, early and as attractive as Beauregard (the industry standard). All new varieties need to be resistant to diseases and insects to promote a more sustainable and environmentally sound production system.

During 2005/2006 'Covington' a new table-stock variety was approved for release and is Plant Patent Pending. Covington is a high yielding table-stock sweetpotato that is more stable across environments compared to the industry standard 'Beauregard'. Additionally, sweetpotato is a crop potentially well suited for the production of valued-added and/or bio-based products such as ethanol because it is capable of producing high yields with minimal chemical inputs.

b. Impact: Over 18,000 acres of 'Covington' were planted in 2005, representing ca. 45% of the total acreage of sweetpotato planted in NC. Based on USDA NASS crop value estimates of $98.3 million for the 2006 crop, the farm-gate value for 'Covington' in 2005 was ca. $44.2 million. 'Covington' is expected to account for over half of NC's sweetpotato crop in 2007.

c. Scope of impact: State and Regional

Key Theme: Invasive Species

a. Issue: Invasive weeds and weeds that have become resistant to currently registered herbicides are an increasing threat to agriculture as well as the natural ecosystems. Among these are agronomic weeds

such as Benghal dayflower (*Commelina benghalensis* L.) which has increased weed management costs. For example, in Georgia cotton production costs increased by more than $2.1 million for additional herbicides in 2005 to combat this weed. One of the key components to the eradication of this weed in NC is how long the seeds might lay dormant in nonfumigated soils. Experiments underway in Goldsboro, NC, are examining the effects of management practices and time to deplete the soil of dormant Benghal dayflower seeds.

b. Impact: The results of these experiments found that shallow tillage tends to stimulate germination of the weed seeds and that the seeds may survive much longer than initially expected when buried deep in the soil. These results will help define better management strategies.

c. Scope of Impact: State and Regional

Key Theme: Plant Health

a. Issue. Asiatic soybean rust is a potentially devastating disease of soybean that was first identified in the United States in 2004 and has the potential to significantly impact NC and US agriculture. North Carolina is the largest soybean producer in the Southeast and soybean has the largest acreage of any field crop in NC with over 1.3 million acres. Currently, the profitability of soybean production for many farmers in North Carolina is marginal and an increase in production costs (expenditures for fungicides and application) without a significant increase in soybean prices will force some growers to either leave farming or switch crops. A monitoring system for early detection of Asiatic soybean research was established with assistance from county staff and the North Carolina Department of Agriculture and Consumer Services. Regular updates and recommendations were issued to select clientele. Asiatic soybean rust was found in 42 North Carolina Counties in 2006, but occurred so late in the season

b. Impact: As a result of the monitoring and communications program only about 10% of the 1.3 million acres of soybean received fungicide applications resulting in a savings of 150 to $ 230 million as a result of avoiding unecessary production costs. Some acreage in the southeast portion of the state did receive fungicide applications because of timely warnings. Preventing yield losses on this acreage was the evquivalent of about 250,000 bushels of soybeans valued at about $ 1.2 million.

c. Scope of impact: State

Key Theme: Plant Health

a. Issue: The phase-out of methyl bromide as a pre-plant soil fumigant occurred January 1, 2005. Strawberry and vegetable growers have been using methyl bromide through the use of Critical Use Exemptions for the past 2 years. Critical Use Exemptions were again granted for 2007, but the amount of methyl bromide allowed under the exemption was reduced below the amount requested. With the reduced amounts of product allowed to be used and the certain elimination of the current exemptions, growers are looking for suitable alternatives to maintain farm productivity and profitability. North Carolina State University, with USDA-CSREES grant support, has formed a multidisciplinary coalition of researchers and extension specialists in North Carolina, Virginia, Georgia and South Carolina to test alternative pre-plant soil treatments for strawberry and vegetable production. Biological and chemical alternatives to methyl bromide were evaluated in multiple replicated and observational strawberry, double-cropped, and vegetable trials.

b. Impact: Our research and extension programs will mitigate the possible direct loss of $14 million per year to Southeastern US growers (GA, NC, TN, VA) if methyl bromide is phased out.

c. Scope of impact: State, Regional and National.

Key Theme: Plant Genomics

a. Issue: Brown patch disease (Rhizoctonia solani) is the major disease of turfgrasses in NC and many areas in the South, while gray leaf spot (Magnaporthe grisea) is becoming an increasingly severe disease nationwide. Four genes from various sources have been introduced into tall fescue plants, and 12 transgenic tall fescue plants which are highly resistant to gray leaf spot disease were obtained. Of these, five also showed significant resistance to brown patch. It is possible that these plants are also resistant to other fungal diseases, although they have not been tested.

b. Impact: Cultivars which may arise from this research have the potential to significantly reduce our dependence on fungicides for disease management in turf. Additionally the genes used were not well-known for fungal disease resistance, and could be used in other grass crops, including cereals, to improve their resistance

c. Scope of Impact: National and International

Key Theme: Adding Value to New and Old Agricultural Products

a. Issue: The area in apple production in the Southeast has been steadily declining over the past three decades. North Carolina had 16,196 acres in commercial apple production in 1976 and only 7,000 acres in 2004. Falling prices and fewer market opportunities for processed fruit, combined with increasing pressure on land for urban development in the mountain region are the major agents forcing this change. The future of the apple industry in the Southeast depends on several factors including the willingness of growers to make the transition from producing low-value processed varieties to production of high-value varieties for the fresh wholesale and retail markets, and to adopt production technologies that improve yield consistency and fruit quality to the consumer. Fruit cosmetic defects such as russet or scarf skin can affect fruit quality and result in significant losses of marketable yield of important varieties including Fuji, Golden Delicious, Rome, and redder strains of Gala such as 'Buckeye' or 'Gala'. Experiments were initiated to further evaluate the potential for various plant growth regulator treatments to improve fruit finish (russet, scarfskin) and increase packout.

b. Impact: Several plant growth regulator treatments were shown to reduce cosmetic defects e.g. russet, and increase packout by an average of 13%, resulting in additional revenue per acre of $1680.

c. Scope of impact: State, National and International

Key Themes: Livestock Systems

Key Theme: Agricultural Competitiveness

a. Issue: Poultry nutrition research on the use of selenium has yielded significant improvements in productivity and performance of all commercial classes of poultry. From 1974 when sodium selenite was first allowed as a feed ingredient, there were improvements in fertility and hatchability of breeder

eggs. These improvements were almost instantaneous with fertility levels jumping as much as 30% and hatch of fertile eggs increasing as much as 25%. Since 1974 sodium selenite has been used exclusively as the selenium source for poultry feeds. In 2000, and organic selenium source was approved for use in poultry diets. With the use of the organic selenium, breeder fertility increased by approximately 3% based and this was attributed to a more than 10% increase in viable sperm from the organic selenium fed roosters. Hatch of fertile eggs also improved about 2-3%.

b. Impact: The improvement in chick numbers from organic selenium fed hens has an impact of roughly $1.10 increased revenue per hen. Considering that North Carolina has more broiler breeder hens than anywhere in the USA, it is estimated that the monetary impact to breeders will be $25 million. The extra dressed carcass weight represents an additional $40 million for the broiler producers. In the commercial arena, the producers realize additional revenue, the processors have more meat for sale, and the consumer gets a higher quality product.

c. Scope of Impact: National

Key Theme: Agricultural Competitiveness

a. Issue: Rapid growth of the swine industry in North Carolina has resulted in a number of environmental concerns. Copper and zinc accumulation in soil has been linked to reduced plant growth in regions where intensive swine and poultry operations exist. A common nutritional practice within the swine industry is to formulate diets with levels of trace minerals that greatly exceed recommended requirements. Over supplementation of diets with trace minerals results in greater excretion of trace minerals in waste. Long-term studies have been conducted to determine the impact of greatly reducing supplemental trace minerals on growth and health of pigs. Fecal excretion of zinc and copper was also measured in these studies. Trace mineral concentrations were reduced considerably in nursery and grow-finish swine diets without reducing production. Excretion of zinc and copper in swine waste was reduced by 30 to 50% as a result of reducing trace mineral supplementation.

b. Impact: This work will lead to a savings of over one million dollars in feed cost in North Carolina per year and improve the sustainability of swine production by reducing concentrations of zinc and copper in swine waste.

c. Scope of impact: State Specific

Key Theme: Agricultural Competitiveness

a. Issue: Phosphorus is both an essential element for animal welfare and productivity as well as an environmental pollutant. Total phosphorus in broiler manure has been reduced by decreasing dietary available phosphorus in combination with added phytase enzymes but the reported effects on environmentally important water soluble phosphorus have been inconsistent. It was found that the water soluble phosphorus in broiler manure was largely controlled by the dietary calcium to available phosphorus ratio and that many researchers had overlooked this apparently simple fact. Maximum phosphorus retention within the broiler, minimum total phosphorus excretion, and minimum water soluble phosphorus production occurred when the dietary calcium to available phosphorus ratio was about 2.3:1.

b. Impact: Sustainable and economical broiler performance can be achieved while reducing negative environmental impacts of phosphorus.

c. Scope of impact: National

Key Theme: Agricultural Profitability

a. Issue: Broiler chicks from young broiler parent stock flocks often do not perform well.
It was learned that the fastest growing and most feed efficient broilers come from the largest parents. While this may seem intuitive, common broiler parent stock management practices tend to provide less than adequate nutrition to the largest parents in a typical commercial broiler breeder flock. This has often resulted in poor broiler growth rate and feed conversion, especially just after commercial flocks begin egg production. A simple but precisely controlled increase in feed allocation during the rearing period and immediately prior to sexual maturity was found to allow genetically superior male and female parents to achieve earlier sexual maturity and produce their better-performing progeny.

b. Impact: Flocks subjected to the altered feeding strategy have exhibited an improved fertility and increased broiler growth rate of as much as 70 grams. This could improve USA broiler industry feed conversion by $10 million annually.

c. Scope of impact: National

Key Theme: Agricultural Profitability

a. Issue: There are hundreds of thousands metabolically active embryos growing in the incubators of a hatchery. The environment these eggs are exposed to need to include a optimal temperature, humidity, oxygen and carbon dioxide environment, and egg orientation. The environment, however, is extremely variable because of egg shell properties, embryonic metabolic rate, the physical constraints of the hatchery building, and the type of management imposed upon the eggs within the incubators. Additionally, recent genetic selection for specific attributes in the processed broiler to meet specific market needs has also created a challenge to the hatchery manager. Research is being conducted at NC State University to determine the physiological response to the temperature, humidity, oxygen and carbon dioxide environment, and egg orientation.

b. Impact: This effort allows the hatchery workers to increase their knowledge with respect to how their management influences the physiology of the embryo and hatchling and thus influence how the hatchling performs in the field. This programming allows them to understand what is happening with regards to the developing embryo and how to use the information and the data they collect to take appropriate action.

c. Scope of Impact: State Specific

Key Theme: Agricultural Profitability

a. Issue: Increased diversion of corn to ethanol production is seriously impacting the amount of grain that will be available for the livestock industry in the future. With the inevitable increase in corn prices, there is a need to come up with alternatives to corn for use in dairy rations to keep dairy farmers competitive and profitable. A series of research trials have been conducted to look at alternative feeding systems commonly referred to ‘partial mixed rations’ as a viable option in the Southeastern region of the United States. Inclusion of pasture with a portion of total mixed ration as an alternative for dairy producers in the southeast has been studied. Forage can be included at 41% of the partial mixed ration

without having any detrimental effect on milk yield and animal performance. Partial mixed rations are a viable alternative to using corn silage in the diet and hence, reducing the dependence on corn as the main source of feed.

b. Impact: This work will aid in the assessment of environmental and economic issues related to dairy farming as well as affects on milk composition and price of milk paid to the producers.

c. Scope of Impact: State Specific

Key Theme: Agricultural Profitability

a. Issue: Reproductive performance of turkey breeder hens is adversely affected during the hot summer season as compared to the winter season. Egg production in the summer may be reduced by 20-40% of that occurring during the winter. Any correction to this egg loss would have substantial economic benefits. Breeder hens may typically be receiving insufficient light each day. Hens receiving 18hr of light per day as compared to the typically used 15 hr per day produced about 11 more eggs per hen during 24 wk of photo-stimulation.

b. Impact: An increase of 11 eggs per hen during the summer has considerable economic benefit and goes a long way in improving the consistent production of turkeys on a year-round basis. Fertility of turkey eggs is expected to exceed 85% and each fertile egg costs about $.75. If 9 of the 11 extra summer eggs are fertile there would be a $6.75 per hen added value and, in North Carolina, we have about 3.0 million breeder hens.

c. Scope of impact: State Specific

Key Theme: Agricultural Profitability

a. Issue: Poultry facilities use considerable amounts of energy in gas and electricity to assure that environmental conditions such as temperature, air quality and light are adequate to obtain the best bird growth and health. In the last five years, propane prices increased over 41%, while the on-farm broiler prices raised only 13% during the same period. Electricity costs have also increased. The volatile energy market augments uncertainty and risk for poultry producers. A research and demonstration program was started to improve and optimize brooding for commercial broilers. From observations in two trials it was concluded that growers can save gas while improving broiler performance.

b. Impact: The poultry integrator was able to reduce gas expenses and save almost two million dollars in energy and by improving flock uniformity, viability and broiler growth rates. The broiler grower involved in the initial trials had significant improvements in his annual income and he is participating in other research projects with our research/extension group. Work continues with three more poultry integrator companies.

c. Scope of impact: State Specific

Key Theme: Animal Genomics

a. Issue: The ability to generate avian germline chimeras has been limited by the number of available primordial germ cells (PGC) to inject into embryonic recipients. Utilizing procedures established for embryonic stem cell culture, culture methods for PGC have been improved. With an appropriate source of fetal bovine serum, PGC cultures from a single embryo, initiated with less than 50 cells, proliferates to cultures of several million within four months. PGC from these cultures are capable of producing

germline chimeras when injected into stage 17 of stage X embryos. The efficiency of germline chimera production is influenced by the gender of the donor and receipt. It appears that male into female chimerism is less efficient than male into male chimerism. This may be influenced by the fact that female germ cells must undergo the first meiotic division prior to or shortly after hatching. Therefore the number of ova in a female tends to fixed at the time of hatching. In males, PGC exhibit periodic mitotic proliferation and enter into meiosis during puberty.

b. Impact: Obtaining large numbers of PGC from in vitro culture would facilitate the transfer of male PGC into female embryos and increase the likelihood that a greater percentage of male offspring would be produced. This would allow for a potentially greater number of germline chimeras to be produced.

c. Scope of impact: State Specific

Key Theme: Animal Genomics

a. Issue: Epigenetic regulation of gene expression was initially described as genomic imprinting where a gene is expressed in a parent-of-origin-dependent manner. The mechanism for the silencing of a single allele of a gene is by methylation of CpG islands in the regulatory regions of imprinted genes such as insulin-like growth factor 2 and mannose 6-phosphate/insulin-like growth factor 2 receptor. A more recent form of epigenetic regulation has been described called fetal "programming". Fueled by epidemiological data the "fetal origins" hypothesis suggests that a poor in utero environment resulting from maternal dietary or placental insufficiency may "program" susceptibility in the fetus to cardiovascular or metabolic disease. In birds, the first description of neonatal programming was referred to as early-life conditioning and was manifest as heat tolerance late in life as a result of neonatal thermal conditioning. Recently thermal conditioning has been associated with alterations in gene expression patterns. The ability to monitor the impact of nutrition and supplements on an organism and its tissues at the genetic level (gene expression) using microarray analysis has opened new doors to understanding the molecular response to diet.

b. Impact: The resulting data will be the first evidence for neonatal programming of gene expression in an oviparous species as well as provide essential information on the mechanism of nutritional programming in chickens for manipulation of dietary components such as P. Feed is the most expensive component of poultry production and any fraction improvement in nutrient utilization will result in a significant economic impact. Reduction in manure nutrients such as P will also have a significant reduction in the impact of animal agriculture on the environment. Molecular genetic research can be useful to the field of nutrition in many ways, whether it is to increase the nutritional value of a food, to identify ways to reduce an individual's risk of certain diseases, or to identify optimal health-promoting diets.

c. Scope of Impact: State Specific

Key Theme: Animal Health

a. Issue: Malnutrition and diarrhea are the two leading biological causes of piglet mortality in the U.S. swine herd, together accounting for 57% of non-crushing deaths. Rotavirus infection is the leading cause of infant diarrhea, accounting for 700,000 infant deaths annually and accounts for a large proportion of swine diarrhea. Clinically, rotavirus infection results in severe watery diarrhea and reduced body weight gain. Neonatal pigs are very susceptible to rotavirus, and it along with E. coli is one of the two major causes of weanling diarrhea. Unfortunately, effective vaccines against rotavirus

are not readily available for use in livestock species as has recently been developed recently for humans. Only marginal effects were observed of several oral treatments on the intestinal mucosa and the course of the disease including high-dose oral epidermal growth factor, and "super oral rehydration" solutions containing L-glutamine, and arginine. One source of growth factors shown to be efficacious in stimulating repair is porcine plasma protein, which is commercially available as a nutritional supplement. Because effective vaccines are lacking, the approach of providing enteral nutritional therapy to enhance intestinal recovery in rotavirus enteritis is paramount.

b. Impact: Reduced diarrhea and improved growth performance were observed when rotavirus infected pigs were fed plasma protein. Supplemental arginine also stimulated in vitro intestinal protein synthesis in virus-infected pigs while glutamine and alanyl-glutamine supplementations were without effect.

c. Scope of impact: State Specific

Key Theme: Animal Health

a. Issue: Misdiagnosis of estrus is the most common human error made on sow breeding farms. It is costly, time consuming and significantly compromises animal welfare and profitability. Sows that are bred at the incorrect time during estrus have poor reproductive performance and are at an increased risk of developing reproductive tract infections, which can permanently affect their fertility. Researchers in the Department of Animal Science have worked with InterVet, Inc., the North Carolina Pork Council, and the National Pork Board to develop management strategies for synchronization of estrus in swine. This research collaboration has resulted in the first F.D.A. approved product for estrus synchronization in mature swine.

b. Impact: Published research indicates that misdiagnosis of estrus is the most common management mistake on swine farms in the U.S. occurring on a regular basis on over 60% of the farms in the U.S. Depending on their severity, these mistakes normally reduce farrowing rates by 10 to 15% and litter size by one to three pigs. Economically, it has been estimated that this costs the U.S. swine industry between $30 to $90 million annually. Implementation of estrus synchronization programs on farms significantly reduced mistakes in detection of estrus. When this occurred, reproductive performance, sow longevity, and profitability all increased.

c. Scope of impact: state specific

Key Theme: Animal Health

a. Issue: A strong immune system should translate to strong resistance to stress and antigenic challenges and thus a healthy organism. There is little doubt that healthy animals perform better than less healthy or sick animals and it is clearly in the best interest of animal producers to maintain the healthiest animals possible. To assure product quality from poultry, producers utilize various chemicals ranging from disinfectants to vaccines to maintain animal health. These are expensive and sometimes accompanied by mandated regulatory issues. It would be very desirable if poultry producers could naturally enhance the immune system with an inexpensive, natural product or use economically feasible management techniques to naturally stimulate the bird's immune system. We have established that environmental light can regulate immune function and that this effect is mediated by the hormone melatonin.

b. Impact: It has been clearly demonstrated that immune enhancement can be achieved by simply controlling the photoperiod appropriately and/or supplementing the diet with melatonin or its precursor, tryptophan. This information has strong implications in the prevention and therapeutics associated with managing health care of a flock and thus production performance. Not the least of these implications is an improvement in the efficiency, or reduction in dependency, for chemicals such as antibiotics and vaccines.

c. Scope of Impact: State Specific

Key Theme: Animal Health

a. Issue: High postnatal mortality of neonatal piglets is a serious problem in the swine industry. The etiology of the mortality is complex, but nutritional deficiency is one of the multiplicate factors. Evidence indicates that newborn piglets have a limited fatty acid oxidation and resultant ketogenesis capacity, which play important roles for neonates to obtain energy. The development of fatty acid oxidation after birth is related with emergent regulation at the level of carnitine palmitoyltransferase I and HMG-CoA synthase. The regulation and gene expression of the two enzymes in neonatal piglets have not been understood completely. The role of carnitine palmitoyltransferase (CPT I) in regulation of hepatic fatty acid metabolism in neonatal piglet has been studied in this laboritory since 1989. In order to investigate the effect of hormones and peroxisome proliferators on CPT I activity and its regulation in fatty acid metabolism, a series of experiments has been conducted at NC State University.

b. Impact: North Carolina is one of the leading states in the swine industry. Economically, improving nutritional management and reducing mortality of neonatal piglets have far reaching significance. Knowledge from this research will help us further understanding of fatty acid metabolism in neonatal piglets and exploring the ways and means of improving nutrition management of the neonates.

c. Scope of Impact: State Specific

Key Theme: Animal Health

a. Issue: Enteric disease and enteric viruses are a major cause of morbidity and mortality in agriculturally important species and in humans. Losses to enteric diseases in poultry can be significant, as demonstrated by the emergence of Poult Enteritis Mortality Syndrome (PEMS) in the 1990s. Enteric diseases can cause high mortality, but their economic impact is often more evident in the inhibition of growth and poor feed conversion. Understanding how these pathogens cause disease is imperative to understanding how to prevent, treat, and control enteric disease and promote animal health. The innate immune system may play a critical role in controlling the replication of this virus in young naïve poults. Molecular characterization and comparison of numerous field isolates of TAstV-2 suggest possible evolutionary changes and selection pressures and will hopefully lead to identification of potential vaccine strains.

b. Impact: These studies will help in the understanding of how enteric viruses cause disease in poultry through identifying the physiologic and cellular changes which occur following TAstV-2 infection. This discovery will allow the development of non-vaccine based therapies which would be less costly to produce, easier to administer, and have a more broad spectrum affect than current strategies for protecting poultry from viral infection.

c. Scope of Impact: State Specific

Key Theme: Animal Health

a. Issue: Efficient dietary nutrient utilization, gut and skeletal health, and cost per unit of saleable product are important to the sustainability and profitability of the North Carolina poultry industry. Understanding of the nutritional requirements must keep pace with the development of fast-growing strains of broilers and turkeys. In response to public concern for food safety, many companies are eliminating the use of antibiotic feed additives and searching for natural alternatives to control enteric pathogens that may adversely affect animal welfare and food safety. Broiler chicks and turkey poults are most susceptible to enteric disease, primarily because of compromised feed digestion and malabsorption during the first 2 weeks after hatch. Early gut health account for about 5% of the total flock mortality, and it may have lasting effects on disease resistance until the birds are harvested. A new technology called in ovo feeding (administration of nutrients into the amnion of embryos) was developed to improve enteric development of young poultry and improve resistance to enteric disease. After surveying the changes in metabolism during late-term incubation in turkeys by gene array technology, in ovo feeding solution formulations were optimized. Automated delivery of in ovo feeding solutions achieved >90% amnion targeting, and advanced enteric development and digestive capacity by 2 days, resulting in better early growth performance and survival.

b. Impact: In ovo feeding has lead to industry development grants totaling over $2 million during the last 2 years. These funds will lead to the commercialization of in ovo feeding technology after development of in ovo feeding formulations and automated delivery applications. Knowledge gained from the in ovo feeding project has resulted in changes in hatchery management and breeder nutrition to enhance the survival of broilers and chicks. Nearly all of the broilers and turkeys produced in North Carolina are now fed diets that are supplemented with enzymes to improve nutrient utilization, resulting in about 5-10% reduction in phosphorus and nitrogen emissions, better nutrient utilization, and improved enteric health. The use of enzymes and feed additives reduce feed costs by at least $2.00 per ton, resulting in a savings of over $60 million to the North Carolina poultry industry. Using natural feed additives and enzymes and more biosecure management practices, at least 5 major integrated poultry companies operating in North Carolina have stopped using antibiotic growth promoters to manage gut health and nutrient utilization.

c. Scope of Impact: State Specific

Key Theme: Animal Production Efficiency

a. Issue: Turkey hens are dependent on proper light management for the year-around production of eggs and offspring. Under current management practices groups of hens have a useful production period of about 24 weeks and then are sold or undergo a time consuming recycling process for a second lay period. A 24 wk production period is economically inefficient, especially considering that hens are not induced to lay eggs until about 33-34 wk of age. Egg production by turkeys is among the poorest in domestic birds being about a third of that in chickens so there is considerable room for improvement. The single most important factor limiting egg production in turkey hens is their development of a state of non-responsiveness (photorefractoriness) to the long day lengths that initially were used to induce the hens to lay eggs. If one can understand the nature and mechanisms of photorefractoriness (PR) there may then be avenues for practical intervention with a resultant persistence of photosensitivity and prolonged production of eggs. Recent identification of a neural locus for PR in the tuberal neurons of the hypothalamus is a big step forward in understanding mechanisms of PR. Also, knowledge of

hormonal changes associated with PR and lighting management for PR have advanced considerable in recent years.

b. Impact: It is known that PR is the reason why turkey hens have such a short egg laying period and stop egg laying. Recent advances in the neural locus of PR, hormonal changes associated with PR, and lighting effects on PR have moved us closer to an understanding of PR and its eventual control. Until recently the only known method of terminating PR and allowing turkey hens to lay eggs was to expose them to short day lengths in light restriction housing for an appropriate period of time. With current level of understanding one can now terminate PR pharmacologically for the first time and delay it (extend egg production) by light manipulation. This provides an additional potential management tool for controlling when, and for how long, turkeys will lay eggs. Complete control of photorefractoriness will make light restriction housing obsolete.

c. Scope of Impact: State Specific

Key Theme: Animal Production Efficiency

a. Issue: The purpose of the North Carolina Layer Performance and Management Test (NCLP&MT) is to provide strain evaluations and management under common husbandry and environmental conditions to the producers in North Carolina. This is the only test of this experimental design, type and size remaining in the world. This extension project has expanded to develop and to provide scientific answers to issues relating to hen welfare, behavior, molting practices, egg processing, and beak trimming practices facing the egg industry. Much of the behavioral research in this program centers on the practice of molting, which is widely used in the egg industry, and in turn has helped industry organizations establish applicable animal care guidelines. This program deals with egg production type chickens in the production environments and to provide insight as to the well-being of the laying hens under different cage densities and husbandry practices (molting

b. Impact: The NCLP&MT reports are sent to all the producers in North Carolina and an additional 330 reports are sent to producers and industry representatives throughout the US and 22 different countries. The primary breeders, egg producers, and egg breaking companies are utilizing the test in increasing intensity to compare and evaluate the impact of strain, environment, and management have on the egg solids, functionality, and safety. This can lead to a shift in layer strain purchases on the part of the breaking companies to enhance their product properties thereby enhancing sales to egg product purchasers. The breeders have increased their support to cover some cost of the research, and all publication, and postage.

c. Scope of Impact: State Specific

Key Theme: Animal Production Efficiency

a. Issue: According to industry geneticists, in the last decade, egg production in male line hens has decreased 8 eggs per hen from 48 to 40 eggs in 20 weeks of lay. The regression line is holding at a loss of about 0.8 eggs/ generation and even the eggs that are produced hatch very poorly because of reduced fertility (75%) and embryo survival (60% of fertile eggs). At this rate it will be too expensive to breed male lines of turkeys within 15 years. Conversely, female line turkey hens, selected for reproductive criteria, have excellent egg production and their eggs hatch very well. Studies were conducted to evaluate the cardiac physiology in turkey embryos. Embryos from commercial breeders were tested for heart growth and function. A correlation between egg permeability and cardiomyopathy was

established. Embryos developing in eggs with Low eggshell conductance showed better embryo survival, lower heart rates, reduced heart weights and a better energy balance in the myocardium. Male lines: Embryos develop in larger eggs with reduced eggshell conductance suggesting they require shorter developmental times and may suffer hypoxia and hypercapnia prior to hatching. Cardiac function may be impeded by both dam and sire DNA when exposed to those conditions. Longer incubation periods may benefit such embryos.

b. Impact: For nearly 50 years, embryo survival has been determined by developmental conditions controlled by a thermostat or humidistat. A better means of controlling the development of avian embryos may be through the use of sires selected for increased body weight with dams selected for increased egg production. Prolonging the developmental periods for such embryos may also be beneficial. Technologies exist to control environmental incubator conditions to further refine and optimize embryo survival.

c. Scope of Impact: State Specific

Key Theme: Animal Production Efficiency

a. Issue: Poultry litter is a mixture of excreta, feed, feathers, and bedding material. However, we also generally refer to both new and unused bedding materials as litter. As the poultry industry in the US has grown and expanded, the availability of litter materials has been challenged. Historically, there are many factors which successful litter management must take into account such as type of litter, time of the year, depth of the litter, floor space per bird, feeding practices, disease, kind of floor, ventilation, watering devices, litter amendments, and even fertilizer value. Many materials have been used as poultry bedding including straw, corn cobs, corn stalks, sugar cane stalks, peat moss, peanut hulls, wood shavings, oat hulls and several others. However, litter type can significantly affect carcass quality and bird performance. Pine shavings has been the bedding of choice because of performance, availability, and cost. Other bedding materials are usually compared to pine shavings as they are examined for possible use as litter material. Some litter materials have been ranked from best to worst: pine shavings, rice hulls, corn cobs, stump chips, pine sawdust, bark & chips, pine bark, and clay.

b. Impact: While the birds performed equally well on all bedding materials, any bedding material that results in higher cake levels than what is currently used (industry shavings) will probably not be used by turkey producers unless no other bedding material can be found. Also, poultry producers are very cost conscious. Any alternative product must be competitive on a cost or value basis compared to wood industry shavings unless shavings are unavailable. Alternative sources of bedding are needed by the turkey industry. Further work exploring possible bedding materials for turkey rearing will continue.

c. Scope of Impact: State Specific

Key Theme: Animal Production Efficiency

a. Issue: The fertility of dairy cattle in the U.S. has declined significantly in the past 30 years because of the negative relationship between milk production and reproductive fitness. Only recently has there been broad concerted efforts to arrest this trend by delivering measures of male and female fertility which enable dairy producers to select animals that are identified as more fertile. Dairy records Management Systems (DRMS) was the primary researcher in male fertility beginning in 1980 and continuing until 2005. As a service to the industry for more than 20 years, DRMS provided measures of the fertility of dairy service bulls at no charge to the entire industry. DRMS was the sole provider of

research data sets to other dairy scientists who developed interests in this area beginning in the mid 1990s. DRMS was instrumental in early discussions about the genetics of female fertility and was an early publisher of research in that area. DRMS delivered all background information and data concerning genetics of service sire fertility to USDA scientists in 2006 to assist in its efforts to establish a national assessment system. In 2006, DRMS was the sole provider of stillbirth data to USDA and enabled the U.S. dairy industry to become a major contributor to international efforts to address this important problem for dairy farmers.

b. Impact: DRMS and NCSU have been recognized as the sole deliverers of service sire fertility information to the U.S. dairy industry for more than 20 years. DRMS and NCSU are recognized as the sole providers of data for U.S. stillbirth genetic measures. Because of DRMS and because USDA includes the effect of stillbirth in every animal's proof , every producer in the U.S. and many producers worldwide have access to improved measures to reduce the effect of decades-long selection for reduced reproductive fitness.

c. Scope of Impact: National

Key Theme: Animal Production Efficiency

a. Issue: Neonatal pig death losses of approximately 8 to 12% represent a significant economic loss to the swine industry. These pigs that fail to survive are often lower in birth weight and do not compete well with littermates of greater weight. Strategies that increase the survival of these low birth weight pigs will increase the number of pigs per sow per year and improve reproductive efficiency. One way to improve survival of low birth weight pigs is to remove them from the sow and rear the pigs using formulated diets. Two problems with this approach, that limit the ability to do this on a large-scale in industry, are the cost of the formulas and lack of information on the nutrient requirements of these young pigs. Greater knowledge of nutrient requirements is needed as a basis for developing optimal formulas. A study was conducted using neonatal pigs to determine the extent to which dietary protein in formulated liquid diets could be replaced with synthetic lysine. Pigs were removed from the sow at 1 day of age and fed diets in which lysine from protein was replaced with up to 40% synthetic lysine. Pigs were fed the diets until they reached approximately 5 kg BW. This represents the initial phase of growth beyond which nutrient requirements likely change. As synthetic lysine inclusion in the diet increased, average daily gain and accretion of body protein by the pigs decreased. However, the decrease was minimal at the lower rates of inclusion. Overall, approximately 15% inclusion of synthetic lysine was possible before there was a significant decrease in performance. The decreased performance at higher inclusion rates may be due to a deficiency of other amino acids that limits growth.

b. Impact: Replacement of dietary protein with synthetic lysine will decrease the cost of formulated liquid diets. Evaluating inclusion rates of other amino acids, that may be limiting, will decrease cost and improve performance on formulated liquid diets. These factors will improve the prospect of adopting these approaches to improve performance in the industry.

c. Scope of Impact: State Specific

Key Theme: Animal Production Efficiency

a. Issue: Increasing Sustainability of the North Carolina Dairy Industry by Improving Growth and Health of Dairy Calves and Heifers and Increasing Milk Production. The main objectives of this extension and

applied research program include 1) using nutritional and management strategies to reduce morbidity and mortality in neonatal calves; and 2) improving the growth and productivity of dairy calves and heifers and 3) improving milk production in early lactation dairy cows. A study investigated the impact of supplementing rumen-protected forms of betaine, choline and methionine to diets with limited methionine content on performance and metabolism of early lactation Holstein cows. A study was conducted to determine the effect of feeding whole milk supplemented with either 0.5 gram or 1 gram of lactoferrin versus whole milk with no added lactoferrin on growth and health of Holstein calves. A study investigating the effect of a feeding a brewers grain yeast product on incidence of coccidiosis, cryptosporidiosis, inflammation, disease incidence, calf losses, growth and feed efficiency in neonatal and postweaned calves.

b. Impacts: Supplementing rumen-protected choline significantly increased milk yield in multiparous early lactation Holstein cows fed methionine-limited diets. Information gained from these studies will be used to develop feeding recommendations to improve growth and health in dairy calves and increase milk yield in cows.

c. Scope of Impact: State Specific

Key Theme: Aquaculture

a. Issue: Commercial culture of flounder, widely and profitably practiced in Europe and Japan, has recently been attempted in the United States. Southern U.S. flounder has great promise for aquaculture, with a high market value and unique ability to grow well in fresh water. Wholesale prices for fresh flounder range from $5-$10 per pound so the economic potential for cultured flounder is promising. Because their range of distribution extends from North Carolina along the Atlantic and Gulf coast into Mexico, the potential for culture in a large geographic area exists. Demonstration and transfer of practical culture methods for the fingerling and foodfish production of southern flounder to commercial producers is important. Males used to in produce all-female fingerlings have been established. The first commercial-scale data on grow-out characteristics with a full economic analysis of the results has also been established. These accomplishments are fundamental steps in the commercialization of flounder culture and will lead to maximizing the economic viability of flounder farming. Current annual production projections for the first private southern flounder hatchery in the U.S. are around 100,000 lbs.

b. Impact: The establishment of southern flounder as a new, high-value aquaculture species represents the first introduction of a fish with a worldwide market appeal and the capability of being cultured over a large geographic area. The potential for flounder culture is equal or superior to that of the hybrid striped bass industry, which has enjoyed a growth rate of 20 percent per year for the past 10 years and the achievement of an annual farm-gate value of more than $7 million to North Carolina alone. The economic potential of flounder farming in the United States could reach five-to-10 times the value of the hybrid striped bass industry within the next 10 years.

c. Scope of Impact: State Specific

Key Theme: Aquaculture

a. Issue: Aquaculture is one of the most rapidly expanding sectors in agribusiness worldwide. At the same time, traditional fish farming methods limit the growth of aquaculture in North Carolina and around the globe because of limited water supplies and concern for environmental impacts of this

"animal agriculture" activity. Recirculating aquaculture production technology is used to produce fish in tanks by cleaning the fish waste from the water and using the water over and over again. While these fish production systems are often viewed as "green" technology, if their effluent is not treated, nothing is gained and in-fact more environmental damage can be done as their waste stream is focused into a single high-strength point discharge. The 9 original Fish Barns in North Carolina are undergoing more scrutiny as environmental regulations become more stringent in the future. New and future Fish Barns will be held to the same high standards. The North Carolina Fish Barn program has been active in the development and dissemination of recirculating aquaculture production technology since 1990. The resulting technology combines water treatment components from around the world to allow for production of freshwater and marine finfish in tanks with very little water usage. Major advancements have been made in the development of wastewater and solid waste treatment from this production technology.

b. Impact: There are currently 11 commercial Fish Barns operated in North Carolina, one more under construction and two in the design phase. These commercial operations are mostly producing tilapia, but one facility currently is growing Sturgeon and one is producing flounder. Ten of these facilities will qualify for the Federal Cost Share program for reimbursement of up to $15,000 each for the installation of this new technology. The Sturgeon farm has already installed the system. The site (next to the Yadkin River) was approved by the Wildlife Resources Commission for the sturgeon operation based upon the ability of the process to contain any fish or fish larvae within the confines of the farm site. Most new facilities planned for North Carolina will utilize this technology. Recent results from our testing indicate that this technology combined with a sterilization (UV light or ozone contact) process will allow the user to re-use much of the wastewater that otherwise would be irrigated on adjacent crop land. This technology is also being investigated for use in marine aquaculture. Complete reuse of seawater through a modified geotube water treatment process would allow for the production of marine finfish away from expensive coastal sites on less expensive farm land in North Carolina.

c. Scope of Impact: National

Key Theme: Aquaculture

a. Issue: Hybrid striped bass (HSB) production in ponds is a highly water-intensive operation. Current production practices require annual pond draining to harvest and move fish and avoid infestations by the parasitic yellow grub. These practices create large volumes of effluent at certain times of the year and have led to complaints by local residents about stream eutrophication and habitat degradation. Effluents released from the North Carolina HSB farms are slow-moving and drain into wide and shallow estuarine coastal creeks. Based on our monitoring of the water quality of the HSB effluents, the only means to satisfy these complaints and to bring the producers into compliance with effluent standards is to drastically reduce or eliminate effluents from the farms. Other aquaculture producers, notably channel catfish producers, effectively practice a near zero-discharge management of their water – either through in-pond conservation or on-farm reuse of effluents.

b. Impact: Improving the management of HSB ponds in North Carolina, through simple changes in current practices, may bring the industry into an environmentally sustainable means of ensuring the long term survival of this vital industry. We have already reduced effluents from ponds by more than 50% which corresponds to an almost 25% savings in pumping costs.

c. Scope of impact: State Specific

National Goal 2: A Safe and Secure Food and Fiber System

Overview

The well being of the United States and its citizens depend on a safe and secure food and fiber production and delivery system. Therefore, protecting the stream of resources from the farm and forest to processors and distributors, and ultimately to consumers, is of utmost priority. Whether the threat may come from poor sanitation during harvest, processing, or preparation or from synthetic or natural toxicant residues, objective, science-based research is necessary to provide producers, suppliers, and consumers with the best management and decision- making tools and techniques possible to prevent illness and disease. Consumers want a safe and plentiful supply of high-quality food and fiber. More foreign-produced food and fiber products are coming to the United States than ever before, with associated concerns about safety and quality. Consumer concern with *Escherichia coli, Listeria monocytogenes* and other potentially life threatening microbiological contaminants as well as pesticides, hormones, and other toxicants require intensified efforts to guarantee a safe and worry-free supply of wholesome food.

To address all aspects of safety and quality in the food and fiber system, research is carried out at the production level, the harvest and marketing level, the processing level and the preparation level. Additionally, with the diverse production systems found in North Carolina, the research must be conducted over a broad spectrum of commodities and situations. The performance goals for this program area are primarily focused on identifying problems and solutions to quality maintenance in storing and marketing fruits and vegetables, field crops and animal products; ensuring that food products are free from toxic contaminants; and protecting food and feed supplies from harmful microorganisms and naturally occurring toxins.

Performance goal 1, which seeks to identify problems and solutions for quality maintenance in storing and marketing fruits and vegetables, field crops and animal products, has been addressed in the following ways:

- As a result of work on peppers, processors are now aware of a previously unrecognized mechanism that could cause rapid loss of quality of their products. The demonstration that sulfite prevents oxygen-mediated softening provides a practical means to prevent this type of quality loss.

- Transgenic lines of peanut were developed that carry a transgene encoding ‘Mod 1’, an active form of the ribosome inactivating protein ‘Mod 1’ from maize, and shown to be resistant against Aspergillus flavus infection, Sclerotinia minor, and Sclerotium rolfsii.

Performance goal 2, which ensures that food products are free from toxic contaminants, has been addressed by:

- Researchers have developed methods for the computational assessment of the toxicity of chemical mixtures. These methods will be of use to environmental managers in assessing the health risks associated with chemicals in the environment.

Performance goal 3, addresses protecting food and feed supplies from harmful microorganisms and naturally occurring toxins.

- Researchers have identified three egg shell membrane-bound proteins (β-N-acetylglucosaminidase, lysozyme and ovotransferrin) that work in concert to alter the normal

functioning of bacterial cell membranes of several foodborne disease causing organisms (*Salmonella, Staphylococcus, Listeria, E. coli*) resulting in a significant increase in their sensitivity to heat treatments.

- There are an estimated 2.5 million cases of campylobacteriosis in the U.S. annually, with a cost of infection between $1.2 and $1.4 billion. Researchers are developing specific inhibitors of C. jejuni that could safely be used in food animals, thereby reducing the level of C. jejuni contamination in the food supply.

FTEs & Program Cost for Goal 2

Program cost is inclusive of federal Hatch funds appropriations, other federal contracts and grants, state appropriations, and other contracts and grant funds.

Federal App.	State App.	Fed G & C	Non Fed Grants	SY	PY	TY	CY
$333,921	$2,889,880	$1,015,530	$649,690	14.42	46.29	28.36	4.75

Key Theme: Food Safety

a. Issue: The relationship between the intestinal microflora and the host is not merely commensal, but rather symbiotic or mutualistic, considering that this association is generally beneficial for both bacteria and host. The intestinal microflora generally impacts the host's health by influencing digestion and nutrient absorption, intestinal morphology, and defense of the host against infection. This protective effect is accomplished by inhibitory effects exerted by the resident microflora, including competition for nutrients, production of antimicrobial substances, such as bacteriocins, and physical binding to the surface of the intestinal epithelium that prevent opportunistic pathogens, such as Salmonella, from obtaining an attachment site along the intestinal mucosa. Promoting the development of the beneficial bacteria within the avian intestinal tract could help to reduce foodborne pathogen colonization, which would reduce human exposure to these pathogens and related illness and deaths. Several alternative products intended to control Salmonella in poultry have been developed in response to the anticipated reduction in using antibiotics as growth promoters. The study reported herein was designed to determine the ileum microbial diversity using Denaturing Gradient Gel Electrophoresis analysis of 16S ribosomal DNA amplicons of broilers fed triticale- or corn-based diets and reared in traditional floor litter systems or a non-conventional cage system.

b. Impact: Broilers raised either on litter floor or in cage batteries were fed either a finely ground corn-(control), a finely ground triticale or a whole triticale-based diet from 0-42 d. Microbial DNA was extracted from the ileum content of 42 d broilers and the 16S rDNA gene was amplified by PCR and the amplicons separated by DGGE. Diversity indexes including richness, evenness, diversity, and pairwise similarities coefficient were calculated. Diversity indexes were related to the dietary treatments, housing designs and with changes in Salmonella colonization of broiler ceca as characterized by the most probable number method (MPN). Higher microbial diversity indexes were observed among birds fed whole triticale-based diets and reared on litter floor. In contrast, finely ground grain treatments had lower diversity and higher Salmonella prevalence than the whole triticale treatment. The combination of high dietary fiber content and increased coarseness of the diet by feeding whole triticale presumably stimulated microbial community diversity and discouraged Salmonella colonization through a competitive exclusion type mechanism. Rearing broilers on litter and feeding

whole triticale encouraged the growth of a greater variety of bacterial species and consequently a more diverse microbial community in the intestinal track. Conversely, the diversity of intestinal microflora of broilers raised in cages was not influenced by the dietary treatments. Therefore, feeding whole high-NSP (non-starch polysaccharides) content cereals, such as triticale, may be a useful approach to control enteric pathogens in poultry with the added benefit of improved intestinal health and food safety.

c. Scope of Impact – National

KEY THEME: Food Security

a. Issue: Mad cow disease, caused by recalcitrant prion protein, has a traumatic impact on food safety concerns and economics of animal industry. Since the discovery of the first case in the U.S. shutdown of beef export has caused multi billion dollar losses for the beef industry.

b. Impact: A keratinase discovered at North Carolina State University (Poultry Science Department) was produced in large quantity. In collaboration with CIDC-Lelystad, the conditions for prion degradation by keratinase were determined. In order to conduct the experiments within a NCSU lab, a non-pathogenic prion-like protein, called prion surrogate protein (PsP) was developed. The ultimate goal of this research is the development of an enzymatic process for prion disinfection of diseased or contaminated materials, including animal carcass and slaughtering equipment. Furthermore, the development of a prion surrogate protein which has prion-like properties yet non-pathogenic will provide a safe marker for the detection or monitoring of prion disinfection processes.

c. Scope: National and State Specific

Key Theme: Food Quality/Security

a. Issue: "Novel Functional Ingredients Using Milk and Soy Protein Formulations"
The United States is both the world's largest producer and exporter of whey and soy protein products. In 2003, 320 million pounds of whey and 65.8 million metric tons of soybeans were manufactured. Presently, only one-half of the total liquid volume of whey, produced during cheese making, is further utilized. The annual yield of whey protein concentrate in the US during 2004 was on the average of 24 million pounds per month produced at an approximate value of $5.00/lb. Thus, the total market value for this concentrate whey product was ~$120 million dollars/month. By comparison, the soy industry contributes only 5% of its total production for human nutritional purposes within the US, and one half of the total value of the US soybean crop is exported as whole soybeans, soybean meal, and/or soybean oil. With the abundance of whey and soy protein resources, there is a critical need for the development of innovative strategies that promote expanded and alternative utilization within the food industry. Since the market for food ingredients is very competitive, the functionality of whey and soy must be continuously improved and redesigned for specific commercial applications. Thus, an understanding of the macromolecular interactions between them is crucial for developing technologies leading to the final formulation of fabricated food products.

b. Impact: Previously, the N.C. State food rheology lab group patented a process that produced a unique whey protein stabilizer. This ingredient, defined herein as modified whey protein (mWP), displayed expanded functional and mechanical characteristics over native whey protein, itself. Similarly, modified soy protein (mSP) preparations were made using analogous methodologies. In preliminary work, we have demonstrated that both mWP and mSP readily react with carbohydrate materials, forming whey/soy glycoproteins via the Maillard reaction under dry heating conditions. Enzymatic processes

also play an important role in this regard. Consequently, in another phase of this work, microbial transglutaminase (Tgase) will be used to generate polymeric proteins and glycoproteins in order to evaluate the functionality of reaction end products. Polymeric end products from these enzyme treatments often reflect dramatic changes in the size, conformation, and stability as compared to initial protein substrates. Initially, homologous (whey-whey) protein polymers and glycoprotein derivatives were created; however, future experimental designs will include the effects of TGase cross-linking on both whey/soy glycoconjugates. Furthermore, Tgase exhibits a wide substrate specificity and catalyzes polymer formation using soy, myosin, gluten, globulin, casein and whey proteins. Thus, we have proposed to create heterologous or hybrid (whey-soy) polymeric protein preparations and glycoprotein derivatives (whey-soy-carbohydrate) in order to define their functional potential within real food systems. This area of research is relatively new and mostly unexplored affording excellent opportunity for new discovery. The ultimate aim for this project is focused on developing new technologies that will enable the creation of new whey/soy protein ingredients, which exhibit unique performance characteristics. For example, the manufacturing of an affordable low-carbohydrate, high-protein food additive will expand the utility of under utilized whey/soy protein powders.

c. Scope of Impact – National

Key Theme: Food Quality

a. Issue: Foods and food ingredients are widely used in a variety of applications. Consistent sensory quality is required to optimize existing markets and to expand into new market segments. Flavor problems (off-flavors or inadequate product understanding or market positioning) cause the food industry billions of dollars every year. Consistent quantifiable ways to document and compare flavor in the industry are lacking. Further, an understanding of the relationship between chemical components and their impact on sensory perception of flavor is lacking. The goal of this research program was to provide quantifiable and applicable ways to document and compare sensory perception of flavor and to further define the role that specific chemical components of food have on sensory perception of flavor.

b. Impact: Standardized sensory languages have been developed for application with cheese, butter and dry milk/whey dairy ingredients. Instrumental and sensory techniques to link specific chemical compounds with flavor were also developed. Fundamental and usable technologies are provided through the development of quantifiable and validated sensory languages for dairy products. The role that specific chemicals(s) play on sensory perception of specific flavors lays the groundwork for an understanding of how to control, maximize, or prevent formation of specific flavors and/or flavor profiles in foods which helps to maximize quality and market demand. Effective marketing strategies can also be developed. The value of these tools and findings to the dairy industry has been estimated at more than one million dollars per year.

c. Scope: National

KEY THEME: Food Handling and Quality

a. Issue: Considerable quantities of edible meat from trimmings and deboned carcasses of meat, poultry and fishes continue to be wasted, and many smaller pelagic fish species are hardly utilized for food, being converted primarily to fish meal for animal feed.

b. Impact: Food Science researchers, working in conjunction with colleagues at the University of Massachusetts and the University of Florida, have developed two important processes to address this

challenge. Firstly, a new method of recovering and refining such meats, which removes fat, connective tissues (including skin) and bone, was developed and is being commercially implemented into the seafood industry this year: four commercial manufacturing plants will soon be online (3 in the US; 1 in Iceland). Meat and poultry applications will be initiated soon now that acceptable labeling has been approved by the USDA. Secondly, a method of solubilizing and injecting this meat protein into intact fillets and cuts of meats, poultry and seafood was developed. In tandem these technologies enhance the texture and taste (succulence) of meat, poultry and fish products while reducing the cost to consumers. Considerable value can be added to both the recovered meat and the treated meat cuts as a result. Because profit margins in the muscle foods industries are relatively small, this additional boost in value will provide tremendous returns to the industry while keeping the cost of muscle foods lower for consumers, worldwide. The new meat recovery method also reduces treatable effluent from meat, poultry and seafood processing factories.

c. Scope: State Specific

Key Theme: Food Security

a. Issue: Foodborne disease is increasingly recognized as an important public health issue, with current estimates citing as many as 76 million cases per year with up to 9000 deaths. Since the events of September 11, 2001, the potential for food bioterrorism also has received significant attention. Development of rapid detection methods for foodborne pathogens is a critical need if we are to adequately address both public health and homeland security issues associated with food safety. Unfortunately, most pathogen detection methods are designed to test for a single organism per assay. Furthermore, the pathogen(s) of concern are usually anticipated before applying the detection method, meaning that it is difficult to screen samples for multiple, "unknown" pathogens. To facilitate effective screening of foods for intentionally added pathogens, an assay is needed that can detect the most relevant foodborne pathogens in a single test.

b. Impact: We have developed a prototype method to detect multiple foodborne pathogens and demonstrated that it works at detection limits required for the protection of foods from intentional and unintentional contamination with pathogens. Improved testing methods such as these will provide food processors with a way to assess the microbiological safety of products and monitor contamination within the processing environment. It will also facilitate the screening of foods for intentionally added pathogens. With further development, our prototype can be used to help assure the safety of food, decrease testing costs incurred by the food industry, and protect our food supply from acts of bioterrorism.

c. Scope of Impact – National

Key Theme: Food Quality

a. Issue: Probiotics are microbial cultures that are considered to provide a variety of health benefits, including stimulation of the immune system, maintaining the proper microbial balance in the gastrointestinal tract, limiting antibiotic associated diarrhea, cancer retardation, antagonism to enteric pathogens, and reduction of intolerance symptoms to lactose. The predominant group of microorganisms considered to elicit these probiotic properties are members of the lactic acid bacteria, most notably species of Lactobacillus and Bifidobacterium. NCSU researchers and others in collaboration with a sequencing laboratory at the California Polytechnic State University, completed the genomic sequence of Lactobacillus acidophilus NCFM, the probiotic culture used widely in yogurts and

Sweet Acidophilus Milk. The project is continuing efforts to identify genes in L. acidophilus that are important to probiotic functions and determining whether or not expression of these genes are affected when the bacterium is exposed to dairy components, products, and environments.

b. Impact: One region responsible for the Lactobacillus acidophilus NCFM's ability to metabolize complex carbohydrates was characterized in depth. Complex carbohydrates are naturally found in breast milk and are known to selectively stimulate the growth of beneficial organisms, such as lactobacilli and bifidobacteria in the gastrointestinal tract. Genomic efforts directed toward many members of the lactic acid bacteria are now revealing the mechanisms through which these organisms preserve our food, colonize our gastrointestinal tract, and evoke important benefits to the general health and well being of humans.

c. Scope of Impact – National

National Goal 3: A Healthy, Well–Nourished Population

Human Nutrition and Human Health

Overview

A healthy, well-nourished population is productive and effectively contributes to a vital and improved society. Although the supply of food resources in the United States is among the most abundant in the world, there are segments of the population that live in poverty and are under-nourished. These circumstances, combined with the problems of inadequate access and delivery of health care place many Americans in a difficult and undesirable standard of living. Still others, who have access to abundant food and health care, often do not have the knowledge and training to make informed decisions about proper diet and exercise to promote a healthful lifestyle. In addition, rapid and accurate disease detection and prevention are necessary components for contributing to healthy individuals and a healthy population.

Insects and related arthropods directly impact quality of life as vectors of major diseases of humans, their pets and domestic livestock and poultry. They further serve as serious pests through direct feeding on humans and animals. Finally, these pests are nuisances and reduce property values by destroying the buildings in which we live. Each of these aspects results in serious economic losses to our state and the nation as well as reducing the quality of life enjoyed by citizens. Therefore, objective, science-based research is necessary to provide citizens, educators, and others with the best information and decision-making tools possible to ensure a healthy population.

To address relevant aspects of human nutrition and human health, research is carried out in various areas, including disease prevention and health promotion, nutrient availability and absorption associated with food choices, habits, and consumption, the linkages between nutrition and disease prevention, and the improvement of quality of life. The performance goals for this program area are primarily focused on the level of adoption of human health practices and hazard reduction, centering on food choices, habits and consumption; food safety issues as related to overall consumer health and well-being.

Performance goal 1 seeks adoption of human health and hazard reduction strategies centering on food choices, habits and consumption.

- Quantifiable and applicable ways to document and compare sensory perception of flavor and to further define the role that specific chemical components of food have on sensory perception of flavor are being developed.

- A protocol for continuous flow microwave processing of sweet potato puree was developed. Several food processing companies have conducted test runs on the microwave unit in our pilot plant, and the results of the runs have interested several of them in pursuing this technology. A patent application was filed based on the results.

Performance goal 2 addresses the issues of food safety as well as overall consumer health and well-being. Some investigations in this area include the following:

- A study involving mutating genes for enzymes of the Campylobacter jejuni indicates the characterization of the energy metabolism pathways and enzymes of C. jejuni is an important first step in developing specific inhibitors of this food-borne pathogen.

- A study demonstrated that low concentrations of certain pesticides are capable of dramatically altering in vitro hormone metabolism in humans, providing an alternative explanation for endocrine disrupting effects of pesticides.

- Several methods have been used to make genome-wide historical inferences of mutation, recombination and inbreeding in the genome of *P. falciparum*, the causative agent of malaria. These can be used help identify genomic regions that allow *P. falciparum* to adapt to new environments and will facilitate the development of strategies to control it, as well as our understanding of the degree to which humans have influenced the global spread of *P. falciparum*.

- In response to the issue of whether some environmental chemicals may be eliciting toxicity to humans and wildlife by interfering with normal endocrine function, a research and training program aimed at the following is operational:
    1) Documenting incidents of environmental endocrine disruption.
    2) Elucidating mechanisms by which chemicals elicit endocrine-disrupting toxicity.
    3) Developing tools to monitor for the presence of endocrine-disrupting toxicity in the environment.
    4) Evaluating the consequences of endocrine disruption to both humans and nonhuman species.
    5) Develop means for assessing toxicity of chemical mixtures, as they occur in the environment.

- Researchers at NC State University, Duke University and Northwestern University are utilizing egg-laying chickens to evaluate two chemopreventive agents (levonorgesterol, as used in birth control pills, and a new drug, 4-HPR, developed at the National Cancer institute) for their potential to reduce the incidence of ovarian cancer. The chicken model is supporting the development of acceptable preventive programs and provides a more rapid evaluation mechanism for new preventive therapies for human ovarian cancer. The avian model allows for chemo-prevention screening at an accelerated rate (2 years versus 5-7 years to screen in women) at a greatly reduced cost to society. Chemo-prevention studies in women cost an estimated $50 million, compared to $500,000 in birds.

Performance goal 3, attempts to develop methods for mitigating impacts of insects and related arthropods as vectors of human and animal diseases, as direct pests of humans and their domestic animals and livestock, and as pests of human habitations and institutional buildings, has been focused on by the following research:

- In 2005, one third of all cases of tick-borne Rocky Mountain spotted fever (RMSF) in the US were reported in NC. An enhanced tick-borne surveillance project was initiated in Chatham County to determine the species of ticks that people were exposed to, and to estimate the true burden of disease from tick-borne illness. Surveys conducted on residential property revealed that tick populations were comprised (>99%) of the lone star tick, which is not a vector of the bacteria that causes RMSF. Molecular tests revealed that *Rickettsia amblyommi*, closely related to the bacterium causing RMSF, was prevalent in lone star ticks. Patients diagnosed with Rocky Mountain spotted fever could not be serologically confirmed as infected with *R. amblyommi*. However, sera from these patients retested against *R. amblyommi* gave positive results. These findings suggest that the high incidence of RMSF in NC is due to the emergence of a new tick-borne pathogen, *R. amblyommi*.

- An all-natural, botanical insect repellent, which is being commercialized as BioUD has been shown to be as effective as DEET against mosquitoes and has been proven effective against ticks and other insects. EPA registration is expected in 2007, and BioUD should be on store shelves for the 2007 summer insect and tick season. BioUD is non-flammable, can be used on young children, can be organically certified, and is derived from all natural sources.

- Work between researchers in the Department of Entomology at NCSU and the Department of Biology at Old Dominion University, has demonstrated that ticks regulate their reproduction by a steroid hormone, ecdysone, rather than by juvenile hormone as has been thought for several decades. For the first time, his discovery makes available the development of new methods for the control of ticks important in the transmission of many animal and human diseases.

- Exposure to the cockroach allergen is the most important risk factor for asthma in inner-city households. Intervention studies in homes have documented that clinically relevant reductions in exposure to cockroach allergen can be achieved with effective pest control alone. In collaboration with a team of scientists from NIEHS we documented that professional pest control companies require more training to achieve similar levels of pest and allergen reductions.

- The pest control industry continues to depend on calendar-based broadcast applications of broad-spectrum neurotoxic insecticides in food-service and residential structures, including homes, nursing homes, restaurants, and public schools. Research showed that relatively low-toxicity, reduced-risk insecticide baits are highly effective at reducing or eliminating cockroach pinfestations.

FTEs & Program Cost for Goal 3
Program cost is inclusive of federal Hatch funds appropriations, other federal contracts and grants, state appropriations, and other contracts and grant funds.

Federal App.	State App.	Fed G & C	Non Fed Grants	SY	PY	TY	CY
$358,878	$2,047,383	$298,913	$583,384	8.55	34.05	13.77	4.39

Key Theme: Human Health

a. Issue: Osteoarthritis (OA) is a severely debilitating disease that affects articular joints resulting in cartilage degradation over time. Morphological changes in the development of osteoarthritis have been documented in many studies using in vivo and in vitro models. However, the molecular mechanisms underlying the degeneration of the articular cartilage, leading to osteoarthritis, are mostly unknown. Evaluation of changes in gene expression levels in experimental OA models have been reported in the last five years and have shed some light on the early changes leading to the disease but these studies provide conflicting data for many of the genes thought to be involved in OA. Two Serial Analysis of Gene Expression (SAGE) libraries were constructed from impacted and non-impacted pig patellae. Over 30,000 SAGE tags from each library have been sequenced and 17 of these tags are differentially expressed between the two libraries. Of these 17 tags, 2 have no known gene match in known pig sequences and the remainders have gene identifications. Of the 15 identified genes, most have previously been implicated in some form of arthritis. Currently these differentially expressed genes are being validated in additional tissues using real-time quantitative PCR.

b. Impact: Knowing the changes that occur in chondrocyte gene expression following an impact injury and how these changes relate to the observed tissue damage will provide insights into the progression of early degenerative changes in the cartilage tissue for both humans and animals. If we can gain a better understanding of the early degenerative changes that precede full blown OA we will be better able to treat the disease and prevent the debilitating changes that occur further down the road. Controlling the early degenerative changes holds the most promise for preventing or mitigating the disease process.

c. Scope of Impact: State Specific

Key Theme: Human Health

a. Issue: Human ovarian cancer is a disease that results in deaths in more women than all other gynecological cancers combined. In the United States, 27,000 to 28,000 women are diagnosed with the disease annually, with 16,000 to 17,000 deaths. Ovarian Cancer is not easily detected and is often discovered in advanced stages, therefore searches for early detection methods or markers are gaining headway. The chicken has been shown to be a viable model because of their high rate of naturally occurring ovarian cancer and the epithelial, or surface, cells of chicken ovaries are similar to the epithelial cells of human ovaries and appear to respond to the hormone progestin in the same manner as those of humans. In addition, it has been found that there is a marker CA-125 that is a blood borne component when ovarian tumors are present. Researchers at North Carolina State University and Northwestern University have utilized egg-laying chickens as a model for studying prevention strategies of ovarian cancer. Recently completed research using Levonorgesterol, progestins like those found in birth control pills, and elevated Vitamin D is completed and the data are being evaluated as a means of inhibiting the development of ovarian adenocarcinomas. The blood borne markers in chickens that are also present in humans may be useful for evaluating potential detection methods for early detection of human ovarian cancer, which could potentially save many human lives. There is a strong relationship between the human and avian CA-125 marker. One potential marker being examined is CA-125 a blood borne marker associated with the presence of ovarian cancer.

b. Impact: This model will enhance the ability of medical researchers to identify potential markers to help verify and determine the efficacy of cancer chemopreventive drug regimens. This model may support the development of acceptable preventive programs and provide for an early detection mechanism for ovarian cancer.

c. Scope of impact: National

Key Theme: Human Health

a. Issue: Food-borne human illness and antimicrobial resistance in bacteria continue to play major roles in the national human health arena. Integrators own the processing plants and realize that there is only so much that can be done at the processing level to prevent carcass contamination. Presenting birds to processing with lower levels of contamination may be the next logical, but costly, step. The need to determine the role of antimicrobial use in poultry husbandry and how that use might relate to human diseases caused by organisms resistant to antimicrobials is essential in order to provide scientific evidence to the debate regarding prohibiting the use of antimicrobials in animals. This is the first work to monitor turkey flocks for Campylobacter species. This work may well provide information that will move the focus from antimicrobial use in animals and re-focus initiatives on antimicrobial use in humans, an area likely to contribute to resistant bacteria. This study currently underway addresses both the issue of carcass contamination with Campylobacter and the issue of antimicrobial resistant organisms. The level of Campylobacter species contamination in turkeys is extensive. Contamination levels are quite variable in turkeys, the Campylobacter species present are variable, and the anti-microbial resistance patterns are variable. This work will provide much-needed scientific evidence to the debate surrounding these issues. The potential impact for the turkey industry will be great in terms of establishing guidelines for on-farm initiatives that are feasible and on providing evidence on what role administration of anti-microbial agents actually has on resistant strains of microbes in humans.

b. Impact: This work will provide much-needed scientific evidence to the debate surrounding these issues. The potential impact for the turkey industry will be great in terms of establishing guidelines for on-farm initiatives that are feasible and on providing evidence on what role administration of anti-microbial agents actually has on resistant strains of microbes in humans.

c. Scope of impact: National

Key Theme: Human Health

a. Issue: Many Americans do not consume diets that provide a safe and adequate amount of vitamins, minerals, and other nutrients. This project will address vitamin and mineral fortification of foods and beverages, assess the effects of vitamin and mineral supplementation in human and animal studies, and promote safe, adequate, and appropriate intakes of micronutrients and macronutrients.

b. Impact: Flavored water and sports drinks seem to be appropriate vehicles for calcium fortification to increase calcium intake in populations that have decreased milk intake in recent years. Development of a water-soluble form of vitamin D for this type of product has been achieved in this project. Improving these beverages through calcium and vitamin D fortification has the potential to reduce the risk for osteoporosis and related chronic diseases for consumers. Investigation of ingredients in sweet potato confirms the recognized low glycemic index of sweet potato and demonstrates that the glycemic index for sweet potato is lower that of white potato. With further research in this area, it may be possible to recommend that people with diabetes or insulin resistance consume sweet potato or use extracts of North Carolina sweet potato to help control blood glucose.

c. Scope of impact: National

Key Theme: Human Health

a. Issue: Many cases of food borne disease are caused by home prepared food, but the role of consumer food handling practices on the propagation of food borne illness is poorly understood. This project uses mathematical tools to evaluate the degree of risk to human health associated with poor handling practices of ready-to-eat (RTE) foods.

b. Impact: Food handlers have a significant role in the initiation and propagation of foodborne disease. However, current microbial risk assessment models either do not address, or address in a limited manner, the role of food handlers. This project will provide mathematical models which characterize food handling practices as they relate to foodborne pathogens, including cross-contamination, poor food handling practices such as time and temperature abuse, and the role of poor personal hygiene of infected food handlers. These efforts will strengthen our ability to more fully describe the entire farm-to-fork continuum in the microbial risk assessment process.

c. Scope of impact: National

Key Theme: Human Health

a. Issue: Environmental exposure to complex chemical mixtures and biotoxins poses a potential risk to both human and ecological health. However, measuring chronic exposure to broad chemical mixtures at these trace levels is currently requires a level of effort is rarely possible and thus risk assessment of chronic chemical exposure requires a new approach. This project proposes to develop a silicone-based time-integrative passive sampling device (PSD) to 1) measure chronic exposure to a broad suite of persistent organic pollutants (POPs) including polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons (PAHs), and organochlorine pesticides (OCPs), along with several larger molecular weight biotoxins (brevetoxins, microcystins); and 2) chemically modify the silicone PSD to include a polar sorption phase to the hydrophobic PSD matrix to increase the sorptive capacity of polar contaminants (pharmaceuticals, current-use pesticides, domoic acid), while at the same time, retaining the ability to accumulate nonpolar compounds.

b. Impact: This work will allow us to understand and quantitatively model the mechanisms controlling water-particle partitioning and bioavailability of chemicals in the environment. This will lead to more accurate and quantitative human and ecological risk assessments. This work also will provide a much better means of measuring chronic environmental exposure to chemicals.

c. Scope of impact: National

National Goal 4: Greater Harmony Between Agriculture and the Environment

Overview

Goal 4 focuses on efforts to enhance cooperative and collaborative efforts to protect the environment and preserve natural resources while promoting a strong and diverse agriculture. Agricultural producers, agribusiness professionals, public officials, agency personnel, special interest groups, university research and outreach personnel, and the general public are all concerned about environmental quality in North

Carolina. Mandates from state government to reduce odor and eliminate the use of lagoon/sprayfield waste treatment systems in confined animal operations are having a significant impact on the direction and urgency of research and outreach efforts in the environmental area.

The research activities associated with Goal 4 are aimed at enhancing our understanding of the physical, biological and chemical processes and interactions influencing agricultural and forest ecosystem impact. Interdisciplinary research projects will advance knowledge of natural processes to enable development of production management and environmental protection technologies that will increase productivity; improve input efficiency; conserve natural resources; and improve and protect environmental quality. Other research activities conducted under Goal 4 have concentrated on understanding relationships between soil fertility and plant communities; identifying biological and physio-chemical factors that influence establishment and growth of trees; developing improved understanding of the habitat factors that influence reproduction and survival of terrestrial wildlife; and identifying environmental factors that influence the reproduction, recruitment and survival of fish. Some of the research efforts and outcomes under Goal 4 follow.

- Two types of samples were taken from a tunnel-ventilated house of a commercial broiler chicken farm in NC for their physical and chemical characteristics analysis. Significant change in particle size distribution (PSD) between samples inside the house and at the ventilation fans indicates rapid deposition of particulate matter (PM) in a short distance. This study provides a comprehensive description of the physical, chemical and biological properties of PM emitted from typical AFO buildings. Combined with studies in particle transport and fate, this database will provide useful data for the development of regulations and control strategies on PM emissions from confinement livestock buildings.

- Pilot studies were implemented to demonstrate and evaluate alternative channel management strategies and design geometries to enhance water quality functions while maintaining the necessary drainage function. Although providing significant environmental benefit, the alternative practices were more expensive and resulted in two to three times more land area being taken out of production compared to conventional drainage practices. The added costs may not be justified by increased drainage benefits to the landowner.

- NCARS is upfitting a research building on the Lake Wheeler Field Laboratories campus in order to conduct cutting edge air and waste management research to better understand the mechanisms associated with pollution (gases, dust, odor, etc.) production and to study ways and means for managing and reducing those problems. Environmental chambers, which can simulate the conditions that animals are grown in, will be used to study the processes that govern both the production and transport of air- and water-borne emissions.

- Hybrid striped bass (HSB) production is being studied at two sites in eastern North Carolina in order to reduce potential pollution from current practices of pond draining after harvest. Comparisons between current practice and zero discharge practice will be made based on fish health and economics. This commercial-scale work is the first such study on HSB.

- Response of NH3 emissions to litter moisture content has been comprehensively investigated under laboratory-controlled conditions. The results of this study fills the gap in estimating magnitude of litter moisture content impact on NH3 emission for different litter ages and litter types, and provides valuable information in designing practical and cost effective strategies to control ammonia emissions from broiler houses.

- Simulation models developed at NC State are being widely used to guide design, management, and regulatory decisions regarding poorly drained agricultural lands and wetlands. Recent completion of a new user interface makes it easier to apply DRAINMOD in all of its applications. The models have been used to develop short cut methods that can be more easily applied. A simulation study resulted in a simple method of estimating required drainage intensities for eastern U.S. Results of our studies will enable engineers and technicians to use simple methods to design drainage systems to fit the soils and conditions for a given site.

- A 2-yr study is being conducted to measure ammonia emissions, in-house ammonia concentrations, and productivity parameters (e.g., bird weight, feed conversion) from commercial broiler houses that receive different rates of PLT®. This study will provide ammonia emissions factors from broiler houses and litter stockpiles receiving different rates of amendments. It will also provide detailed cost-benefits data on using different litter amendment rates. Quantification of specific gaseous emissions will provide the necessary data to determine what, if any, limitations should be implemented in the form of regulations, and to establish whether cultural changes in the growing of broilers to minimize emissions are warranted.

- Bioethanol production from cellulosic materials, such as switchgrass and Bermudagrass, can be a great supplement to ethanol production from corn. Growing Bermudagrass is a typical practice for nutrient management in the North Carolina swine industry. However, there is a very limited market for Bermudagrass in North Carolina. Converting grass to ethanol provides a great opportunity for the state's hog farmers and rural economy. Switchgrass can be grown on marginal land and produces biomass at a rate much higher than most crops. Collaboration with Novozymes, a biotech company, and North Carolina agricultural industry is underway.

- A modified portable multi-gas (CO_2 & NH_3) unit (PMU) has been developed and tested under both laboratory and commercial farm conditions for accuracy, repeatability and stability. This study will provides comprehensive information about the ozonation technology that may potentially help solve current and future environmental, sanitary, and human occupational risks associated with broiler production. This study will aid in identifying possible toxic effects or other adverse effects in use of O_3 in poultry production facilities. The findings will provide data for a cost-benefit analysis of O_3 use in broiler production.

- The North Carolina Fish Barn program has been active in the development and dissemination of recirculating aquaculture production technology. Most new facilities planned for North Carolina will utilize this technology. Recent results from our testing indicate that this technology combined with a sterilization (UV light or ozone contact) process will allow the user to re-use much of the wastewater that otherwise would be irrigated on adjacent crop land. This technology is also being investigated for use in marine aquaculture. Complete reuse of seawater through a modified geotube water treatment process would allow for the production of marine finfish away from expensive coastal sites on less expensive farm land in North Carolina.

- Field studies have been completed that evaluated the agronomic effectiveness of incinerated animal waste as a phosphorus fertilizer. Wheat, corn, and soybean response to commercial fertilizer P was compared to the response with the animal waste P product. No significant differences between products were observed over the two years of field evaluation.

- Animal scientists are currently evaluating the effects of fiber type and level in the diet of swine on ammonia and odor. Addition of non-starch polysaccharides increased the concentrations of VFA in feces, but decreased concentrations of ammonia, indole, and skatole. A panel analysis of odor intensity of fecal samples from pigs fed different levels of fiber and of air samples collected from odor chambers that housed pigs fed different levels of dietary fiber has been completed. Analysis of those results is currently underway.

FTEs & Program Cost for Goal 4
Program cost is inclusive of federal Hatch funds appropriations, other federal contracts and grants, state appropriations, and other contracts and grant funds.

Federal App.	State App.	Fed G & C	Non Fed Grants	SY	PY	TY	CY
$304,064	**$3,999,102**	**$725,095**	**$559,823**	**12.21**	**30.76**	**26.24**	**5.45**

Key Theme: Water Quality

a. Issue: Pilot studies were implemented to demonstrate and evaluate alternative channel management strategies and design geometries to identify alternatives that would enhance water quality functions while maintaining the necessary drainage function. Channel alternatives included: establishment of in stream and riparian wetlands, lowering of the floodplain to reconnect the channel with the floodplain, redesign of channels using natural channel design principles, and establishment of conservation easements to encourage establishment of perennial riparian buffer vegetation. Hydrology and water quality were monitored from one to three years at each site. In addition, plant communities and macro-invertebrates were monitored at three sites.

b. Impact: Nitrogen transport was reduced by 20-40% with in-stream wetlands. Reconnecting the channel with the floodplain dampened the hydrograph peak and reduced the "out-of-floodplain" risks outside the project area. These projects accomplish the first step in the evaluation process which is to demonstrate technical feasibility. The alternative practices were more expensive and resulted in two to three times more land area being taken out of production compared to conventional drainage practices. The project costs in these studies ranged from a low of about $40/linear foot of channel to $140/linear foot of channel. However, the benefits were improved water quality, lower peak outflow rates, and enhanced habitat for wildlife. It is concluded that there are environmentally friendly alternatives to traditional practices of frequently cleaning and mowing trapezoidal ditch channels to achieve drainage requirements. However, in most cases, the added costs may not be justified by increased drainage benefits to the landowner. Therefore, it becomes incumbent on society to put a value on the water quality and ecological functions achieved to determine if public funds should be used to help landowners offset the costs of achieving the additional water quality and ecological functional benefits.

c. Scope of Impact – State Specific

Key Theme: Air Quality

a. Issue: *An experimental study of three measurement techniques in NH_3 emission measurement was conducted in well-controlled test facilities.* Litter samples were tested simultaneously by the chemiluminescence NH_3 analyzer and the acid scrubber system to derive emission fluxes. In the meantime, a litter nitrogen mass balance approach was also applied in the study. The chemiluminescence

NH_3 analyzer provided multiple measurement points through a testing period that show emission trend, whereas the acid scrubber measurement only provided a single average emission measurement through a test. However, results of this study also show that measurements of the chemiluminescence NH_3 analyzer are significantly higher than the acid scrubber measurements. It is suspected that there may be other gas emissions in forms of NO or NO_x which were detected and reported as NH_3 by the chemiluminescence NH_3 analyzer, whereas the acid scrubber measurement would not have such errors. There were some negative fluxes obtained from the mass balance approach It is suspected that the nitrogen content distribution in the litter samples was not uniform, which may cause higher measurement of nitrogen content in the ending litter compared with the content in the beginning litter.

b. Impact: This study provides a better understanding of advantages and pitfalls associated with the most commonly used NH_3 emission measurement techniques. It will be helpful in improving air emission measurement protocols from broiler operations.

c. Scope of Impact – State Specific, Multistate research

Key Theme: Soil Erosion/Water Quality

a. Issue: Soils researchers are providing evaluations of current and newly developed systems to reduce off-site movement of sediment. Studies are continuing on how effective polyacrylamide (PAM) can be in various settings: erosion control on slopes and turbidity reductions in runoff control structures. Researchers are cooperating with the Aquatic Toxicology Unit in the Division of Water Quality (NCDENR) to determine potential impacts of PAM on aquatic organisms.

b. Impact: Using aerial color infrared photography of corn and wheat fields to determine where N fertilizer is needed and in what quantity can help optimize N-use efficiency and improve N fertilizer profitability for producers. Optimizing N fertilization sometimes, but not always, minimized the amount of excess N that can pollute ground and surface waters. The statistical methods developed will have widespread application to the analysis of precision agricultural research worldwide.

c. Scope of Impact – State Specific

Key Theme : Wetlands Restoration and Protection

a. Issue: North Carolina State University, with support from the North Carolina Ecological Enhancement Program, is evaluating techniques for restoring and creating wetlands at several sites. Research and monitoring indicate that within a few years restored wetlands provide many of the functions and values of natural wetlands. Tidal brackish-water creeks, which will drain a portion of a restored wetland, were constructed at North River Farms in Carteret County. The riparian areas associated with this drainage system were graded to the elevations required to support inter-tidal marshes. Native vegetation adapted to each elevation and salinity zone was planted during late spring and summer creating new fish and wildlife habitat. The marsh vegetation will also be an important part of the water quality improvement goals of the project. A portion of the drainage water from Open Grounds Farm was routed through the drainage creeks. During high tides and high flow events, drainage water passes through the restored riparian marshes. The goal of the research in progress is to measure and document establishment and growth of marsh vegetation in the restored riparian zone, and to determine the role of the vegetation and soil in improving water quality by removing and accumulating sediments, nitrogen, and phosphorus.

b. Impact: Successful wetland restoration has positive environmental and economic benefits. It is an environmentally sound method of increasing natural habitat. Wetlands also remove pollutants from water flowing through the marsh vegetation and soils. Returning prior converted farmland that is located adjacent to sensitive estuarine waters to wetlands is expected to improve water quality and allow shellfish beds to be opened for harvesting and remain productive.

c. Scope of Impact – State Specific, Multistate Research

Key Theme: Water Quality

a. Issue: The nitrogen simulation model, DRAINMOD-N II, was developed to simulate nitrogen dynamics and turnover in the soil-water-plant system under different management practices and soil and environmental conditions. The model was successfully tested using a six-year data set for an artificially drained site in the North Carolina Lower Coastal Plain. Another field testing was conducted using a six-year data set from Indiana. These testing exercises are necessary to prove the reliability of model predictions.

b. Impact: Researchers as well as state and federal agencies can potentially use the nitrogen model, DRAINMOD-N II as a tool for the development and evaluation of agronomic and water management practices that reduce nitrogen loading to receiving waters while maintaining or improving the productivity of agricultural lands.

c. Scope of Impact – State Specific

Key Theme : Natural Resources Management

a. Issue: Biological and Agricultural Engineers at NC State have completed design and implementation of an innovative coastal stormwater Best Management Practice that diverts stormwater from ocean outfalls into the dune system at Kure Beach, NC.

b. Impact: An innovative coastal BMP, a Dune Infiltration System (DIS), was designed to divert stormwater from the outfalls into the dunes with a bypass system for larger storm events. Constructed with a series of commercially available open bottomed HPDE chambers buried beneath the dunes at two different sites, post-construction monitoring of these systems has shown that this design is economically and technically feasible. The dune system remains stable, handling storm events larger than anticipated. For example, precipitation associated with Tropical Storm Ernesto totaled approximately 10 cm (4 in). Based on our monitoring, this produced approximately 720 m^3 (190,000 gallons) of runoff in 48 hours from the two watersheds connected to the DIS – all of which was diverted into the dune rather than entering the ocean directly. Only on four occasions during the first 25 storms monitored did overflow of stormwater to the ocean occur. Overall bacterial concentrations have been reduced by over 97%, based on measurements of storm water inflow and groundwater concentrations during and immediately following storm events.

c. Scope of Impact – State Specific

National Goal 5: Enhanced Economic Opportunity and Quality of Life for Americans

Overview:

Solutions to problems faced by the agricultural community and rural residents depend partly on timely and effective research on the part of the Land Grant system, in general, and the Colleges of Agriculture and Life Sciences, in particular. Social and economic restructuring, the reorganization of agriculture and natural resource-based industries, de-industrialization and outsourcing, the communications revolution, the shift to a service-oriented economy, alternative energy demands, and major demographic changes in population composition and processes are among the manifestations of the fundamental switch from a mostly rural to a mostly urban society.

The shift of jobs away from rural communities has brought with it a set of problems related to human behavior and health. Changes in policy for key farm products, and other events not under the control of North Carolina farmers, have contributed to further uncertainty and stress in rural communities. Today, the increasing demand for bio-fuels presents a new set of opportunities and challenges for farmers and rural communities. Many research results described here have helped to improve the atmosphere in which North Carolinians in rural areas live and work. Others have contributed to the development of strategies for improving the economic viability of rural communities. Still others have facilitated conflict resolution in areas important to the economy of rural North Carolina. Research undertaken this year has contributed to the general improvement in the quality of life for Americans, particularly those in the rural South.

FTEs & Program Cost for Goal 5
Program cost is inclusive of federal Hatch funds appropriations, other federal contracts and grants, state appropriations, and other contracts and grant funds.

Federal App.	State App.	Fed G & C	Non Fed Grants	SY	PY	TY	CY
$209,757	$999,559	$143,222	$0	5.47	10.17	1.59	2.85

Key Theme: Conflict Management

a. Issue: One project was successful in conflict resolution that affects two types of users of a fishery. The overall goal of this project is to promote cooperation and understanding among user-groups, and strengthen North Carolina's commitment to maintaining user diversity and public access to fishing opportunities and fisheries resources. Through this project, volunteer and professional mediators were trained to deal specifically with fisheries-related, multi-party disputes. The project team also worked with personnel from NCDMF to establish a referral program for targeting appropriate user conflicts to mediation.

b. Impact: Since the establishment of the pilot program in the summer of 2006, one conflict has been targeted for mediation and was mediated successfully. User conflicts in the Atlantic Ocean striped mullet beach seine fishery have existed along Bogue Banks since the mid-1980s, and have involved allocation issues between commercial gill netters and stop net crews. Successful mediation of this conflict resulted in striped mullet fishery remaining open to both gill netters and stop netters in 2006 by proclamation of the North Carolina Marine Fisheries Division Director.

c. Scope of Impact – State Specific

Key Theme: Conflict Management

a. Issue: Another project aims to improve our ability to resolve conflicts over the use of biotechnology. At the political level, conflicts are intensifying between countries that support the development of genetically modified crops and those that oppose such development (mainly the European Union and Japan). In fact the United States has just taken its case to the World Trade Organization over Europe's moratorium on crop approvals.

b. Impact: Research in this project has focused on factors affecting consumer acceptance of biotechnology and public attitudes about agriculture and on the practices that leading companies use to develop and market new food products. The results have helped to focus on possible causes of the conflict and the resulting perceptions generated. The information will be used in the resolution of these conflicts on the world stage.

c. Scope of Impact – State Specific & International

Key Theme: Impact of Change on Rural Communities

a. Issue: The following project has measured the total welfare effect of elimination of production contracts in the N.C. and U.S. hog industries. By eliminating the availability of production contracts in North Carolina, on average, the welfare gain of a cash/marketing contracts farmer outside North Carolina amounts to $44,185 per year and that of a cash/marketing contracts farmer in North Carolina amounts to $7,088. The difference comes from the fact that most of the cash farmers outside North Carolina operate on a larger production scale than their North Carolina counterparts. On the other hand, contract production farmers suffer welfare losses. For example, an average North Carolina contract farmer's welfare loss amounts to $80,892 per year. Finally, the aggregate welfare for all farmers in the U.S. resulting from banning production contracts in North Carolina is $3.28 billion. Hence, we can conclude that this hypothetical regulation would improve the welfare of farmers as a group but some farmers would win while some would lose.

b. Impact: Regulators and legislators can now make more informed decisions about production contracts in the hog industry, since they now have measures of the costs and benefits of eliminating them, a subject of consideration in both the N.C. legislature and the U.S. Congress.

c. Scope of Impact: State Specific

Key Theme: Impact of Change on Rural Communities

a. Issue: Another project examined the changes in the geographic pattern of tobacco production in North Carolina after the elimination of the Tobacco program. The specific goal was to understand the county-by-county effects of both the cash settlements to farmers and the elimination of tobacco price supports and quota restrictions.

b. Impact: The analysis answers the question: how will production within North Carolina relocate now that the tobacco program is gone and regional restrictions on tobacco production are lifted. Such information is vital in order to understand the economic impact of changes in tobacco policy. The study

team forecast that tobacco production in North Carolina will increase by 72% as a result of the elimination of the quota program. The distribution of that production increase is uneven: production should increase by 110% in the Old/Middle Belt, by 54% in the Eastern Belt, and by 91% in the Border Belt. The effects on growers of tobacco and previous owners of tobacco quota can be quantified as well. Producers, aside from their role as quota owners, gained from the elimination of the program. Aggregate annual gains were estimated to be $17 million in the Old/Middle Belt, $36 million in the Eastern Belt, and $11 million in the Border Belt.

c. Scope of Impact: State Specific

Key Theme: Impact of Change on Rural Communities

a. Issue: A project focused on identification and valuation of the non-pecuniary characteristics of crop biotechnologies at the farm level. Results from several past studies undertaken by the researchers were adjusted for bias according to a new methodology discovered during the course of this research. The results indicate that farmers value the improved human health and safety, the improved environmental impact, the risk reduction, and the improved convenience of the biotech crops.

b. Impact: This information has been used in regulatory decisions at the Federal level and in international negotiations involving biotech crops.

c. Scope of Impact – National & International

Key Theme: Jobs and Employment

a. Issue: There are many domestic industries experiencing large declines in product demand due to lower cost competitors from abroad. A prominent example is the U.S. textile industry, once central to the North Carolina economy. Thousands of workers become displaced annually due to import competition, among other reasons. How these workers fare after displacement in terms of their re-employment wages and jobless spell duration are important questions to answer in light of the increased globalization of our state and country.

b. Impact: A research project was undertaken to examine the effect of imports from developed and developing countries on the U.S. labor market. Using county-level data, it was determined that when U.S. counties with higher endowment of high-skilled (non-production) workers engage in more trade with low-skilled labor-abundant countries, they experience greater demand for their high-skilled labor. The magnitude of the estimated elasticity of the wage bill of non-production (high-skilled) workers relative to that of production (low-skilled) workers with respect to trade with low-skilled labor-abundant countries is 0.5. This means that as trade from such countries increases by 10 percent, the wage bill of non-production workers relative to that of production workers in the U.S. rises by 5 percent. These results are important inputs into trade policy discussions and have already influenced current WTO negotiations.

c. Scope of Impact – International

Key Theme: Supplemental Income Strategies

a. Issue: A project examined the determinants of the farm-to-market price difference for food and found that increases in the price "spread" are due to increased consumer incomes, which created increased demand for food. The relative importance of increased consumer demand for food, through rising real

incomes, suggests that consumers are continuing to demand goods with higher value added. Farmers could benefit from offering value-added products that are more consistent with what consumers want.

b. Impact: In support of the research results above, a new effort was launched to assist North Carolina farmers in developing value-added products. With the assistance of the Department of Communications Services a new website, www.cals.ncsu.edu/value-added, was developed for educational resources for value-added and alternative agriculture. The website is targeted to CALS field and campus faculty. Business management and entrepreneurial resources are the focal point of the website. The website also features current articles on CALS programs and faculty in value-added and alternative agriculture, provides information and assistance on grant writing, and provides links to other major programs and resources in value-added and alternative agriculture.

c. Scope of Impact – State Specific

B. Stakeholder Input Process

The North Carolina Agricultural Research Service (NCARS) is committed to seeking, receiving and utilizing input from all stakeholder groups, including under-represented groups and the general public. A significant portion of the input from individuals throughout the state comes from interactions of research scientists with county-based Extension personnel and directly with producers, industry and other agribusiness representatives. Approximately 100 research faculty also have Extension appointments. These faculty are the primary day-to-day communication link between agribusiness, county extension centers and NCARS. Because their research and extension activities are directed toward the development-implementation phase of new knowledge and technology, they are constantly relating industry needs and suggestions to other researchers whose emphasis is more in the discovery phase. In addition, these faculty interact with county Extension personnel in such a way that input from individual consumers is also effectively communicated to NCARS administration and faculty.

To enhance our efforts to connect with stakeholders, the Dean has moved to implement a commodity based workgroup structure in which CALS Research-Teaching-Extension workgroups would be identified that focus on specific commodities or groups of commodities. These work groups would facilitate bi-directional flow of information regarding research needs and priorities and outcomes and impacts of our research efforts. Part of the plan would involve the work groups meeting annually with the commodity groups for the purpose of sharing mutually beneficial information.

Stakeholder input utilized in determining research directions is also received through numerous associations. NCARS interacts with 90 official commodity and agricultural industry associations from within North Carolina. A College of Agriculture and Life Sciences administrator is appointed as the official liaison for each of these associations and attends at least one, and sometimes more, of their meetings or conferences each year. During these meetings, opinions and facts related to the needs and concerns of that industry sector are obtained through both formal presentations and informal conversations with attendees. The NCARS representative is always introduced early in the meeting so that any individual there can contact them and discuss whatever issues they desire. In addition, the college has employed a Director of Commodity Relations, who reports directly to the Dean and coordinates the activities of the liaisons. This individual also has responsibility for working with any association that has a need or concern relative to the college's programs, particularly if it might involve any state or federal legislation.

Of the 90 state agricultural industry associations, 24 provide funding to various research projects annually, usually on a competitive basis. In these cases, the association board give NCARS information on high-priority research areas to be used in the request for proposals, and the board decides which proposals to fund. This is the most targeted type of stakeholder input, having a direct effect on research activities within NCARS

NCARS leadership team interacts deliberately and frequently with leaders in the North Carolina Agricultural Foundation, N. C. Farm Bureau Federation, N. C. State Grange, North Carolina Department of Agriculture and Consumer Services, the N. C. Agribusiness Council and numerous other allied organizations that provide insight on research needs and priorities. These groups and organizations assist in program reviews, as well as advocate for the NCARS agenda by promoting the importance of agricultural and life science research.

Many of the departments within the College of Agriculture and Life Sciences have formal advisory groups with stakeholder members that meet on a regular basis to provide input and guidance into the department's research programs. There are 21 such advisory groups among the 18 research departments that meet at least once per year, and their membership includes a total of over 200 stakeholders from a wide range of agricultural interests. In addition, there are currently nine formal centers within the college with industry advisory boards that meet at least twice per year, adding another 60 stakeholders providing NCARS administrators and scientists input and direction from research programs.

NCARS receives support annually from college-based foundations, including the Agricultural Foundation, Tobacco Foundation and the Dairy Foundation. These foundations fund research projects and graduate students on a competitive basis across a wide range of areas. NCARS administration meets with the Research and Extension Committees each fall to hear discussion of priority areas for research activity in all aspects of agricultural production and agribusiness. Then in late winter, these committees meet again to select and approve research projects for funding, which provides another opportunity for input on research priorities.

As greater emphasis is being placed on integrated Extension and Research efforts, top administrators and program personnel hold both Research and Extension appointments and duties. These personnel continuously interface on decisions for program prioritization, budgeting, staffing, and a greater exchange of information from the state's citizens to assure that all audiences are identified and served to the extent that the mission and resources of the these Research and Extension program make such coverage possible. This research, extension interface for program prioritization and meeting the needs of potentially underserved audiences is assured by the means already articulated, but especially via the extensive organization and operations of the Extension Advisory Leadership System which has major responsibility in obtaining stakeholder input through out the program development process. Members of the State Advisory Leadership System and county Advisory Leadership Council represent geographical, cultural, ethnic, and economic diversity of the state's population. In addition to Advisory Leadership Councils, each county and the Cherokee Indian Reservation have specialized committees with responsibilities for review of overall programming, collaborating in needs assessments and environmental scans, and marketing extension programs and impacts. These specialized committees provide specific program input for individual commodities, issues and ongoing program needs. Membership on both the council and the specialized committees represents the diversity of the respective county population including under-served populations and retired professionals from business, extension and other relevant organizations and agencies. While the advisory council will meet quarterly, the specialized committees will meet at least annually to discuss accomplishments and needs still to be addressed and techniques to market extension. This system is monitored administratively to assure that stakeholders provide such program input and

actions. Many of these citizens also serve in the decisions relating to the commodity associations and foundations as described above.

The integrated programming structure and thrusts of Research and Extension assures that local citizens, local and regional Research and Extension personnel as well as statewide specialists interface directly with local citizens in identifying their specific needs, and emphasizes that those local citizens are included in programming functions that assures that non traditional audiences and underserved audiences have great opportunities for direct interface and needed services as applicable and appropriate. One example of this special attention to underserved audiences was the provision of Spanish language handouts at a tomato field day program that was attended by both English and Spanish speaking individuals.

C. Program Review Process

There have been no significant changes in the program review processes since the NCARS 5-Year Plan of Work was submitted.

D. Evaluation of the Success of Multi and Joint Activities

Evaluation of the Success of Multi and Joint Activities

North Carolina State University faculty was involved in 27 Multi-State Research Projects in the Southern Region, and in other regions. These activities were all multi-state, multidisciplinary and involved integration of research and extension. They continue to be an excellent vehicle for collaborative, coordinated research and a broad-based, systematic approach to solving problems relative to the Southern Region and the nation. The impacts of these projects are indicated in the respective Goal Reports as well as the in the Integrated reports. Some examples of multi-state, multidisciplinary, integrated activities are discussed below.

Genetic and Functional Genomic Approaches to Improve Production and Quality of Pork

Pork quality and disease resistance involve complex systems that require a multi-disciplinary approach to develop an understanding of the underlying genetic factors and to develop strategies for their genetic advancement. This research addresses the genetic control of product quality, animal health, and environmental sustainability. Specific aims are to a) identify and confirm putative QTL regions, b) identify and confirm the roles of candidate genes, c) further evaluate the role of genes using expression technology, d) evaluate direct and correlated responses to selection, and e) develop strategies for the use of this information in breeding programs.
Cooperating States: AL, IA, IN, NC, NCAT, NE, and OH

Mineral Controls on P Retention and Release in Soils and Soil Amendments

This phenomenon is a concern at a wetland restoration site (Juniper Bay) in southeastern North Carolina. Our research objective was to measure reductive P dissolution in soil samples ranging from organic to mineral soils collected from this drained, 250 ha Carolina Bay that had been farmed for up to 30 years before wetland conditions were restored. Wetland restoration is essential to counteract loss of wetlands to development. Excess levels of phosphorus in soils receiving animal waste contributes to the problem of

water quality deterioration. This project will evaluate the forms of phosphorus in phosphorus-enriched soils to better develop management practices that minimize phosphorus impacts on water quality. Relate soil mineralogical properties to organic and inorganic P speciation, release, and saturation/retention capacity; and (2) evaluate the influence of solid phase speciation of P on the partitioning and mobility of trace element contaminants (e.g., As, Se, Cu, and Zn).
Cooperating States: Southern Region

Benefits and Costs of Resources Policies Affecting Public and Private Lands

Many important environmental services, such as recreation, are not traded in the market. This project develops methods to value these environmental services for use in cost-benefit analysis. The purpose of my work in this project is primarily methodological. The KT model is a relative newcomer and further methodological development is necessary before the model can be widely applied. Likewise the mixed logit model has generated excitement. The main Objectives are: 1. Estimate the Economic Benefits of Ecosystem Management of Forests and Watersheds 2. Estimate the Economic Value of Changing Recreational Access for Motorized and Non-Motorized Recreation 3. Calculate the Benefits and Costs of Agro-Environmental Policies 4. Estimate the Economic Values of Agricultural Land Preservation and Open Space. This research uses survey techniques, economic modeling, and applied econometrics to empirically assess values and costs of policies affecting public and private land.
Cooperating States: NC, Southern Region

Advanced Technologies For The Genetic Improvement of Poultry

The methods to develop transgenic poultry are inefficient. The purpose of this study is to develop more efficient means of developing transgenic chickens, and to develop methods for location new genetic variation in poultry by gene transfer and chromosome alteration. The ability to isolate pure populations of primordial germ cells that have the ability to contribute to the germline will have applications in transgenic technology and preservation of avian genetic resources. Modification of the chicken germline has been difficult because it has been challenging to obtain sufficient numbers of primordial germ cells for manipulation and implantation into developing embryos. A technique to enrich cell suspensions for primordial germ cells, using fluorescence-activated cell sorting (FACS), has recently been developed. The objective was to demonstrate that the FACS-enriched early embryonic gonocytes could fully participate in development of the germline. Depending upon the results additional transgenic/chimeric embryos will be incubated to hatch, raised to sexual maturity, test mated and the offspring will be screened for the transgene. Cooperating States: NC, Southern Region

Biological Control of Arthropod Pests and Weeds

Certain agricultural pest management practices have raised public concerns over environmental and food safety. In addition, exotic, invasive organisms pose threats to southern agriculture. Biological control is the manipulation of beneficial organism populations to suppress populations of undesirable organisms. This project aims to continue development of biological control as a safe, effective means of agricultural pest suppression in the southern region. Quality control studies of commercially available beneficial insect habitat seed mixes has provided a way for growers to distinguish between quality products and suppliers, something they were previously unable to do. Ongoing work comparing insect populations in organic and conventional cropping systems will provide organic growers with sorely needed information on insect management. The ongoing studies on beneficial insect habitat will also provide organic growers guidance on how to improve their insect management systems.
Cooperating States: NC, Southern Region

Development of Genetic Resources for Cotton

To refine and develop cotton breeding and variety testing methodologies and techniques.
A random-mating population was intercrossed for the fourth cycle using bumblebees; the 11 parents were a diverse group of upland germplasm. I examined the ramifications of random mating and selfing on chromosome lengths and their impact on recombination. I collaborated in compiling pedigrees of Upland and Pima cotton cultivars from 1970 through 2005. I began refining a spatial analysis whereby local variability is considered. I collaborated in developing an intergrated website for genomic information on cotton. Random mating of 11 diverse genotypes should create populations where improvement can be made via recombination of favorable alleles. Pedigree compilations have been useful for breeders, geneticists, and public policy makers. Field variability complicates evaluations of promising lines whether it is by visual observation or actual harvest of plots. Refining this phase of a breeding program should enhance the probability of choosing better lines.
Cooperating States: NC, Southern Region

Genetic Bases for Resistance and Immunity to Avian Diseases

Genetic makeup affects both the performance and disease susceptibility or resistance in chickens. In the proposed study, we will examine the bases of such genetic influences and find ways to improve responsiveness of chickens to diseases challenges. Characterize the functions of genes and their relationships to disease resistance in poultry with an emphasis on the major histocompatibility complex as well as other genes encoding alloantigens, communication molecules and their receptors. Identify and characterize environmental, husbandry, dietary and physiologic factors, and immunosuppressive agents that modulate immune system development, optimal immune function and disease resistance in poultry genetic stocks. Research conducted on the influence of selenium supplementation and antioxidant status of infected chickens has revealed that part of the problem associated with reovirus infection is increased oxidative metabolism and hijacking of the RNA metabolism in the cell. This work potentially can be used for the development of nutritional strategies that will greatly reduce the impact of the viruses in poultry flocks around the world.
Cooperating States: NC, PA, Southern Region

Improvement of Thermal and Alternative Processes for Foods

There is a need for safe and high quality foods. Regulatory agencies need scientific data for approval of various processes. Each of these studies has the potential to improve the current state-of-the-art in food processing and preservation. To develop and verify methods for measurement and prediction of engineering and biochemical properties of foods as needed in process design and analysis, and product development. To measure and model process dependent kinetic parameters which affect food quality and safety attributes, identify and describe transport mechanisms occurring in food processes and to develop mathematical models for analysis, design, and improvement of food processes. The thermophysical and dielectric data on sweetpotatoes will aid processors in establishing the appropriate system and process parameters for aseptically processing sweetpotato puree using a continuous flow microwave system. The optimal conditions for converting certain proteins into ingredients will be used to manufacture new ingredients for comparison with other food stabilizers and application in food systems.
Cooperating States: NC, Southern Region

Animal Manure and Waste Utilization, Treatment and Nuisance Avoidance for a Sustainable Agriculture

This project examines various treatment processes, both engineered and natural, for more effective management of animal manures, will develop methods to reduce odor, gases, other airborne emissions from animal production systems, and will develop feeding systems to alter the excretion of environmentally-sensitive nutrients by animals. Swine lagoon liquid will be treated with diffused air and microbial augmentation in a partitioned pond before recycling for flushing swine manure. Economic feasibility of products will be evaluated. Several alternative swine manure management systems or technologies have been evaluated in N. C. Most of these systems were evaluated on swine farms, and some were pilot scale or lab scale systems. Intensive livestock production presents challenges for preventing air and water quality degradation. Concerns include odor, ammonia emission, and nutrient management. It is important to demonstrate and evaluate alternative systems in pilot-scale and full-scale before they can be recommended for farmers. Livestock producers need more management options to address the environmental concerns, but the management options need to be reasonable in costs and management requirements, and clearly show environmental improvements. The evaluations of alternatives for swine manure management in N. C. should have application for other states that raise swine.
Cooperating States: NC, Southern Region

Variety and Quality Evaluation of Virginia-Type Peanuts

To evaluate the yield, pest resistance, and maturity (genetic potential) of advanced virginia-type peanut breeding lines developed by peanut breeding programs in Virginia and North Carolina, evaluate the quality characteristics and consumer acceptance of advanced peanut breeding lines, and to develop research procedures and management systems for the evaluation of peanut lines. Forty-three experimental lines (24 from NC State University and 19 from Virginia Tech) were entered with 9 check cultivars in the small-plot phase of the program in 2005. Small-plot tests were grown at three sites in North Carolina (Martin County, Sampson County, and Columbus County) and two in Virginia (City of Suffolk and Southampton County) with separate tests dug early and late (approximately 14 days after the early digging) at each site. Forty-two experimental lines (24 from NC State University and 18 from Virginia Tech) were entered with checks in the program in 2006. This is the final performance testing program for peanut breeding lines that are candidates for release in Virginia and North Carolina. All varieties currently grown in the two states passed through this program prior to their release.
Cooperating States: NC ,VA

Development and Evaluation of TMDL Planning and Assessment Tools and Processes

Riparian buffers and vegetative filter strips can reduce offsite movement of nutrients and impact watershed-scale TMDL studies. This project is developing methods and approaches to easily incorporate the positive impacts of riparian buffers and vegetative filter strips into TMDL nutrient assessments. NC will develop and evaluate procedures for including the effectiveness of vegetative filters and riparian buffers into watershed/basin scale water quality models. Current modeling approaches limit the inclusion of tools and methods to assess water quality benefits of these narrow zones. Modeling scales make it nearly impossible to easily model these zones. NC is working on procedures to easily incorporate results from field-scale models such as VFSMOD into watershed/basin scale modeling efforts. NC is also involved in efforts to incorporate procedures for determining model uncertainties and using these in model results.
Cooperating States: NC , Fl

The Science and Engineering for a Biobased Industry and Economy

This project aims to develop cost-effective process to convert agricultural residues and waste such as coastal Bermudagrass into ethanol as a renewable energy source. Sufficient energy supply is a key to the US economy and crude oil has been the major resource to meet the energy demand. The limited crude oil supply will be exhausted in the near future if oil consumption continues to increase at its current rate. Therefore, there is great interest in exploring alternative energy sources. Abundant supplies of lignocellulosic materials are available for use as biofuels, either through biological conversion to liquid fuels such as ethanol or through direct thermochemical conversion processes. Current U.S. production of fuel ethanol from corn starch supplies less than 2% of our automotive fuel needs. Lignocellulose is a major component of renewable biomass, which is produced at a rate of approximately 200 million dry tons per year in the US. Cost-effective ethanol production systems based on the utilization of switchgrass and coastal Bermuda grass will be developed and demonstrated in the project. Successful development of the systems will not only produce ethanol, a renewable energy source, but also protect the environment from potential pollution by the agricultural residue. The innovative technologies will provide farmers with an alternative production system for future agricultural industry. Cooperating States: NC, Southern Region

Genetic Selection and Crossbreeding to Enhance Reproduction and Survival of Dairy Cattle

Fertility in dairy cattle has declined to unacceptably low levels and is an economic problem for dairy producers. This projects looks at ways to improve reproduction in dairy cattle through genetic selection and crossbreeding. With improved knowledge of factors affecting dairy cattle health and fertility and improved measures of associated factors, we expect to be able to reverse recent trends in declining fertility in lactating dairy cows. Evaluation of reproduction and lifetime performance of crossbred dairy cows will have practical implications for competitiveness of dairying in Southeastern U.S. Increased use of fertility measures and other fitness traits in selection programs should have long-term benefits to the dairy industry in NC and beyond. North Carolina State University joined Virginia Tech and Kentucky in a reciprocal dairy crossbreeding project late in 2004. Planned mating in NC included approximately 100 Holsteins and 100 Jerseys mated to 3 or 4 sires of each breed in order to generate purebreds and reciprocal cross females comparable to those in the other two states.
Cooperating States: NC, VA, KY

Rural Communities, Rural Labor Markets and Public Policy in North Carolina and the Southeast

The combination of increasing numbers of people living in rural communities and ever tighter connections between rural and urban labor markets has had a profound influence on the economic well-being of rural communities. This research analyzes how rural-urban labor market linkages affect the economic development prospects of rural counties in North Carolina and the Southeast. The proposed research has two primary objectives isolate the factors underlying patterns of rural population and employment growth in North Carolina and more broadly throughout the Southeast; and to develop information supporting analysis of the fiscal consequences for local governments of spatial spillovers of residential and economic growth. These research findings represent an important input into current debates over desirable economic development strategies, land use planning, and 'smart growth.' Because of this, they have already elicited significant interest on the part of policy makers and local government officials throughout North Carolina.
Cooperating States: NC, Southern Region

Development of New Potato Clones for Improved Pest Resistance, Marketability, and Sustainability in the East

OBJECTIVES: Potato production in the East spans a diverse set of growing environments, pest complexes, and markets. Potato growers in the eastern United States and Canada need better-adapted, pest-resistant cultivars to serve the large and diverse markets in the region. Maintaining the growers' profitability while achieving improvements in yield and/or quality, and reducing negative environmental impacts is a major goal of this research.
This multidisciplinary, regional project is designed to take advantage of the existing strengths and resources of the potato breeding community in the eastern US, and it encourages the pooling of regional resources and promotes increased communication within the potato community located in the northeast, mid-Atlantic and southeast.
Cooperating States: FL, MD, ME, NC, NJ, NY, OH, PA, and VA

Host Resistance as The Cornerstone for Managing Plant-Parasitic Nematodes in Sustainable Agroecosystems

Nematodes are economically important pests of many crops. Host resistance is environmentally and economically effective management that increases production efficiency and reduces pesticide use. Resistance in most crops being studied will be identified based on inhibition of nematode reproduction, which is typically measured based on final nematode population densities in field plots or as numbers of nematodes per g roots in greenhouse tests. Progress made in this research project to facilitate the development and use of nematode-resistant crop cultivars for nematode management in agriculture will reduce the estimated $80 billion in world crop losses due to nematode damage each year. The value of the annual loss in soybean yield due to nematode damage in North Carolina alone is estimated at 12 million dollars US. Other North Carolina crops suffer yield losses on the order of five to ten percent annually, and the cost for pesticides to manage these parasites is valued in millions of dollars.
Cooperating States: GA, IA, KY, MO, OH

Postharvest Biology of Fruits

Consumption of fruit contributes significantly to human health, and yet Americans fall far short of consuming the recommended servings. Consumers limit purchases with the primary complaint of insufficient quality and lack of flavor. The key to increasing consumer consumption of fresh fruits, without loss of grower income, lies in providing fruit with both superior flavor and shelf life. The focus of this project is to evaluate the storage potential of new apple cultivars, make better use of existing storage technologies, and develop new, safer technologies, with a minimum use of chemicals. This project will evaluate postharvest requirements of new and existing fruit varieties ,develop recommendations for the beneficial use of essentially safe postharvest chemicals to assure high quality and wholesomeness. To expand knowledge of the influence of cultivar, production practices, and postharvest handling on the nutritional and eating quality of fruit ,and to expand fundamental knowledge of fruit biology required for development of improved and new technologies for maintenance and enhancement of fruit quality.
Cooperating States: NC, Southern Region

Plant Genetic Resources Conservation and Utilization

The purpose of this study is to maintain genetic resources related to crop plants, evaluate materials for useful traits, and to discover methods to utilize these genetic resources. This project will lead to improved genetic resources in the form of breeding lines and will benefit the general public as new cultivars are released. Plant genetic resources are being introduced, evaluated, and utilized in plant breeding programs to improve cultivars of many agronomic species of both horticultural and agronomic crops. Especially important are superior plant types having increased disease and insect resistances, quality, and yield.

Many of the cultivars released from breeding programs have allowed producers to maintain sustainable farming operations and have improved the products sold in the marketplace.
Cooperating States: NC, Southern Region

Enhancing Reproductive Efficiency of Poultry

Artificial insemination in turkeys has been successful since the 1960s because it was requisite to maintain selected lines. Artificial insemination also allows the use of superior larger sires so genetic improvements occur more rapidly. Unfortunately, the increased growth rate is negatively correlated with fertility. Thus, fertility declines as growth rates increase. The ability to use genetic markers for sperm binding that will be identified in the current proposal can assist geneticists in selecting individual breeder males for both rapid growth and fertility. The use of genetic markers can also preclude the need to differentiate environmental and genotypic factors when making genetic selections. The US public currently consumes nearly 100 pounds of poultry per year because it is a healthy and economical source of nutrients. Reproduction remains a constraint to the production of commercial turkeys. Fertility and neonate survival cause significant financial losses for the industry. Hatchlings also suffer metabolic diseases as a consequence of rapid growth. Identification of environmental and genetic factors that alter embryo cardiac function will improve survival rates and improve the economics of poultry production.
Cooperating States: NC, Southern Region

Enhancing production and reproductive performance of heat-stressed dairy cattle

Heat stress reduces milk production and reproductive performance of dairy cattle in the southeast. This project will test methods of improving milk production and reproductive performance in dairy cows under heat stress conditions. The objectives of the current project are to improve methods of quantifying heat stress in dairy cattle and to determine the effect of various summer cooling strategies on symptoms of heat stress, endocrine status and lactation performance. Improved pregnancy rates in dairy cows during the summer will enable dairy producers to make more efficient use of facilities and by decreasing days open increase dairy profitability.
Cooperating States: NC, Southern Region

The Poultry Food System: A Farm To Table Model

Outbreaks of foodborne illness continue to persist in the U.S. food supply even though it is considered one of the safest in the world. There are an estimated 60 to 80 million individuals who contract foodborne illness each year leading to approximately 5,000 deaths. The annual costs of foodborne illness in the U.S. are estimated at from $5 to $6 billion, including both medical costs and productivity losses. Contaminated poultry products contribute significantly to these foodborne disease statistics. Removal and destruction of pathogens on the surfaces of poultry products and processing equipment are important links in the goal of producing pathogen-free products. Hence, new on-farm and in plant strategies and methods to reduce bacterial populations inherent to the live bird and on poultry products are needed while assuring that products reach the consumer in a wholesome state. The intent of this study is to evaluate different strategies and interventions to achieve the goal of improving the safety and quality of poultry and egg products.
Cooperating States: AL, OH, NC

Ecological and Genetic Diversity of Soilborne Pathogens and Indigenous Microflora

Ecological and Genetic Diversity of Soilborne Pathogens and Indigenous Microflora

Use of pesticides in agriculture is non-sustainable and can lead to detrimental non-target environmental effects. This project examines biologically-based alternatives to management of plant diseases. This project would apply to SAAESD Priority Areas under Goals 1A (integrated and sustainable agricultural production systems), 4B (natural resource and ecosystem management), and 4F (IPM systems, including biologically-based tactics). Soilborne pathogens are a diverse group of pathogens that reduce plant emergence and infect roots and crowns. The result is reduced plant productivity, increased costs to the grower and potential ecological damage to the adjacent natural environment.
Cooperating States: NC, Southern Region

Multistate Research Coordination, Southern Region

The Station Director through designated administrative advisers will authorize expenditures by administrative advisers, technical committee members, participating scientists and other personnel in attending meetings, work groups and conferences authorized for the purpose of conferring, coordinating and furthering research on specific problems of concern to two or more states. This program Facilitates planning and coordination of multistate research; Simplify accounting for funds used for this purpose.
Cooperating States: NC, Southern Region

Rural Development, Work and Poverty in the North Central Region

There is serious poverty is rural areas. This project links analysis of labor markets and cultural perceptions of poverty with economic development models to reduce poverty and increase local residents assets. The project is working collaboratively with the National Rural Funders Collaborative and USDA Rural Development to develop a model of regional strategic readiness aimed at poverty reduction and regional rural prosperity. addressing issues The interaction of labor markets and levels of poverty and cultural perceptions of poverty will be analyzed qualitatively and quantitatively. Conduct a series of case studies of displaced rural workers. Using Census data, we developed a North Carolina county level data base on the working poor. Using 125% of the poverty line as the operational defining of the working poor, we used descriptive statistics to identify counties with rates of working poor above 25 percent. Community case studies will determine the degree of community agency and its impact on low wage work. For North Carolina, the community case studies will identify the individual, household, and community adaptations to job displacement.
Cooperating States: NC, Southern Region, and North Central Region

Assuring Fruit and Vegetable Product Quality and Safety Through the Handling and Marketing Chain.

This project develops technology to remove low quality (over ripe) blueberries from the fresh pack and tackles the two quality issues of skinning in sweetpotatoes and removal of low quality (size defects) sweetpotatoes. Develop, evaluate, and apply rapid non-destructive sensor technology for quantitative measurement of fruit and vegetable quality. Integrate sensor technologies with handling and storage systems to retain postharvest quality in fruits and vegetables. Blueberries will be visually selected in different maturity categories, such as, green, white, red, just-ripe, ripe and overripe. Recent advances in biometrics and machine vision technology involve low cost digital imaging systems coupled with sophisticated pattern recognition algorithms. Digital images of area spectrographs of transmitted light form fresh blueberries atvarious stages of physiological ripeness will be classified with a neural network trained on the individual berry's physiological ripeness parameters of soluble solids and acidity.
Cooperating States: NC, Southern Region

Molecular Mechanisms Regulation Skeletal Muscle Growth and Differentiation

Ultimate meat yield and meat quality are the ultimate goal of most broiler, turkey, swine, and beef operations. A goal of this project is to understand mechanisms regulating muscle growth that will lead to new ways to optimize animal production systems to provide the consumer a high quality low-cost product. The North Carolina Station is actively focused on studying the dynamics of satellite cell number/activity and myonuclear apoptosis during different feeding regimens over the early embryonic and post-hatch periods. Fed poults had higher body masses throughout the experiment, and they had higher muscle mass at ten days of age than the fasted poults. Fed poults had higher satellite cell mitotic activity at three days and four days of age compared to the fasted poults. Ultimate meat yield and meat quality are the ultimate goal of most broiler, turkey, swine, and beef operations. A goal of this project is to understand mechanisms regulating muscle growth that will lead to new ways to optimize animal production systems to provide the consumer a high quality low-cost product.
Cooperating States: NC, Southern Region

Rootstock and Interstem Effects on Pome and Stone Fruit Trees

To evaluate the field performance of pome and stone fruit rootstocks in various environments and under different management systems. Replicated randomized apple rootstock plantings will be established at the Mountain Horticultural Crops Research Station, Fletcher, NC. Plantings are a cooperative effort among the participating states in the NC-140 Regional Research Project. Data to be collected include yield, tree growth, fruit quality in addition to other characteristics of tree growth, efficiency and performance. The information generated from this project continue to be an educational tool for growers in the Southeast to help in rootstock selection for high to medium density orchards. With size-controlling rootstocks, growers are able to change to higher value cultivars much more quickly in addition to the benefits of better economic returns to the grower, reduced labor, and reduced pesticide usage. From this research we have identified several rootstocks that growers should not consider in areas where high wind can be a problem. This information will be used by growers to keep them from establishing orchards on weaker rootstocks which can be devastated by high winds saving the grower thousands of dollars. The information generated in this project is given at grower meetings and orchard tours in the plantings to help educate our clientele about apple rootstocks. Information generated in this project is used to benefit apple growers across the southeast.
Cooperating States: NC, Southern Region

E. Multistate Extension Activities (see NCCES AREERA report, not applicable to NCARS report)

F. Integrated Research and Extension Activities

Research and extension activities are integrated within the College of Agriculture and Life Sciences at the administrative, departmental and faculty levels. The directors of the North Carolina Agricultural Research Service (NCARS) and the North Carolina Cooperative Extension Service (NCCES) work closely together and coordinate all aspects of administration, including position management, state budget requests, budget allocation, facility management and space utilization. Currently, there is an integrated effort to more closely align administrative structure of the directors' offices with programmatic areas across research and extension in the college.

Research and extension activities are integrated formally in a number of key program areas, in which faculty serve in the roles of research and extension coordinator or as a center director of multidisciplinary, multi-function programs. This approach has been particularly successful in water quality, animal waste management, integrated pest management, sustainable agriculture, air quality, small fruits and specialty crops program areas. These coordinator and center director positions are funded by both NCARS and NCCES, and operating funds are allocated from both offices. In all college departments that have both research and extension faculty, these faculty are housed together and interact on a day-to-day basis in all operational and programmatic aspects of the department. This also promotes close interaction with faculty who teach, most of which have research or extension appointments.

The most complete integration of research and extension occurs at the individual faculty level. Over 70 of the 285 college tenured and tenure-track faculty with research appointments also have extension appointments. In fact, most of these split appointment faculty have 50 to 80% Extension appointments, so their research programs are specifically designed to support their Extension programs. These faculty serve as a strong link between those faculty who have a majority research appointment (usually split with teaching) and the county-based extension field faculty and state's agricultural industries. Working closely with the more basic, discovery oriented research faculty, these research/extension faculty, in conjunction with county field faculty, bring new knowledge and technology to the producers and agribusinesses through development, field testing and demonstration. In addition, certain faculty with research/teaching appointments have their research activities in program areas that are highly integrated with extension. These faculty work closely with one or more extension faculty to deliver the knowledge and technology gained from their research to clientele. These research faculty commonly give presentations at county agent training sessions, grower meetings and field days. Therefore, project expenditures for these faculty are included in NCARS total expenditure for integrated activity.

Since all research faculty have an approved federal or state research project cataloged on the CRIS database, the NCARS expenditures and personnel commitment for the research aspects of their activities can be documented. Altogether, there were 63 faculty with research and extension appointments who led integrated projects in 2006. Of those, 57 were supported by Hatch funds along with state, federal and other sources. Hatch expenditures for these projects amounted to: $1,614,746 which was **26.63**% of the 2006 Hatch and regional allocation.

The following is the project/program names and brief descriptions of the NCARS Integrated Research-Extension programs, broken out by *National Goal Area.*

Hatch integrated projects for 2006

GOAL 1. AN AGRICULTURAL SYSTEM THAT IS HIGHLY COMPETITIVE IN THE GLOBAL ECONOMY

Integrated Project	Project #
Orchard Systems and Production for a Successful Apple Industry	6758
Assessing farming system sustainability and research support for organic agriculture production	6625
Small fruit diseases and their control	6747
Production Strategies For Improved Vegetable Production and Alternative Crops For Diversification	6596
Weed management for small fruits and vegetables	6735

Weed Management in Turf And Forage Crops and Plant Growth Regulator use in Turf	6704
Genetic and production environmental influences on processing and planting quality of nutritionally enhanced soybean seed	6632
Using Remote Sensing To Manage Nitrogen In Corn, Wheat And Soybean	6425
Development and refinement of strategies for peanut production in North Carolina	6466
Nematode interaction with resistant and susceptible plant genotypes	6769
Development of Medicinal herbs, new crops organics, and sustainable e vegetable production systems	6832
Apple & Grape Disease Management	6223
Increasing Efficiency, Sustainable, and Productivity Of Tomatoes Grown In Greenhouse And High Tunnels	6891
Influence Of Orchard Management Systems On Tree Fruit Growth And Productivity	6196
Farming System Impacts on Strawberry and Tomato Diseases and Soil Microbial Ecology: Short and Long-Term Initiatives	6641
Management of Arthropod Pests of Turf and Peanut	6731
Weed Management In Transgenic Cotton And Roadside Wildflowers	6835
Farm Level Decisions, Effectiveness Of Conservation Policies And Sustainable Land Use	6837
Cultural Management of Strawberries and Grapes	6324
Small fruit production systems	6681
Integrated Peach Disease Management and Evolutionary Dynamics And Competitiveness Of Bacterial Plant Pathogens	6160
Management of arthropods on fruits and vegetables and Western North Carolina	6402
Best Management Practices for Anti Gibberellins in Floriculture Production	6718
Biology And Management OF Aquatic And Non_Cropland Weeds	6848
Contracting In Agriculture: Testing Theories About Incentives, Risk Aversion, And Asymmetric Information	6838
Alternative Forages And Concentrates For Beef Cattle In The Southeastern US	6736
Developing Strategies for Improved Pasture Fly Management	6803
Nutritional Strategies to Improve the Growth, Productivity, and Profitability of Dairy Cattle	6605
Improving Reproduction and Management of Conventional and Pasture-Based Dairy Production Systems	6600
Use of feed additives to reduce aflatoxin transfer to milk.	6778

Genetic approaches to enhance efficiency and profitability of pork production	6792
Nutritional approaches to enhance swine production efficiency and profitability	6777
Maximization of laying hen performance Economic Return, and Egg Quality	6184
Functional Fish Food Ingredients Produced By Solubilization/ Reprecipitation	6616
Use of novel technologies for the control of Food-Bourne disease agents	6888
Strategies To Enhance Meat Goat Production In North Carolina	6701
Integrating Crops And Livestock Systems In North Carolina	6602
Fish Responses to Biotic and Abiotic Factors Affecting Behavior, Growth and Survival	7257
Mountain aquaculture research	6153
Economic Of The Soybean Complex And The Impact Of Changes In Technology, Processing, Policy , and Trade	6781
Economics of adoption of agricultural technologies	6610

Orchard Systems and Production for a Successful Apple Industry (McArtney)
Project 6758
This program is evaluating new apple cultivars with respect to their suitability for the southeast region. Larger field plantings have been made of six promising new cultivars to emerge from the NE 183 Regional Apple Cultivar Program in order to develop best management practice recommendations for producers. On-farm studies were utilized in close collaboration with participating growers throughout the region as a technology transfer agent to demonstrate the benefits of promising new technologies for enhancing fruit quality and/or production in a commercial context. New technology for reduced drift from pesticide application in orchards is being evaluated that compares pesticide drift and biological efficacy with currently available methods. Orchard sprayer calibration workshops were held in collaboration with county agents and regional research stations to ensure that growers are using current best practice methods for pesticide applications. Presentations were made to apple producers at the State and County level to educate growers on current developments in orchard management practices. An Integrated Orchard Management Guide for Commercial Apples in the Southeast was developed, updated and disseminated to all commercial apple growers in the Southeast.

Assessing farming system sustainability and research support for organic agriculture production (N. Creamer)
Project 6625
The NC Choices project, initiated by the Center for Environmental Farming Systems with funding from the W.K. Kellogg Foundation, is facilitating the development of alternative pork production and marketing systems in a number of ways. These include but are not limited to: the development of a hoop

house-based production system for research at CEFS; technical support for farmers related to all aspects of sustainable pork production, including animal health and welfare, on-farm conservation practices, processing options and meat quality; a technical workshop series co-funded by the USDA SARE; and development of a range of direct marketing models as a way for producers to connect directly with consumers and increase profit potential.

Small fruit diseases and their control (Cline)
Project 6747
Since the early 1940s, USDA and North Carolina State University plant pathologists have worked hand-in-hand with plant breeders to develop disease-resistant blueberry cultivars adapted to low-chill climates. This effort continues today. Disease investigations, control practices and recommendations tailored for our extended growing season have been under continuous development.

Production strategies for improved vegetable production and alternative crops for diversification (J. Schultheis)
Project 6596
Covington sweet potato seems to be more responsive to N rate than Beauregard. The bottom line is that Covington root yields can be increased, and root sizing can be quicker in response to N. At least 60 pounds per acre N should be used as a standard N rate for many of North Carolina's sweet potato producing soils. For soils that are very sandy, 90 to 120 pounds per acre can improve sweet potato yields. A split application can also be advantageous when producing Covington in terms of yields and root enlargement compared with a single application. Nitrogen application with Covington sweet potato can be managed to improved earliness and overall yields.

Weed management for small fruits and vegetables (Monks)
Project 6735
Clary sage growers in North Carolina have no method for controlling broadleaf weeds in this crop. Research trials were conducted to identify an herbicide that would control weeds without crop injury. Gramoxone (paraquat) was found to give effective weed control and was safe to clary sage. A collaborative effort among North Carolina State University, the national IR-4 program, growers and Syngenta Crop Protection led to an EPA registration for Gramoxone herbicide in this crop. According to the contractor of this product, approximately $1 million per year will be saved by growers through the registration and use of this herbicide.

Weed management and turf grass and forages and plant growth regulators for use in turf (Yelverton)
Project 6704
Progress continues to be made in developing cost-effective weed management programs for turfgrass and forage crop producers. For effective turf weed management, the turf must have acceptable tolerance. Tolerance trials were conducted on the various warm and cool-season grasses commonly grown in North Carolina utilizing experimental chemistries such as mesotrione and also newly-registered chemistries. Annual bluegrass control programs continue to be fine-tuned in overseeded and nonoverseeded bermudagrass turf. Sulfonylurea (SU) herbicides were tested at various October application dates for annual bluegrass efficacy and also perennial ryegrass tolerance when overseeded one week after application. Fall, winter and spring SU herbicide applications were investigated in nonoverseeded bermuda to determine if there is an optimum timing for postemergence annual bluegrass control. Biological herbicides were tested on catsear dandelion. Research was conducted on perennial weeds such as wild garlic, purple nutsedge, path rush, dallisgrass and Virginia buttonweed. Mesotrione was evaluated for postemergence smooth crabgrass, white clover and common dandelion control when applied to wet vs dry turf. Pre crabgrass control trials were designed to compare standard herbicides against generics that

are being produced and promoted by smaller companies. Fluroxypyr-containing herbicides were tested against older chemistries on cool season weeds such as henbit, common chickweed, Carolina geranium and common dandelion, as well as warm season weeds such as common lespedeza and Virginia buttonweed. Newly registered Dismiss herbicide was tested on henbit, hop clover, purple nutsedge and goosegrass postemergence, as well as smooth crabgrass preemergence. Experimental granules containing mesotrione, trifloxysulfuron and other chemistries were evaluated on wet vs dry smooth crabgrass, catsear dandelion, white clover and buckhorn plantain. Turf trials were also designed to investigate the efficacy of removing bentgrass from tall fescue and tifway bermuda from el toro zoysia. Pasture weed trials targeted horsenettle control with newly registered aminopyralid vs industry standards. Herbicide programs for pre and post grass and broadleaf weed control were developed for switchgrass production before and after establishment.

Genetic and production environmental influences on processing and planting quality of nutritionally enhanced soybean seed (Spears)
Project 6632
Preliminary projects suggest the high oleic trait in peanuts and soybeans can reduce seed germination and vigor. Cooperative work with Dr. John Wilcut and his graduate students will help extension professionals formulate management practices based on germination parameters of different weed populations.

Precision agriculture for agronomic crops and nitrogen management for corn in Eastern North Carolina (Heiniger)
Project 6425
Research has identified the key components of a corn cropping system based on plant populations over 30,000 plants per acre, banded starter fertilizer and careful seed placement to achieve uniform plant spacing. This research indicates corn growers could increase yield by 22 to 27 bushels per acre using this system compared to previous corn management practices. The goal of this work is to identify high-yield corn management systems that allow growers to grow corn profitably.

Development and refinement of strategies for peanut production in North Carolina (Jordan)
Project 6466
Studies were conducted to define agrichemical interactions and to continue developing IPM approaches that potentially may lead to more efficient use of crop protection chemicals. Research has also been conducted to compare subsurface drip and overhead sprinkler irrigation and to determine if pesticide inputs can be reduced in these systems. Cropping system experiments are in place at five locations in the state and some of these experiments have included various rotations since 1997. Results from applied research have demonstrated risks associated with adopting reduced tillage systems for peanut. Preliminary research has helped determine the possibility of using hyper-spectral and multi-spectral imagery to improve disease management and to assist in maturity determination. Performance of runner and Spanish market types has been compared in some experiments.

Developing new crops and sustainable production systems for vegetables and medicinal herbs
Project 6595 (Davis)
By the summer of 2006, 40 growers, many of them present or former tobacco growers, were involved in a project to determine the feasibility of growing medicinal herbs. Eleven medicinal herb buyers from four states cooperated on the project. They advised on the herbs they would like to buy, how to handle and test the herbs, and quality issues. We facilitated the buying and selling of the herbs between the cooperating growers and buyers and offered technical assistance to the producers. Farmers grew one or more of 17 kinds of herbs, including California poppy, valerian, Echinacea, dandelion, German chamomile, and skullcap. In addition to assistance in growing and marketing their crops, educational opportunities were presented in the form of workshops, field days, conference calls, newsletters and

websites. County extension agents were trained so they could continue to assist farmers after the grant project was completed. Information on this project, including the step-by-step "How to Grow Medicinal Herbs in North Carolina" program, can be found at: *http://ncspecialtycrops.org/medherbs.*

Apple disease management (Sutton)
Project 6223
Several new products were evaluated in trials at the Mountain Horticultural Crops Research Station and the Central Crops Research Station. Trials focused on evaluation of fungicide programs for management of Glomerella leaf spot and the effectiveness of phosphite fungicides. In addition, 2006 highlights of the NAPPFAST weather-based modeling project include new global data sets, new model templates and new pest information web sites. New global data sets include a 10 km daily data set for pest modeling and a 55 k data set for climate matching. New model templates include a climate matching tool and a new degree day model. New pest information platforms were developed for sirex, citrus greening and Japanese beetle. New NAPPFAST models were created for olive and peach fruit flies and maize wilt.

Processes limiting pollen development and release under heat stress in tomatoes and other crop plants (Peet)
Project 6223
Six experiments were conducted to study the effect of potting mixes and their components on seed germination and seedling growth of tomato (*Lycopersicon esculentum* Mill cv. 'Celebrity') and to compare existing commercial organic and conventional substrates with a sample grower mix (peat, perlite, vermicompost, feather meal, kelp meal). Variations on the grower mix ingredients were added in some experiments in order to optimize seed germination and nitrogen nutrition. Analysis of pH, salts, ammonium content and physical properties was conducted on each potting mix and on all components of the grower mix. Tissue nutrient content and plant growth was analyzed weekly from each treatment to determine plant nutrient status. Based on this research, we can recommend specific protocols to organic tomato transplant growers to optimize seed germination as well as transplant growth and nutrition utilizing either commercial or on-farm blends.

Post-harvest quality maintenance of horticultural crops; influence of orchard management on tree growth; rootstock and interstem effects on pome and stone fruit trees (Parker)
Projects 6717, 6196 and 1840
We are evaluating preplant soil treatment strategies and new rootstocks to increase tree growth, survival and productivity. This is also being done in association with newer North Carolina developed peach cultivars (Intrepid, Challenger, Contender and China Pearl) that are cold tolerant during spring frost/freeze events. Educational programs have been developed and presented to growers and potential growers to provide the latest production information available such as preplant considerations, rootstock selection and cultural management.

Farming system impacts on strawberry and tomato diseases and soil microbial ecology: short and long-term (Louws)
Project 6641
Interdisciplinary, multi-state, and (stakeholder) participatory research, extension and educational programs were implemented to evaluate, adopt and develop alternatives to methyl bromide in strawberry and vegetable production systems. From 2000-2006, 47 Phase I trials (research conducted on research stations to evaluate new products or farming practices) and 28 Phase II trials (on grower farms) were implemented. Results were translated to key stakeholders through grower field days, agent training programs, and presentations at extension conferences. Over 49 research and extension articles or abstracts were published. Results were translated to key stakeholders through 16 field and agent training programs

and over 35 presentations at grower meetings and commodity conferences. Research projects focused on development of integrated approaches to manage key soilborne pests.

Management of arthropod pests of turf and peanut (R. Brandenburg)
Project 6731
A major research and extension effort focused on developing and implementing several management strategies to reduce the incidence of tomato spotted wilt virus. Research has proven the value of specific decisions on planting date, insecticide use, cultivar selection, tillage, seeding rate and row spacing. Documentation of the tomato spotted wilt virus advisory has been placed on the North Carolina State University Web site, and this advisory has been widely adopted by growers. Host plant resistance studies have shown that thrips resistance is not the mechanism to select for virus resistance. The southern corn rootworm advisory has also been made available on line, and this continues to guide farmers in maximizing benefits from rootworm insecticide treatments. This research and extension effort has produced a rootworm advisory that provides sound decision-making principles for southern corn rootworm insecticide use and reduced unnecessary insecticide use by 49 percent. The tomato spotted wilt virus risk index has been validated and initially presented to growers, and the incidence of tomato spotted wilt virus has been 50 percent lower since this introduction.

Ecology and management of European corn borer (Van Duyn)
Project 0205
A study of brown stink bug in grain crops began in 2004. Field surveys were conducted for three seasons. Brown stink bug was monitored by sampling the crops, and pheromone traps were also used to trap bugs as the moved about in the environment. Within a seasonal cycle, brown stink bugs emerged from over-wintering in litter and other vegetation and moved to wheat fields and wild vegetation in early spring. While in wheat, the bugs reproduced, and immatures successfully developed into new adults. The increase in population in wheat fields was significant. As wheat matured and was no longer an attractive host, the bugs moved to near-by corn and cotton fields and fed upon the developing plants. In this situation the corn and cotton had not begun to fruit, and the bugs fed for a short period and left. In corn this resulted in damage only if the pre-flowering ears were immature; if the ears were near flowering they were not damaged. In cotton, some flower-bud damage occurred but this did not damage the crop. The bugs left these crops, but when fruit began developing on these crops, the brown stink bugs returned, fed upon and reproduced in the corn and cotton. In soybean, the bugs were not attracted to fields until pods (fruit) were available. Bugs could seriously damage small immature fruit, but as the beans became more mature bug damage decreased. Bugs moved among differing fields as early fruiting varieties became mature and late fruiting varieties began to develop pods. These findings allowed growers to understand when it is important to examine wheat, corn and soybeans for brown stink bug and thereby appropriately manage this pest.

Weed management and growth regulators for agronomic crops (York)
Project 6417
Glyphosate-resistant Palmer amaranth was found in North Carolina in 2005. Research in 2006 focused on screening 300 fields for resistance. Resistance was found over a wide area in Eastern North Carolina. Field research was initiated to develop management systems. In glyphosate-resistant cotton, best control was obtained with a program consisting of pendimethalin plus fomesafen PRE, glyphosate plus pyrithiobac or s-metolachlor POST, and diuron plus MSMA POST-directed.

Economic decision support for sustainable ag products (Wossink)
Project 6528
A two-year study is comparing zero-discharge production of hybrid striped bass with the current practice of annual draining and restocking of Phase II fish for final growout. Six ponds will be used during the

normal two-year production cycle for hybrid striped bass. Three of the ponds will be managed under current practices of annual draining and restocking of Phase II fish for final growout (control). Three other ponds will be managed under a zero-discharge practice that eliminates annual draining between harvests and restocking (zero-discharge). Next, the economic data on hybrid striped bass production from CHF and the estimated changes in production levels caused by the different water management practices will be used in an environmental-economic trade-off analysis model. This model balances the cost of achieving water quality goals with the benefits and is used to compare the alternative BMPs. The information generated from this work will be the first commercial-scale analysis of water conservation practices for hybrid striped bass.

Cultural management of strawberries and grapes (Poling)
Project 6324
The North Carolina Winegrape Grower's Guide was produced. The new publication is a revision of the Mid-Atlantic Winegrape Production Guide, which was produced in 1995. The new publication represents the work of nine faculty members and is designed to serve North Carolina emerging winegrape industry.

Small fruit production systems (Fernandez)
Project 6681
In response to anticipated growth in the commercial blackberry industry in North Carolina, a budget was developed for the costs associated with growing, harvesting and marketing 10 acres of blackberries. Costs to establish blackberries (field preparation and establishment) were $8,810/acre or $88,100 for 10 acres. In addition, a new grower could spend an average of $12,768/acre ($127,680 for 10 acres) for additional equipment, machinery and cooling facilities required for the production and proper post-harvest handling of the berries. This analysis showed that if growers received a wholesale price of $14.00/flat they would receive a return to land and management of $9,085/acre for the third through 10th years with a marketable yield of 9,000 lb/acre. The annual net cash flow is positive after the planting is established and enough revenues are projected to be generated to cover start-up expenses in the fourth year. The budget includes costs often ignored by growers such as overhead costs, fixed labor costs, and the costs of owning equipment and machinery (excluding depreciation). Despite these additional costs, blackberry production in North Carolina can be a profitable venture if grower use the recommended practices, secure a viable market and meet the post-harvest handling requirements.

Integrated Peach Disease Management (Ritchie)
Project 6160
Fungal and bacterial diseases of horticultural crops such as peaches and peppers can cause significant economic losses. Compounding this situation is the lack of adequate controls for bacterial diseases particularly once the epidemic has started. Successful management of bacterial diseases depends greatly upon prevention, with a heavy dependence on host resistance if available and preventative sprays using a very limited number of chemicals. For bacterial spot of stone fruits, it is important that spray applications be properly timed, taking into consideration that fruit are most susceptible immediately following bloom. Infection of fruit also is closely related to specific periods of moisture. A model is being developed with the objective of timing spray applications better and understanding of the disease epidemiology.

Management of arthropods on fruits and vegetables and Western North Carolina (Walgenbach)
Project 6402
Research is focusing on the population dynamics of spider mites to develop a model that can predict when fields become infested and the mite density-yield reduction relationship to determine when chemical control of mites is justified. Understanding the factors that lead to high mite densities in tomato fields will help researchers devise non-chemical management strategies that can be used by growers to delay or prevent mite populations from increasing to damaging levels. It is expected that chemical use on tomatoes

will decline, which will decrease production costs for growers and reduce pesticide inputs and potential negative environmental impacts.

Best Management Practices for Anti Gibberellins in Floriculture Production (Whipker)
Project 6718
Optimal recommended rates for plant growth regulators vary by crop type. Working with GrowerTalks magazine, researchers developed a PGR Production Guide. The guide provides the latest information on optimal rates for PGR application. Greenhouse growers are using this guide to control excessive crop growth more effectively and efficiently.

Biological control of arthropod pests in weeds (Orr)
Project 6223
Studies of commercially available beneficial insect habitat seed mixes have provided growers with much needed guidance on whether to use these products, and if they choose to, how best to plant them. A simple, easy-to-use method was implemented to dramatically increase the lifespan of parasitic insects released for insect pest management. Ongoing work comparing insect populations in organic and conventional cropping systems will provide organic growers with sorely needed information on insect management. The ongoing studies on beneficial insect habitat will also provide organic growers guidance on how to select habitat plants to improve their insect management systems. Extension and outreach programs and materials in biological control have been delivered to a large number of individuals in a variety of client groups.

Risk aversion, risk shifting and alternative payment mechanisms in settlement of broiler contracts
Project 6527 (Vukina)
The objective of this research program is to study the contract design problem as it appears in agriculture and food sectors, to develop methods that would allow the identification and estimation of the structural models, and to test predictions aimed at assessing the empirical reliability of these models. The central orientation is on agricultural contracts frequently observed in North Carolina such as poultry and swine industries production contracts. In this segment of the project, we analyzed the transfer of risk from risk-averse farmers to risk-neutral (or less risk-averse) firms (integrators and packers), and the importance of producers' risk-aversion for the choice of alternative marketing arrangements (AMA) in the hog industry. We were able to show that: (a) Different types of AMAs exhibit different price volatilities as measured by the variance of price, and as such they may subject the producers selling their hogs through these channels to different levels of risk. (b) When it comes to risk shifting associated with the production contracts we were able to document that in a typical contract settlement formula, production contracts eliminate about 94 percent of the total income variability if one uses the income volatility of an independent market hog producer as the benchmark. (c) Finally, we showed that farmers who use production contracts are more risk averse than farmers who use the cash/marketing arrangements. The obtained results are consistent with the economic intuition that those farmers who are more risk averse self select themselves into less risky projects. The difference in risk exposure between the contract producers and independent farmers is huge as production contracts eliminate all but 6 percent of the total income volatility. Therefore the welfare losses associated with forcing producers to market their hogs through channels different from their risk-aversion-preferred marketing arrangement choice are substantial.

Use of alternative supplements in grazed, hayed and ensiled forage systems for beef cattle (M. Poore)
Project 6736
Applied research showed that both dry and wet corn gluten feed are economically viable feed ingredients for use in beef finishing diets. This information led to increased adoption of those ingredients in cattle diets. Other research exploring feeding frequency and feed sources has also impacted the profitability of

byproduct utilization in the state. The extension ruminant nutrition program works both directly with producers and through extension agents to enhance and expand the use of byproducts in feeding programs. In 2006, over 1,000 tons of recycled poultry bedding, 10,000 tons of soybean hulls, 6,000 tons of dry corn gluten feed and 8,000 tons of wet corn gluten feed and 5,000 tons of other miscellaneous byproducts were utilized by clients for a realized savings of over $1 million.

Developing Strategies for Improved Pasture Fly Management (Watson)
Project 6803
Working with scientists at Cornell University, the University of Arkansas and the Center for Environmental Farming Systems (CEFS), we are exploring farming systems that are environmentally, economically and socially sustainable, including alternative fly management programs for dairy and beef cattle. We have evaluated an experimental electric walk-through flytrap that reduced horn fly populations on cattle and submitted a disclosure statement to the Office of Technology Transfer. A patent was submitted on the use of push-pull strategies for the management of pasture flies. The modified NZI biting fly trap was tested to aid in the management of stable flies on pastures. We have also focused on dung beetle ecology and identified dung beetle compatible fly management strategies. In addition to dung beetles rendering dung pats unsuitable for horn fly development, beetles also improve pasture condition, increase soil percolation and nutrient cycling. Additional studies are focused on the enhancement of native biological control agents through augmentative release of parasitoids to control flies on dairies.

Nutritional strategies to improve the growth, productivity and profitability of dairy cattle (Hopkins)
Project 6605
A study investigated the impact of supplementing rumen-protected forms of betaine, choline and methionine to diets with limited methionine content on performance and metabolism of early lactation Holstein cows. Supplementing rumen-protected choline significantly increased milk yield in multiparous early lactation Holstein cows fed methionine-limited diets. Information gained from this study will be used to develop feeding recommendations to improve growth and health in dairy calves and increase milk yield in cows.

Improving reproduction and management of dairy cattle (Washburn)
Project 6600
Data from a study that began in 1997 involving crossbreeding Holstein and Jersey cows along with data from other crossbreeding studies are providing evidence that crossbreeding of dairy cattle may have positive effects on traits of economic importance to dairy producers. If crossbred cows increase calf survival, reach puberty earlier and have improved reproductive success compared to Holsteins, then there should be potential economic advantages for use of a planned crossbreeding program in commercial dairy herds.

Use of feed additives to reduce aflatoxin transfer to milk (L. Whitlow)
Project 6778
North Carolina Cooperative Extension provides a dairy cattle nutrition educational program to dairy farmers and the dairy industry. Information includes the selection and use of feeds, feeding strategies, diet formulation programs, and the effect, prevention and treatment of mycotoxins. The State of North Carolina operates a feed analysis program for farmers to determine nutritional value and contamination with mycotoxins. Computer feed formulation programs are provided to the industry. Nutrition and feeding recommendations are supported by research at North Carolina State University. Cooperative Extension specialists and agents provide the latest information to dairy producers and the feed industry.

Genetic approaches to enhance efficiency and profitability of pork production (See)

Project 6496
The Pork Information Gateway (PIG) was launched at the 2006 World Pork Expo. This is a web portal of research-based and unbiased information and educational tools for the pork industry. Editors organize content in a manner that meets the needs of all potential users and never requires readers to conform to an interface that places unnecessary obstacles in their paths. The PIG consists of electronic publications organized as peer reviewed factsheets, Frequently asked questions (FAQ), references including books, conference proceedings and software, an image library, industry calendar of events, and a glossary. An important aspect of PIG is that each of its centers interrelates. The Resource Center is the basis of the material used to develop FAQ for the answer center, and each FAQ is linked to its resource for further information. In addition, the materials in the Resource Center are the major references used in development of courses for the Learning Center to be added in 2007.

Nutritional approaches to enhance swine production efficiency and profitability (VanHeugten)
Project 6777
We are currently evaluating effects of fiber type and level on ammonia and odor. Addition of non-starch polysaccharides increased the concentrations of VFA in feces, but decreased concentrations of ammonia, indole and skatole. We have completed panel analysis of odor intensity of fecal samples from pigs fed different levels of fiber, and air samples collected from odor chambers that housed pigs fed different levels of dietary fiber. We are in the process of statistical analysis of the results.

Maximization of laying hen performance, economic return and egg quality (K. Anderson)
Project 6184
This program deals with egg production type chickens in the production environments and is designed to provide insight as to the well-being of laying hens under different cage densities and husbandry practices (molting). Non-Anorexic Molting programs are now the industry standard, but refinements to these alternative molting programs are needed to enhance their effectiveness as related to the previous industry standard program of fasting. These experiments have included a survey of the microbial shedding and egg quality from laying hens subjected to alternative molting programs. In addition, the integration of an egg solids study, for the breaking industry, along with functionality and egg safety studies were recently completed.

Fish food ingredients produced by solubilization/reprecipitation (Green)
Project 6616
Research has shown that rapid cooling of fish on-board harvest vessels and maintaining good temperature control in the cold-chain can reduce the risk of food-borne illness. Processing properly chilled fish using hydrostatic pressure will further reduce the risks to acceptable levels. Adopting proper control measures to ensure a safe product will require a continuing education effort. These studies lay the groundwork for extension education programs and further research studies into other intervention strategies.

Strategies to increase meat goat production (Luginbuhl)
Project 6701
We are evaluating forages for year-round grazing and to control gastrointestinal parasites. We are evaluating three varieties of fescue with lactating does and their kids in spring and with growing replacements in fall, grazing the same fescue varieties stockpiled for fall/winter. An additional field was planted with MaxQ fescue, orchardgrass and chicory, a forage having potential to control gastrointestinal parasites. Another field will be planted with pearlmillet, Sericea lespedeza (a forage known to contain tannins that affect gastrointestinal parasite fecundity) and a combination of both to examine performance of growing goats during summer and control of gastrointestinal parasites.

Integrating crops and livestock systems (Mueller)
Project 6602
Silvo-pastoral studies with meat goats are focusing on defining the utility of Black Locust as a browse species for goats. Additionally, a 3-year grazing study is looking at meat goat performance and preference for tall fescue cultivars.

Fish Responses to Biotic and Abiotic Factors Affecting Behavior, Growth and Survival (Rice)
Project 7257
We used a combination of extensive field studies and bioenergetic simulation modeling to determine the relative importance of warm summer temperatures, effects of heated effluent and the abundance and types of prey fish species available as factors potentially responsible for poor striped bass growth and condition. Results showed that while striped bass in Lake Norman are forced by low-oxygen conditions to occupy much warmer water than they prefer during the summer, these conditions are no worse than those in many other North Carolina reservoirs (even those without heated effluent inputs) that exhibit much better striped bass growth and condition. Furthermore, the higher metabolic costs of these warm temperatures don't prevent good growth if adequate prey are available. Prey abundance in Lake Norman is limited by the relatively low productivity of the system, not by what prey species are present. The main cause of poor growth by striped bass above 16 inches is lack of sufficient food; the problem of forage limitation is made worse because these fish eat a significant portion of the prey resource even though they aren't growing. Increasing striped bass stocking rates would only make the problem worse.

Mountain aquaculture research (J. Hinshaw)
Project 6153
Researchers began the first comprehensive yield verification study of trout farming in the U.S. Yield verification trials are designed as a means of achieving implementation and evaluation of Extension's research-based recommendations. Joint research and extension trials are designed to implement, demonstrate and test such recommendations against yields obtained through existing practices used in commercial production settings. Yield verification trials are widely credited with increasing state yield averages for several major commodities, including other aquaculture products. Predicted values for growth, size uniformity, feed conversion, survival and farm yield from research facilities may or may not reflect observed values in commercial settings. In particular, recommended practices for trout production were generally developed in research or public hatchery settings over 20 years ago, prior to adoption of high-energy extruded diets, oxygenation techniques and modern vaccination methods.

Economics of the Soybean Complex and the Impact of Changes in Technology, Processing, Policy, and Trade (Piggott)
Project 6781
Some of the economics of bio-energy (ethanol and biodiesel) have been studied and penciled out. Also, the benefit of blending of petroleum-based fuels with bio-based fuels has been analyzed and has been shown to have a stabilizing impact on price volatility. The results of these analysis remains the topic of further current work but has been presented at national conference held by Risk Management Agency in Kansas City in summer 2006. It has also has been presented in North Carolina in county meetings involving grain growing regions of Chowan, Bertie, Perquimans and Gates counties. This work has served to inform interested parties of the economics of bioenergy, as well as the catalyst for the current run up in grain prices, and where a new equilibrium might be achieved.

Economics of adoption of agricultural technologies (Marra)
Project 6610
Data were obtained for a study of the effects of a natural refuge for Bollgard II cotton. This resulted in the following publication: Piggott, N.E. and M.C. Marra. 2006. "The Net Gain to Cotton Farmers of a Natural

Refuge Plan for Bollgard II® Cotton". AgBioforum, in review. In addition, other publications were produced, including Vukina, T., A. Levy, M.C. Marra and B. Ziang. 2006. "Do farmers value the environment? Evidence from the Conservation Reserve Program Auctions." *American Journal of Agricultural Economics,* in review (second round); Sydorovych, O. and M.C. Marra. 2006. "A New Risk Index for Measuring Pesticide Use." Submitted to the *Journal of Agricultural and Resource Economics*, in review; Dan Phaneuf, M.C. Marra, and J. M. Alston. 2006. "The role of public goods characteristics in the adoption of a new biotechnology: The case of corn rootworm-resistant corn." *American Journal of Agricultural Economics*, in revision to resubmit; N.E. Piggott and M.C. Marra. 2006. "Modern Determination of Soybean Acreage: The Effects of Biotechnology and Recent Farm Policy", in preparation for submission to the *American Journal of Agricultural Economics;* Marra, M.C. and N.E. Piggott. 2006. "Measuring and Correcting for Part-Whole Bias in Non-pecuniary Values in Crop Biotechnology", in preparation for submission to the *American Journal of Agricultural Economics.*

GOAL 2
A SAFE AND SECURE FOOD AND FIBER SYSTEM

Integrated Project	Project #
Evaluation of pre and post – production - strategies for inhibiting food borne bacterial pathogens associated with poultry	6774

Evaluation of pre and post – production - strategies for inhibiting food borne bacterial pathogens associated with poultry. (Sheldon)
Project 6774
Broilers raised either on litter floor or in cage batteries were fed either a finely ground corn- (control), a finely ground triticale or a whole triticale-based diet from 0-42 days. Microbial DNA was extracted from the ileum content of 42-day broilers and the 16S rDNA gene was amplified by PCR and the amplicons separated by DGGE. Diversity indexes including richness, evenness, diversity and pairwise similarities coefficient were calculated. Diversity indexes were related to the dietary treatments, housing designs and with changes in *Salmonella* colonization of broiler ceca as characterized by the most probable number method (MPN). Higher microbial diversity indexes were observed among birds fed whole triticale-based diets and reared on litter floor. In contrast, finely ground grain treatments had lower diversity and higher *Salmonella* prevalence than the whole triticale treatment. The combination of high dietary fiber content and increased coarseness of the diet by feeding whole triticale presumably stimulated microbial community diversity and discouraged *Salmonella* colonization through a competitive exclusion type mechanism.

GOAL 3
A HEALTHY, WELL - NOURISHED POPULATION

Integrated Project	Project #
Biology and control of Nuisance Vector Arthropods in NC	6752

Biology and control of nuisance vector arthropods in North Carolina (C. Apperson)
Project 6752

Stormwater retention facilities were sampled to characterize the seasonal occurrence and relative abundance of mosquito species in relation to the structural complexity and biological diversity of the facilities. The three different types of facilities included standard wetponds, innovative ponds and wetland ponds. All retention structures were sampled at the beginning, middle and end of the mosquito season so that seasonal changes in mosquito production could be characterized. Mosquitoes were collected from 34 percent of the retention structures. Fourteen species representing seven genera were collected, but only five species (Culex erraticus, Cx. territans, Anopheles quadrimaculatus, An. punctipennis and Uranotaenia sapphirina) were commonly collected in all three types of stormwater management facilities. In general, the seasonal prevalence and relative abundance of mosquito species did not vary among three types of retention structures. A significant association (P,0.01) between the presence of mosquito larvae or pupae and the absence of mosquitofish was found for innovative and wetland stormwater retention facilities but not for standard retention facilities (P.0.05).

GOAL 4
AN AGRICULTURAL SYSTEM WHICH PROTECTS NATURAL RESOURCES AND THE ENVIRONMENT

Integrated Project	Project #
Environmental nursery crop production	6224
Evaluation and modeling of riparian buffer performance in the Neuse River Basin	6609
Precision agriculture for agronomic crops and nitrogen management for corn in Eastern North Carolina	6652
Implementation of improved erosion, sediment, and turbidity controls at construction sites	6789
Evaluation of Tillage Practices, Organic Production, and trickle Fertigation for Nutrient Management	6648
Development of plant pathogens as bioherbicides for weed control and weed management in landscapes	1001
Nutrient and by-product utilization and health of turkeys and broilers	6343
Effect of management on turkey production, turkey reproduction and turkey waste handling	6390
Improved efficiency of water reuse aquaculture systems through advancements in treatment technologies	3975
Engineering processes to enhance nutrient management and reduce environmental impacts of animal manure	6575
Evaluation of soil and site criteria for onsite wastewater and land use decision	6647
Performance of on-site wastewater system and other land-based technologies for Low Impact Development (LID)	6793
Practical control of sex determination in flounder and compensatory growth in hybrid striped bass	6819

Environmentally compatible nursery crop production practices (Bilderback)

Project 6224
Incremental amounts of cotton stalk and swine waste compost-amended pine bark substrates were used in research study to grow an ornamental nursery crop. Laboratory physical and chemical analyses were also conducted. Plant growth results showed top dry weight of cotoneaster increased linearly with increasing rate of the compost. In addition, top dry weight of cotoneaster grown in 15 percent, 30 percent and 45 percent compost was significantly greater than cotoneaster grown in a pine bark:sand control substrate. Home grown back yard alternatives are seldom available resources of value. In this case cotton stalk swine waste compost additions fit well with nursery production practices. The composts provided excellent growth, had appropriate physical properties and provided sufficient micro nutrients, calcium, magnesium and contributed to the NPK requirements to grow nursery crops in containers.

Evaluation and modeling of riparian buffer performance in the Neuse River Basin (Evans)
Project 6609
Pilot studies were implemented to demonstrate and evaluate alternative channel management strategies and design geometries to identify alternatives that would enhance water quality functions while maintaining the necessary drainage function. Channel alternatives included: establishment of in stream and riparian wetlands, lowering of the floodplain to reconnect the channel with the floodplain, redesign of channels using natural channel design principles, and establishment of conservation easements to encourage establishment of perennial riparian buffer vegetation. Hydrology and water quality were monitored from one to three years at each site. In addition, plant communities and macro-invertebrates were monitored at three sites. Nitrogen transport was reduced by 20-40 percent with in-stream wetlands. Reconnecting the channel with the floodplain dampened the hydrograph peak and reduced the "out-of-floodplain" risks outside the project area. These projects accomplish the first step in the evaluation process which is to demonstrate technical feasibility. The alternative practices were more expensive and resulted in two to three times more land area being taken out of production compared to conventional drainage practices. The project costs in these studies ranged from a low of about $40/linear foot of channel to $140/linear foot of channel. However, the benefits were improved water quality, lower peak outflow rates and enhanced habitat for wildlife. It is concluded that there are environmentally friendly alternatives to traditional practices of frequently cleaning and mowing trapezoidal ditch channels to achieve drainage requirements. However, in most cases, the added costs may not be justified by increased drainage benefits to the landowner. Therefore, it becomes incumbent on society to put a value on the water quality and ecological functions achieved to determine if public funds should be used to help landowners offset the costs of achieving the additional water quality and ecological functional benefits.

Precision agriculture for agronomic crops and nitrogen management for corn in Eastern North Carolina (Crozier)
Project 6652
Researchers collaborated with producers to develop fertilizer rate and timing recommendations for conventionally produced agronomic crops as well as certified organic production systems. The ongoing education of farmers, county agents, regional agronomists, agricultural consultants and certified crop advisors enhances voluntary adoption of best management practices. Acceptance of certain practices is mandatory, and needed to achieve nutrient reduction goals for runoff into rivers. Field tours serve to generate producer interest in these activities, with meetings scheduled to disseminate more specific results. Four research publications describe recent grain crop nitrogen management issues. A coordinated effort was developed to successfully deliver nutrient management education to Tar-Pamlico River basin farmers. Planned field experiments and field day demonstrations will further educate farmers in this area about optimal utilization of this new resource. Collaboration is ongoing with the North Carolina Department of Agriculture and Consumer Services to re-evaluate and update critical sulfur level

guidelines for grain crops. This collaboration, as well as efforts to improve nutrient deficiency problem diagnosis in general, led to the development of a Soil Fertility field training event in July 2006 for 33 agronomic professionals, with plans to develop a website containing photographic images and relevant laboratory data.

Evaluation of tillage practices, organic production, and trickle fertigation for nutrient management (Hoyt)
Project 6648
Researchers developed between-row mulching for Christmas trees by using live white clover plantings to stabilize sloped land and recycle plant nutrients. Biological nitrogen fixation in the white clover also increase soil nitrogen to reduce grower inputs of nitrogen. A majority of farmers across Western NC are adopting these cover cropping practices for Christmas tree production. Farmers using this conservation practice will improve soil organic matter and nutrients available to Christmas trees, along with reducing water and sediment runoff to streams and improving water infiltration into the soil.

Development of Plant Pathogens as Bioherbicides for Weed Control and Weed Management in Landscapes (Neal)
Project 1001
Currently no biological control options are available for weeds of urban landscapes. Experiments were initiated in 2005 to evaluate the endemic wood-rotting fungus, *Chondrostereum purpureum*, as a biological option for woody weed control. This biocontrol candidate was also evaluated on established hardwoods and Oriental bittersweet vines. No control of any of the inoculated species was observed in 2006 evaluations. The experiments were repeated in 2006 and will be expanded in 2007 to evaluate the effectiveness of inoculations at different growth stages and different times of year.

Improving Sediment and Erosion Control Measures (McLaughlin)
Project 6559
This research and extension program is providing evaluations of current and newly developed systems to reduce off-site movement of sediment. Studies continue on how effective PAM can be in various settings: erosion control on slopes and turbidity reductions in runoff control structures. Research also focuses on determining potential impacts of PAM on aquatic organisms. This program has demonstrated the effectiveness of porous baffles in sediment basins in reducing turbulence and flows, allowing greater settling efficiencies. And we have determined the minimum rate for PAM for erosion control is 20 lb per acre. Optimum use of PAM for turbid water from borrow pits and similar operations is being developed. These studies have resulted in changes to the North Carolina DENR Erosion and Sediment Control Design Manual to include surface outlets and porous baffles in most sediment detention devices (instead of the old rock outlets).
Work with the NC DENR Aquatic Toxicology Unit resulted in the registration of six PAM products for use in turbidity.

Nutrient and by-product utilization and health of turkeys and broilers (Ferket)
Project 6343
A new technology called in ovo feeding (administration of nutrients into the amnion of embryos) was developed to improve enteric development of young poultry and improve resistance to enteric disease. After surveying the changes in metabolism during late-term incubation in turkeys by gene array technology, in ovo feeding solution formulations were optimized. Automated delivery of in ovo feeding solutions achieved more than 90 percent amnion targeting, and advanced enteric development and digestive capacity by two days, resulting in better early growth performance and survival. Global patents have been awarded for this technology and a commercial company (Embrex, Inc.) will be field testing at commercial turkey and broiler companies in 2007. In ovo feeding has been demonstrated to improve

hatchability and energy status of hatchlings, and increase appetite and early growth rate by 3 to 10 percent over controls. Breast muscle development of chicks and poults was also improved.

Effect of management on turkey production, turkey reproduction and turkey waste handling (Grimes)
Project 6390
An experiment was conducted using Large White turkeys to test the suitability of different cotton based materials for use as turkey bedding. Treatments consisted of the following: 1) pine shavings, 2) industry shavings (sawdust) 3) cotton gin trash (GT1), 4) cotton gin trash with extra burrs (GT2), 5) chopped cotton stalks, and 6) aGroChips (a processed and pelleted mixture of old news print, gypsum, and cotton fibers). Birds were observed for growth and performance. Litter cake material was removed at six and 20 weeks of age and at other times as needed. Litter cake removed from each pen was recorded by weight. Typical turkey diets were provided. There were no treatment effects on body weight of the turkeys at any time during the trial. Birds were slightly below the breeder's standard at six weeks and below standard at 12 and 20 weeks of age. This may have been due to the seasonably hot weather during June – September and lack of sufficient air movement in the turkey facility. Cumulative feed conversion was different by treatment only at 12 weeks. Birds reared on aGroChips had a higher (worse) feed conversion (2.08) compared to the birds on the other beddings (mean=2.01). However, by 20 weeks of age there were no differences due to bedding treatment, and the flock mean feed conversion (2.64) was similar to the breeder standard (2.58). Pen litter cake was different by treatment at both six and 20 weeks of age. Pens with industry shavings had consistently less cake at six (4.9 kg) and especially at 20 (116.5 kg) weeks of age. Even pens with pine shavings (196.5 kg) had more cake than pens with industry shavings at 20 weeks of age, which was unexpected. Some of the cotton derived beddings resulted in similar pen litter cake levels compared to pine shavings, but all resulted in higher pen litter cake levels compared to industry shavings. Pens with aGroChips (235.2 kg) bedding had the highest litter cake levels. The pens with gin trash 1 (184.4 kg), gin trash 2 (171.9 kg) and chopped cotton stalks (204.5) were intermediate in litter cake levels.

Improved efficiency of water reuse aquaculture systems (Losordo) (DeLong)
Project 3975
The Fish Barn program has focused on effluent management with an eye toward complete water reuse. In 2005 - 2006, the program took a commercially available technology called Geotube and used it in combination with other technologies to create a very affordable and efficient waste treatment system. The geotextile bag, when used with a potable water approved organic polymer, has achieved solids removal from the Fish Barn waste stream of up to 98 percent in a single pass.

Engineering processes to enhance nutrient management and reduce environmental impacts of animal manure (Westerman)
Project 6575
Evaluations of on-farm demonstration projects for innovative swine waste treatment were concluded. The high level of interest in these projects from various persons within and outside of North Carolina has resulted in numerous opportunities for answering inquiries, providing information, hosting visitors and making presentations. The results have been presented in national symposia and journals to make the information available to the various groups that are highly interested in swine waste treatment and utilization.

Evaluation of soil and site Evaluation BPM's for On-site Wastewater Systems in Seasonally Saturated Soils. (Lindbo)
Project 6800

Research showed that the current method of assessing soil wetness overestimates the depth to seasonal wetness. Seasonal wetness is a major cause of system failure, thus the overestimation of soil wetness depth results in systems being installed too deep in the soil and being subject to premature failure.

Performance of on-site wastewater system and other land-based technologies for Low Impact Development (LID) Hoover
Project 6793
North Carolina State University and North Carolina Cooperative Extension worked with the Wake County Department of Environmental Services to assist the County in a pilot study to determine how well septic systems are functioning. The study indicated that the vast majority of systems (90 percent) were operating fine, even in the worst-case scenario, that is, the springtime when system performance is usually most at risk. It was concluded that the County regulatory program was on track. However, the failure rate observed (about 8-10 percent) was agreed to be too high. The study identified specific O&M factors that have significant effects on system failure rates and also showed which factors don't influence failure rates. Post-installation inspection would alleviate some of the problems observed. Also, providing long-term protection and maintenance of the location where the system was installed and the immediate area around it significantly reduced failure rates and was one of the important factors that must be addressed in order to keep system failure rates low.

Aquaculture of southern flounder and improved water quality management of ponds in Eastern North Carolina (Daniels)
Project 6387
We have succeeded in the establishment of XX males for use in producing all-female fingerlings. Our research has also established the first commercial-scale data on growout characteristics with a full economic analysis of the results. These accomplishments are fundamental steps in the commercialization of flounder culture and will lead to maximizing the economic viability of flounder farming. We have also assisted in the establishment of the first private southern flounder hatchery in the U.S. Current annual production projections for this facility are around 100,000 pounds.

GOAL 5
ENHANCED ECONOMIC OPPORTUNITY AND QUALITY OF LIFE FOR AMERICANS

Integrated Project	Project #
Economics of socially optimal pork production	6706
Strategies for economic renewal of rural north Carolina counties	6773
Rural communities, rural labor markets and public policy in North Carolina	1011

Economics of socially optimal pork production (Zering)
Project 6706
Reports were completed in 2006 on economic analysis of 11 alternative manure management systems evaluated through the North Carolina State University Animal and Poultry Waste Management Center and the North Carolina Attorney General's agreements with Smithfield Foods, Premium Standard Farms and Front Line Framers. Systematic evaluation of the expected costs and returns of two additional technologies was conducted in 2006. This information is viewed as being of critical importance in

determining the direction of legislation, regulation and design of pig production systems in North Carolina.

The public economics of fast growing regions(Walden)
Project 6532
Wake County, North Carolina, is fast growing, and infrastructure needs appear to be outpacing the availability of public revenues for those needs. This shortfall results in crowded schools and congested highways and citizen frustration with growth. Faculty member Dr. Mike Walden was appointed by the Wake County Board of Commissioners to the Blue Ribbon Committee on the Future of Wake County. Dr. Walden developed an economic and statistical model of Wake County's growth and used the model to forecast public revenues from various tax sources over the next 25 years. The revenue scenarios were then compared to projections of spending for required infrastructure investments. This effort was instrumental in formulating recommendations by the Blue Ribbon Committee to the Wake County Board of Commissioners, who are developing a plan for addressing expected future growth.

Rural communities, rural labor markets and public policy in North Carolina and the Southeast (Renkow)
Project 1011
Research was conducted on the extent to which county employment growth is divided between current residents, in-migrants, and (non-resident) commuters. The research employed a labor market model that was developed in the preceding Hatch Project. The model explicitly accounts for movements of workers across county lines - in conjunction with labor market adjustments that occur within a county - when an exogenous labor demand shock takes place. A paper was published synthesizing the findings resulting from applying the model to two separate data sets - one for North Carolina in the 1980s and the other for 13 Southern states in the 1990s. Both sets of estimation results suggest that the bulk of local labor market adjustment to new employment opportunities is accounted for by changes in commuting flows, with the remainder being accounted for by labor force growth (primarily taking the form of in-migration). It is concluded from this that the fiscal impacts of employment growth associated with changes in residential demands for publicly provided services and residential provision of property tax revenues will be substantially smaller than is commonly supposed. Significant rural-urban differences were found to exist. A relatively greater fraction of new jobs in metro counties are filled by (non-resident) in-commuters than is the case for rural counties, while employment growth in rural counties appears to be accommodated to a relatively greater degree by reductions in out-commuting. Evidence is also presented indicating that labor force growth (and, by extension, population growth and residential development) in rural counties is substantially more sensitive to employment growth in nearby counties than is the case for urban counties. Thus, while employment growth in rural counties may lead to smaller fiscal impacts than is often supposed, employment growth in nearby counties represents an important countervailing factor that also tends to be overlooked in economic and fiscal impact analyses.

Summary:

Research-Extension Integrated Project Initiatives involved over 63 projects, and 57 of those involved Hatch Funding Sources in support of 57 Scientists who led projects.

Total Hatch funding allocated and expended on 57 projects for FY 2006: $1,614,746

Total Hatch budget allocation for 2006 was $6,062,138.

Percent of total Hatch funds allocated to Integrated projects amounted to 26.6%

U.S. Department of Agriculture
Cooperative State Research, Education, and Extension Service
Supplement to the Annual Report of Accomplishments and Results
Actual Expenditures of Federal Funding for Multistate Extension and Integrated Activities
(Attach Brief Summaries)
Fiscal Year: 2006

Select One: **Interim** **X Final**

Institution: NC Agri. Research Service
State: North Carolina

		Integrated Activities (Hatch)		Multistate Extension Activities (Smith-Lever)		Integrated Activities (Smith-Lever)	
Established Target %		25	%		%		%
This FY Allocation (from 1088)		$6,062,138					
This FY Target Amount		$1,515,535					
Title of Planned Program Activity							
Goal 1	An Agricultural System That is Highly Competitive in the Global Economy	$1,147,357					
Goal 2	A Safe and Secure Food and Fiber System	$25,418					
Goal 3	A Healthy, Well-Nourished Population	$42,403					
Goal 4	An Agricultural System That Protects Natural Resources and the Environment	$327,793					
Goal 5	Enhanced Economic Opportunity and Quality of Life for Americans	$71,775					
		$1,614,746					
	Total	$6,062,138					
	Carryover	$99,211					

Certification: I certify to the best of my knowledge and belief that this report is correct and complete and that all outlays represented here accurately reflect allowable expenditures of Federal funds only in satisfying AREERA requirements.

3-21-2007

Director **Date**