NORTH CAROLINA AGRICULTURAL RESEARCH SERVICE

AREERA PLAN OF WORK Update

(Agricultural Research, Education, and Extension Reform Act of 1998)

October 1999 - September 2004, 2005-2006

North Carolina Agricultural Research Service
College of Agriculture and Life Sciences
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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, forestry, and family and consumer sciences. Its research projects involve NC 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 and life sciences;
- conserve and improve the state's natural resources and environment;
- improve the health, well-being and quality of life of all citizens of North Carolina.

Numerous facilities are utilized in conducting research on and off campus. On-campus facilities include many laboratories, some highly specialized (i.e., molecular imaging, genomic sequencing, soil analysis, x-ray crystallography, etc.); two greenhouse ranges; the Phytotron controlled environment facility; the Biological Resources Center small animal facility, and the Pesticide Residue Laboratories, among others. Off-campus research facilities include nine field laboratories near campus with extensive animal and crop production capabilities and facilities for agricultural and municipal waste management research; regional research and extension centers with resident research faculty in both western and eastern North Carolina; and 16 agricultural research stations spread throughout the state, including the Center for Environmental Farming Systems, which specializes in sustainable agriculture research.

NCARS personnel include 320 research faculty accounting for approximately 197 full-time scientist equivalents, most on shared appointments with academics or extension. Working with these faculty are over 393 graduate students, researchers and research assistants; 445 laboratory and field technicians and 168 clerical staff. These faculty and support personnel conduct basic and applied research in over 600 projects to support more than 70 commodities as well as many life science industries.

The following updated Plan of Work represents the original five year AREERA plan, plus an additional two year period to conclude at the end of the 2006 fiscal year. This plan covers the 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

Narrative

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 life 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, forestry, and family and consumer sciences. Its research projects involve NC State University's colleges of Agriculture and Life Sciences, Natural 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.

North Carolina has a robust agricultural industry. In 2002 it contributed $62.6 billion to the state's economy, which accounted for 22% of the state's income. Sales of agricultural products were over $9 billion of which about 60% was derived from animal production and 40% from crop production. North Carolina has always had a diverse agricultural economy. For example the greenhouse and nursery industry now accounts for 13.3% of the total sales of crops, exceeding that of all other plant related commodities. 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, editable soybeans, kenaf, sea oats and winegrapes. As an example, the number of commercial vineyards has more than doubled since 1998 and North Carolina now ranks 12th in wine production. 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, managing pests and pathogens, harvesting and storing these commodities. There is also a great need for North Carolina growers to become more efficient in the production of traditional row crops so that they can remain competitive in the global marketplace. New varieties with improved yield and quality traits and pest resistance, increased mechanization, increased use of precision agricultural techniques, and more efficient use of fertilizers and pesticides are all needed for North Carolina growers to maintain their competitive edge. Consequently the NCARS is challenged with developing sustainable production systems that position our growers to take advantage of opportunities for producing and marketing new commodities that meet local, national and international demands. These production systems need to be structured so that they not only ensure a profit for our growers, but produce products in an environmentally sound manner that meet consumers concerns over food safety, quality and

nutrition.

Production of poultry, swine, beef, dairy products, fish, honey, horses, sheep and goats has averaged more than $4.2 billion annually in sales over the last four years (1999-2002). Tremendous increases in the economic impact of animal agriculture has occurred over the last few decades. Among the many factors that have contributed to the substantial increase in animal production are a favorable economic environment and the adoption of modern production practices by animal producers. The concentration of animal production in limited geographical areas poses major challenges for the food-animal industries in terms of maintaining a healthy and sustainable environment. The production of animal by-products (*i.e.*, manure, litter, mortalities) and the odors and pests associated with production constitute one of the major challenges to the food-animal industries. Methods must be developed to handle and recycle these by-products in a manner that is not only environmentally safe but also economically feasible and socially acceptable. The concentration of animal production has also resulted in increased risks of disease exposure and disease outbreaks and has resulted in much greater attention to preventative medicine and methods to minimize pathogen exposure. These changes in the scale of animal production have also caused changes in the general approach to animal health, such as from the treatment of single animals to the treatment of large groups of animals. Pests associated with confined poultry and livestock include flies, biting flies, darkling beetles, mites, and cockroaches. Integrated Pest Management (IPM) is a multidisciplinary approach to the management of these pests, and includes sanitation, cultural control, biological control and chemical control. Other areas of research include understanding immune function, the effect of dietary mycotoxins on animal health, productivity, and physiology, and the use of probiotics as an alternative to growth promoting antibiotics. Improving animal productivity, efficiency, and health while providing proper environmental stewardship will encompass a vast array of research subjects, topics, and components from determining and understanding the optimal management programs for rearing healthy and productive animals to determining the gene or complex of genes responsible for economically important traits to the development of socially acceptable best management practices. The target audiences will also be vast from producers to consumers and from students to scientists. The audiences will be within North Carolina as well as across the U.S and around the world.

Program Area 1:
Technologically Integrated and Sustainable Crop and
Livestock Production Systems

Subprogram Area 1a:
Crop Production Systems

Statement of Issue
Agriculture is North Carolina's number one industry and has generated farm income of over $9 billion yearly for the past 3 years. As a very diverse animal and plant agricultural industry exists, the plant industry for example produces over 80 crops commercially. The development of improved crop production systems has long been the mainstay of research conducted in commodity departments such as Crop Science and Horticultural Science with support and collaboration from the departments of Soil Science, Biological and Agricultural Engineering, Entomology, Plant Pathology, Agriculture and Resource Economics, Food Science and Biochemistry and others. Research has focused on identification, selection, breeding,

introgression and genomics designed to develop improved varieties with superior disease resistance and quality; mechanization of all phases of crop production from planting to harvest; the development of technologically advanced production systems; integrated pest management; and postharvest handling of various commodities. Advances in these areas have given producers the ability to competitively produce quality products, which directly benefits the consuming public.
In recent years low grain prices and pressures exerted on tobacco production have resulted in the redirection of programs to explore and examine diversification of crop production in North Carolina with alternative and specialty crops. In addition, economic downturns in other agronomic crops and sensitivity to environmental concerns regarding pesticides, nutrients and animal waste have spurred an increase in research on sustainable production techniques.

To remain competitive in a national and global agricultural economy, it is necessary for producers in North Carolina to become more efficient in the production of traditional crops and diversify their operations to incorporate alternative and specialty crops in their mix. In addition, consumers have become more educated and food safety, quality and nutrition are concerns of many people. It is, therefore, incumbent upon our producers to supply a quality, nutritious and safe product to the market place.

Performance Goals

1. Develop improved pre- and postharvest management techniques for field, fruit, specialty, and vegetable crops.

2. Develop improved production management systems for field, fruit, specialty and vegetable crops.

3. Improve the acceptability/quality of field, fruit, specialty, and vegetable crops.

Key Program Components
Nearly 80 different North Carolina Agricultural Research Service projects in nine departments involve crop production systems. Key program components are listed below in relation to the three performance goals listed above.

Performance Goal 1.
Projects will focus on ways to increase the mechanization of crop planting and harvest and the development of improved postharvest management techniques, with emphasis on perishable crops such as vegetables and fruits. Studies on precision agriculture are a component of this goal since its adoption in many crops requires mechanization of certain operations so that yields and other parameters associated with crop production and quality can be monitored. Projects on plant breeding and cultural management support increased mechanization as they relate to modifying plant growth habit and yield traits that are compatible with mechanical harvesting.

Performance Goal 2.
There are over 30 different projects underway in this category, with 15 in the fruit and vegetable area and 17 in field crops. Research activities on fruits, vegetables, specialty crops and ornamentals, include sustainable production systems; plant establishment; nutrient cycling and fertilizer management; stress physiology; IPM strategies for managing plant diseases and

arthropod pests; pesticide resistance management; production systems for herbs and botanicals; and general cultural management practices for a number of different fruit and vegetable crops.

Projects involving field crops will include economic assessments and modeling for several different crops; assessment of precision farming technologies; transplant production systems; the relationship of environmental factors related to productivity of various crops; fertilizer management; techniques for reducing herbicide and chemical inputs in cropping systems; and studies on the genetic diversity of various plant pests.

Performance Goal 3.
This goal captures many of the resources devoted to crop production systems. There are over 30 different projects, with 14 in horticultural crops and 20 in field crops. Plant breeding and genetics of horticultural and field crops will comprise a large amount of the activity related to this goal. A number of projects overlap with Goal 2, including some of the projects on nutrient cycling and fertility with vegetables as well as projects on plant establishment. Other areas of emphasis with horticultural crops include nondestructive quality sensing of high-value crops; physiology of apple fruit ripening and storage; and influence of small and tree fruit management systems on fruit quality.

Other areas to be addressed under field crops include the evaluation of legumes and natives grasses for nutrient content and effects on animal growth in sustainable production systems; yield and quality evaluation of many crops including peanuts, corn, soybean, and cotton; mycotoxin monitoring; parameter sensing and control systems for drying agricultural commodities; and biodiversity of soybean germplasm for value-added traits.

Output Indicators: The performance goals involve research with direct application to the crop producer, with ultimate benefits to the consuming public. Anticipated outcome indicators include:

- adoption of labor saving and more efficient practices in the planting, cultivating and harvesting of crops;

- application of sustainable production techniques that result in reduced risk of off site movement of nutrients and pesticides;

- use of improved varieties that have multiple disease resistance, improved quality characteristics including taste, flavor and nutritional/health value;

- use of crop varieties adapted to a wide range of environmental conditions and physiological stresses;

- improvement in post harvest handling procedures resulting in increased shelf life and storage with minimal losses;

- increased use of nonchemical methods of pest control and/or reduced pesticide use through application of IPM strategies; and

- application of precision agriculture techniques to enhance sustainability and production efficiency.

Internal and External Linkages
Internal linkages exist with many departments in the College of Agriculture and Life Sciences. Faculty from the following departments are most heavily involved in this program area.

Crop Science
Horticultural Science
Biological and Agricultural Engineering

Faculty in these departments collaborate with faculty from the following departments.

Soil Science	Plant Pathology
Food Science	Molecular and Structural Biochemistry
Statistics	Entomology
Poultry Science	Animal Science
Botany	Genetics
Environmental and Molecular Toxicology	

Multi-state collaboration exists in many of the programs, both formally through SRIEG agreements and Memorandums of Understanding and informally between individual faculty at a number of land- grant institutions in the Southeast and other regions of the country. Additionally, a number of the projects involve direct and indirect international collaborations, both with individuals in other nations and through international centers in Central and South America, Europe, Africa and Asia. Both the internal and external linkages greatly enhance research efforts within this program area.

Target Audiences
Producers of field and horticultural crops in North Carolina are the primary stakeholders or clientele of this program area although research related to this area often has regional, national and international impact. However, the ultimate consumers of the commodities produced are also important customers.
Program Duration
Long-term, 5 years, plus 2 additional years.

Allocated Resources
Following are expenditure and commitment data for 1997-98.EXPENDITURES

Source	Amount
CSREES Funds	$366,606
USDA-CGCA Funds	$162,009
Other Federal Funds	$572,688
State Appropriation	$2,731,620
Non-Federal Funds	$286,828
Total	$4,119,752

PERSONNEL COMMITMENT

Scientist Years	10.59
Professional Years	14.29

Technician Years	29.30
Clerical Years	10.64
Total	64.82

No major shifts in future resource allocations appear to be warranted; however, in view of the importance of developing sustainable agricultural practices, including organic farming techniques, more resources may have to be assigned to Performance Goal 2 (Production Management Systems for Field, Fruit, ornamental, and Vegetable Crops).

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The following two performance goals identified under Program Area 11 in the original plan have been added to National Goal 1 for 2005-2006 from the original National Goal 5 plan for 1999-2004.

2 Performance Goals from the Components of Former Program Area 11 under original plan Goal 5 are now performance goals 5 and 6 below.

Statement of Issue

The green industry locally, regionally and nationally has experienced phenomenal growth in recent years. Commercial flower production; ornamental nurseries; landscape design and maintenance; and turf production and maintenance constitute the major enterprises in the green industry. This is a segment of agriculture that has recorded double digit growth over the past 10 years. There are many issues that these industries face, from environmental to production problems. To provide the service and the aesthetics that the general public expect from this industry, research efforts must be undertaken to solve environmental and production problems as well provide the industry and ultimately the public with a more diverse selection of plants for the landscape. During periods of economic prosperity in the country, individuals and corporations invest more in enhancing their living environment and spend more on outdoor recreational activities such as golf and gardening. This translates into more demand for products and services from the green industry.

Because many golf courses are in critical drainage systems and near wetlands, fertilizer residues cannot be allowed to run off into the streams and rivers. If regulations go into effect preventing chemical use on turf, golf courses could be shut down and the quality of life for many people decreased. However, we do not know if there is a problem if good management practices are used. Studies need to be implemented to better understand nitrogen application and its fate in recycling on golf turf as opposed to runoff in surface or underground water so lawmakers can have data to make good policy decisions.

Performance Goals

1. Develop improved production management systems for ornamental and floricultural crops and turfgrass.

2. Develop and introduce superior landscape plants to enhance rural and urban environments.

Key Program Components

Projects focusing on ornamentals, turfgrass, floriculture and landscape involves six departments. These projects have been grouped into two categories as outlined under performance goals 5 and 6

Performance Goal 5.
A total of 25 projects are underway in this category with six in the turf area and 19 in ornamentals/turf. In the turf area research that will be conducted includes weed and disease management; breeding and genetics; and fertility and water management. Ornamentals and floriculture research to be pursued includes pest (weeds, insects and diseases) management; hydrology of horticultural substrates and urban soils; improved propagation procedures for selected ornamental species; production, culture, and physiology of landscape plants; fertility and nutrient management in floral and ornamental crops; breeding and genetics of ornamentals; taxonomy of ornamental plants; and development of environmentally compatible nursery production practices.

Performance Goal 6
This goal involves the identification of superior landscape plants for the Southern U.S. Two related projects will be involved in this category. The first project to be pursued is evaluation of plants for landscape use in the southeastern U.S. which essentially covers one of the missions of the J.C. Raulston Arboretum (JCRA). This will involve plant exploration and exchange, on site evaluation at the JCRA and satellite sites; and introduction of superior performing plant material to the nursery industry through a plant introduction program. The other project will address the evaluation of various tree species for performance in all the geographic areas of NC for performance and such attributes as suitability under utility lines.

Output Indicators:
These performance goals involve research with direct application to the commercial producer with ultimate benefits to the consuming general public. Anticipated outcome indicators include:

- adoption of more efficient production practices for ornamental and floricultural crops;

- application of sustainable production techniques for ornamental and turf production that result in reduced risk of off site movement of nutrients and pesticides;

- use of improved ornamental and turf varieties that have multiple disease resistance, insect resistance and improved quality characteristics;

- use of ornamental and turf varieties adapted to a wide range of environmental conditions and physiological stresses;

- use of nonchemical methods of pest control and/or reduced pesticide use through application of IPM strategies; and

Internal and External Linkages
Internal linkages exist with several CALS departments and College of Natural Resources faculty in this program area. Major players in this program include faculty from the Horticultural Science, Entomology and Plant Pathology departments who cooperate with faculty from Soil

Science, Statistics, Poultry Science, Animal Science, Botany, and Genetics. Multi-state collaboration exists in many of the programs both formally through SRIEG agreements and Memorandums of Understanding and informally between individual faculty at a number of land grants in the southeast and other regions of the country. Cooperative efforts also exist with such commodity groups as the N.C. Association of Nurserymen and the N.C. Landscape Association in terms of plant introduction programs. Additionally, a number of the projects have direct and indirect international collaborations both with individual countries and international centers in Central and South America, Europe, Africa and Asia. Both the internal and external linkages greatly enhance research efforts within this program area.

Target Audiences
Producers of ornamental and floricultural crops and turfgrass managers and pest control operators in North Carolina are the primary stakeholders or clientele of this program area. However, the ultimate beneficiary of these efforts is the public at large as results of this research touch the lives of almost every citizen of the state with regard to quality of life. Although efforts are targeted for North Carolina, results of the research often have regional, national and international implications.

EXPENDITURES

Source	Amount
CSREES Funds	$229,455
USDA-CGCA Funds	$0
Other Federal Funds	$83,202
State Appropriations	$1,431,502
Non-Federal Funds	$339,168
Total	$2,083,327

PERSONNEL COMMITMENT

Scientist Years	5.7
Professional Years	4.8
Technician Years	8.8
Clerical Years	5.2
Total	24.5

Subprogram Area 1b:
Animal Production Systems

Statement of Issue
Animal production in North Carolina impacts virtually all citizens in the state by providing income, products for human consumption and use, and recreation. Production of poultry, swine, beef, dairy products, fish, honey, horses, sheep and goats has averaged more than $4.2 billion annually in sales over the last four years (1999-2002). In 2002, total livestock sales represented more than 59 percent of the agricultural income in the state. This amount does not include the value of sales and services of animals associated with the pleasure industries involving horses and companion animals.

Each of the broad animal production categories listed consists of subcategories. For example, poultry production can be subdivided into broiler production, turkey production, chicken egg production, game bird production, etc. Most of these subcategories contribute significantly to North Carolina's agricultural income and each has its own unique set of inputs and outputs.

Animal production systems have changed during the past several decades, and there is an expectation that they will continue to change in the future. Certain segments of the animal industry have undergone aggregation into fewer controlling business entities and have experienced vertical integration. For example, corporate businesses now have a controlling interest in the turkey, egg, broiler, swine and commercial fish production industries. On the other hand, many segments of the animal industry remain quite diverse and are controlled by many individuals. Beef production continues to increase in North Carolina, with increases occurring in both the number of animals being raised and the number of producers involved in the industry. Upland game bird producers of quail, pheasant and chukar partridge produce more than two million birds annually for the shooting and hunting preserve industry. Segments of the state's animal industry that rely on the increased affluence of North Carolinians also continue to grow, with the most notable among these being the horse industry.

While animal production is located in every county in North Carolina, there are geographical areas of the state that contain concentrated animal production. For example, most of the swine production is in the coastal plain, whereas other industries are more geographically dispersed. Certain relationships exist between intense animal production systems and the surrounding communities including land and water resources. These relationships need investigation in order to sustain both agricultural production and environmental stewardship. Animal production systems are affected by both internal and external factors. Among these factors are business considerations and the biological limitations of the animals. Laws and regulations governing animal production and the expectations of society also affect animal production.

The following key components that contribute to a better understanding of animal production systems have been identified. The input of producers and users of animal products, proponents and opponents of animal production, and researchers was used to identify these components.

- Underlying physiological processes of animals
- Economics and profitability of animal enterprises
- Impacts of animals on the environment
- Relationships among animals, animal housing and equipment
- Associations of animal production systems with the health and well being of animals and the products derived there from
- Societal acceptance of best management practices

Performance Goals

1. Improve the overall biological efficiency of animal production through understanding of the basic physiological processes of animals. New knowledge gained and knowledge transferred will be the output/outcome indicators for this performance goal.

2. Investigate and develop best management practices for animals in various animal production systems that are environmentally sensitive, economically realistic and socially acceptable. New knowledge gained and knowledge applied to existing problems that result in profitable and environmentally sustainable animal production will be the output/outcome indicators for this performance goal.

3. Develop, improve and enhance the structures, facilities and equipment used in animal production systems. New knowledge gained and the transfer of knowledge into new ways to house and maintain animals will be the output/outcome indicators for this performance goal.

4. Examine relationships between animal production systems and animal uses and products for the purpose of improving consumer and societal acceptance. New knowledge gained, new services and products developed and a safer, more wholesome food supply will be the output/outcome indicators for this performance goal.

Key Program Components
Research will focus on developing a better understanding of the following subjects. Adequately addressing these subjects is considered key to successfully reaching the performance goals.

 The Reproductive Performance of livestock, poultry, fish and other animals

 Environmental stress experienced by livestock, poultry, fish and other animals during production

 Production management systems for livestock, poultry, fish and other animals

 Production management and disease control for bees and other Pollinating insects

 Improvement of structures, facilities and general purpose farm supplies and equipment

 Mechanization and improvement of structures used in production of livestock, poultry, fish and other animals

 Production of animal products with improved consumer acceptability

Internal and External Linkages:
Numerous linkages will be required to meet the performance goals. Within each key program component, there is an expectation that linkages will be formed internally within the NC State University community as well as with partners outside the university. Listed below are members of partnerships that have been formed previously to address these goals and that most likely will also be forged in the future.
Departments in the College of Agriculture and Life Sciences
Animal Science Poultry Science

Biochemistry
Toxicology
Agricultural Resource Economics
Entomology
Soil Science
Zoology
Biological and Agricultural Engineering
Crop Science
Food Science

Colleges at North Carolina State University
College of Veterinary Medicine
College of Physical and Mathematical Sciences
Universities in North Carolina
North Carolina A & T State University
Duke University
University of North Carolina at Chapel Hill
University of North Carolina at Wilmington
Commodity Organizations
Numerous including North Carolina Poultry Federation, North Carolina Pork Council, North Carolina Cattlemen's Association, North Carolina Dairy Producers, North Carolina Horse Council
Other Linkages

Faculty at North Carolina State University have formed formal and informal linkages with faculty at Universities across the U.S. and internationally. In addition, NCSU faculty form investigative links with state, national, and international agribusinesses, pharmaceutical companies and other industries.

Target Audiences

The research conducted in this area has many stakeholders and beneficiaries, both internal and external to North Carolina. Target audiences will include, but not be limited to, animal producers, the agribusiness community, consumers of animal products, individuals who maintain animals as pets, scientists and researchers, and students.

Program Duration

Long-term, 5 years plus 2 additional years.

Allocated Resources

Following are expenditure and commitment data for 1997-98.

EXPENDITURES

Source	Amount
CSREES Funds	$721,546
USDA-CGCA Funds	$22,001
Other Federal Funds	$321,477
State Appropriation	$3,097,112
Non-Federal Funds	$767,493
Total	$4,929,629

PERSONNEL COMMITMENT

Scientist Years	7.76

Professional Years	12.89
Technician Years	41.17
Clerical Years	2.67
Total	64.43

During the next five years, it is expected that the total Animal Production Systems commitment will remain at approximately $5 million, adjusted annually for inflation, and that the personnel commitment will remain consistent with the 1997-98 fiscal year. As conditions change and upon the appropriate recommendations from stakeholders, the budget and personnel inputs for this program may change.

Subprogram Area 1c:
Biological Systems

Statement of Issue
Basic research on fundamental biological systems creates the knowledge base and foundation used by scientists to improve agricultural production systems, the marketability of agricultural products and these products for human health. The growth and development of plants and animals and their response to the environment are key to productivity, marketability and sustainability. There is a need to understand the basic biochemical, physiological and genetic mechanisms that regulate these processes. In the last decade, the new field of genomic science has changed the paradigm for basic and applied biological sciences. New technologies have allowed rapid progress in the sequencing and mapping of organisms' genomes, and advances reveal striking interrelationships in the structure and function of these genomes. Bioinformatics deals with the handling and analyzing of the vast amount of sequence, genomic mapping and expression data being generated. The area of functional genomics encompasses gene discovery, cellular and developmental biology, structural biology and genomic approaches to breeding as well as comparative studies of ecology and evolutionary biology. Genomic science approaches integrated with traditional approaches in physiology, biochemistry and genetics applied to model biological systems will provide the knowledge base needed to prevent and treat disease, identify infectious organisms and improve the yields and quality of the foods we produce and consume.

Performance Goals

1. Map, identify and analyze genes responsible for quantitative traits.

2. Characterize the structure and expression of genes and pathways required for growth, development and behavior.

3. Develop new approaches for gene transfer and gene regulation, and new methods for visualizing gene products within cells.

4. Identify biochemical factors and pathways involved in response to abiotic and biotic stresses and environmental factors such as drought, gravity, light and pathogens.

5. Elucidate the structure, function and evolution of macromolecules that are key to growth, development, defense and behavior.

Key Program Components
This program area involves more than 60 projects in 13 departments. Projects focus on the fundamental processes that regulate growth, development and responses to the environment at the cellular, tissue and organismal levels. The projects include the following overlapping research areas in model plant, animal and microbial systems.

Statistical, quantitative and evolutionary genetics of complex traits.
Projects in four departments using experimental and theoretical statistical, quantitative and evolutionary genetics approaches focus on:

- The mapping and identification of quantitative trait loci;
- Quantification of the extent of genetic diversity in natural and domesticated species;
- Detection of genes affecting economic traits in plants and animals, and genes affecting human disease; and
- Reconstruction of the evolutionary history of modern species.

Analysis of genes and pathways involved in growth, development, and behavior.
A large number of projects in six departments focus on an understanding of the genetics, biochemistry and physiology that impact growth, development and behavior in model systems. These include projects on:

- The identification and expression of genes and involved in a) microbial, plant, insect and mammalian growth and development, and b) insect and mammalian behavior;
- An understanding of the mechanisms of gene regulation in microbial, plant and animal systems and the development of methods for optimizing transgene expression in plants; and
- An understanding of biochemical pathways affecting growth and development in microbial, plant and animal systems.

Structure, function and evolution of macromolecules.
Projects in three departments focus on understanding of macromolecules and macromolecular complexes that are key to growth and development. These include projects on:

- The structure/function relationships of macromolecular assemblies involved in replication, translation, and protein and nucleic acid degradation;
- The thermodynamic and kinetic folding properties of proteins;
- An analysis of higher order DNA structures in vivo; and
- The molecular evolution of transcription factors.

Responses to the environment, including biotic and abiotic stresses.
Projects in seven departments address responses to the environment. These focus on:

- The genetic and biochemical basis of pathogenesis in plant, animal and microbial pathogens;
- Defense responses to pathogens in plants;
- Responses to oxidative and nutrient stress in microorganisms; and
- Plant responses to external stimuli such as light and gravity.

Output indicators: These performance goals involve fundamental research on model systems, and thus, the output indicators are the dissemination of this information and its use by other scientists. Indicators include the dissemination of knowledge to scientific colleagues, postgraduates, graduate students, undergraduate students and K-12 teachers through peer-reviewed publications,

technical publications, seminars, presentations at scientific conferences, classroom instruction, student laboratory training, teacher workshops, and web access to publications and laboratory protocols for teaching and research.

Internal and External Linkages
This program area includes faculty from 13 departments in the College of Agriculture and Life Sciences. These departments are:

Biochemistry	Biological and Agricultural Engineering
Botany	Crop Science
Entomology	Food Science
Genetics	Horticultural Science
Microbiology	Plant Pathology
Statistics	Toxicology
Zoology	

Many projects are multidisciplinary in nature and involve faculty from different departments and/or other universities. Faculty work freely across departmental and college boundaries and various faculty are linked through a number of university programs and research and training grants, including:

the Biotechnology Faculty,
the NIH Program Project in Statistical Genetics,
the NIH Training Grant in Quantitative and Molecular Genetics,
the TriAgency (USDA/DOE/NSF) Training and Research Program,
the NASA Center of Training and Research in Gravitational Biology,
the Keck Program in Behavioral Biology, and
the College of Veterinary Medicine.

External linkages include the involvement of the faculty in a number of Research Triangle area groups that include scientists from the University of North Carolina at Chapel Hill and Duke University and scientists at local industry and government organizations. These include:

the RNA Society of North Carolina,
North Carolina Biotechnology Center Plant Molecular Biology Program,
Triangle Virology,
Triangle Lower Eukaryotes Group and
Triangle Arabidopsis Group.

Target Audiences
The national and international community of scientific researchers and teachers

Program Duration
Long-term, 5-plus 2 years

Allocated Resources
Following are expenditure and commitment data for 1997-98

EXPENDITURES

Source	Amount
CREES Funds	$721,321

USDA-CGCA Funds	$77,108
Other Federal Funds	$2,466,290
State Appropriations	$4,666,484
Non-Federal Funds	$838,136
Total	$8,844,370

PERSONNEL COMMITMENT

Scientist Years	22.50
Professional Years	60.11
Technician Years	28.03
Clerical Years	5.94
Total	116.58

It is anticipated that future funding and human resource allocations for this program area will continue with roughly the same emphasis as shown in the above tables during the period of this plan of work (5 plus 2 years).

Goal 1, Program Area 2:
Plant and Animal Germplasm,
Genetic Resources and Conservation,
and Plant Improvement

Subprogram Area 2a:
Crop Improvement

Statement of Issue
An adequate quantity of nutritious food is critical for a healthy human population and for sustained economic growth. To ensure continued sources of useful plant products, technologies must be enhanced to economically grow the food and fiber resources needed to feed both the human population and animal industry, as well as to supply quality raw materials to the nation's industrial complex. Plant cultivars that are grown on the state's high-quality soils are mostly productive, but on less favorable soils there can be significant declines in yields. Further, diseases and insects continue to plague field crops and orchards in all areas of the state, and they cause significant yield reductions as well as reduced quality of marketable products. In addition to field crops, orchards and vegetables, more than 2.5 million acres of forages in North Carolina supply about 70 percent of the feed resources for the state's cattle, horse, sheep and goat industries. These perennial crops provide both feed for animals and a rapid, low-cost method of utilizing animal and industrial by-products.

Agricultural industries have undergone dramatic changes during recent years as prices have greatly fluctuated and government support programs for several commodities have come under political scrutiny. If they are to continue to be economically solvent, producers must grow their products with either fewer or less expensive inputs while at the same time generating a high-quality product. In addition, producing crops economically has become difficult as federal and state environmental regulations restrict some farm management practices and chemical use to control weeds, pathogens and other pests. Many farms produce both plant and animal products, and management problems become more complicated as animal waste is used on cropland in

place of commercial fertilizers, sometimes resulting in high concentrations of nitrogen, phosphorous, and other elements in soil and groundwater. New, innovative strategies must be developed and implemented on farms to enhance economical and environmentally sustainable crop production.

Performance Goals

1. Improve plant productivity and quality of fruits, vegetables, ornamentals, and agronomic crops through breeding methodologies to increase yield and quality and reduce the incidence of diseases and insects.

2. Increase biological efficiency through control of metabolic processes and gene regulation in plants used for food, fiber, fodder, and decoration.

3. Develop methods and strategies to more efficiently produce horticultural and agronomic crops in North Carolina.

Key Program Components
Performance Goal 1.

North Carolina Agricultural Research Service programs to improve plant productivity through improved breeding methodologies encompass a wide range of horticultural and agronomic species and research areas including: a) quantitative genetics, b) qualitative genetics, c) molecular genetics, including molecular marker technologies and transformation methodologies, d) interspecific hybridization, e) manipulation of ploidy levels, f) germplasm collection, introduction and conservation, and g) variety development. Plant breeders in the Crop Science and Horticultural Science Departments interact with a large number of faculty and programs in Agriculture Engineering, Botany, Entomology, Food Science, Genetics, Plant Pathology and Soil Science.

Plant breeding programs are being conducted to develop improved varieties and/or genetic stocks in barley, blueberries, corn, cotton, cucumber, luffa, oats, peanut, potato, rubus, soybean, strawberry, sweet potato, tomato, triticale, watermelon, and wheat. Specifically, the objectives of these programs are to:

- Develop high yielding and superior quality cultivars and germplasm lines with resistance to biotic stresses, including plant diseases caused by fungi, bacteria, viruses, insects and nematodes;
- Develop high yielding and superior quality cultivars and germplasm lines with resistance to abiotic stresses, especially to drought and soil toxicities; and
- Develop and test new breeding methodologies to improve efficiency of genotype selection.

Breeding program goals are met through a number of hybridization and plant manipulation techniques. Research involves clonal materials, cross- and self-pollinated species, annuals and perennials. Breeders of blueberries, peanuts, cotton, potato and small grains make extensive use of interspecific hybridization to introduce new genes from related wild species into the respective cultivars. Corn breeders are manipulating daylight sensitivity in a program to utilize South American land races. New germplasm resources are acquired both by plant exploration and

through seed acquisition from cooperators. Introductions are then evaluated for important disease, insect and quality traits for the respective species. Ploidy levels are manipulated to utilize simpler genetic systems at the haploid level for several autotetraploid and allotetraploid crops. Molecular marker technologies are utilized by the corn, peach, peanut, potato, small grains, soybean and other programs. Transformation technologies are used for peanut, grasses, tobacco and several other crop species.

Each commodity program has genetic components where the quality of oils, fibers, flavors, disease and insect resistance are characterized. Genotype x environment interactions are evaluated at field sites to estimate adaptability of cultivars. Variety testing programs are conducted prior to release to the user community for all major crop species grown in North Carolina.

Output Indicators:

- Release of superior cultivars for use by commodity producers
- Release of improved germplasm lines for use in hybridization programs
- Release of inbred lines for use as parents in hybrid production

Performance Goal 2.

Research in crop management has historically been crop specific, but in recent years a more systems-specific approach has been implemented. Research projects include the major agronomic crops, cover crops, vegetables, vineyards, orchards, herbs and botanicals produced in North Carolina. A large percentage of the research focuses on quality issues during the time of plant growth and development as related to plant establishment, pest and fertility interactions, tillage practices, weed and integrated pest management, fertilizer management and harvesting methodologies. Post-harvest issues are especially important for preserving quality of apples, grapes and other fruits.

Environmental issues have a significant impact on crop management due to implementation of federal and state regulations. The effects of conservation tillage and cover crops on yields are being investigated. Soil fertility is an important component of research projects for management of nitrogen and other elements from fertilizers and animal waste. In addition, soil microorganisms play a key role in plant utilization of nutrients, and studies are underway to determine the diversity and interactions of bacteria and fungi in the rhizosphere.

The specific objectives of these programs are to:

- Develop improved cultural methodologies to increase yields of high quality plant products; and
- Understand the interactions between plants and the environment in which they are grown.

The objectives of the management projects are met at research stations across the state of North Carolina, which are generally located in the centers of the commodity production area. Both traditional and newly developed agricultural practices are tested experimentally. For example, sustainable agricultural systems are being tested at one farm using a highly integrated systems approach to both crop and animal production. Management research is multidisciplinary and involves integration of all disciplines in plant-related agriculture. This research is leading to higher degrees of specialization and modeling production practices to the ultimate benefit of a

broad range of farming enterprises.

Output indicators:

- Development of new technologies that lead to higher quality plant products
- Higher levels of crop production with economical management practices
- Implementation of best management practices that lead to production of safe products with consideration for both growing and surrounding environments

Performance Goal 3.

Plant metabolism and cell functions are investigated to understand the biochemical and plant processes leading to higher yields and better quality products. Source-sink relationships are studied to direct more photosynthetic products into desired organs. Carbohydrate and sugar metabolism and protein synthesis have significant effects on harvesting and product maintenance in storage. To create more efficient plants and higher quality products, it is necessary to understand the developmental and metabolic processes leading to the plant part that is marketed.

The specific objectives of these programs are to:

- Understand biological processes which can lead to higher yields and quality of plant products; and
- Identify unique genotypes which can be utilized in applied plant improvement programs.

Output Indicators:

- Number of New technologies developed that lead to higher quality plant products
- Number of new basic biological principles elicited related to crop plants

Internal and External Linkages

Internally, this program area primarily includes faculty from the following departments.

Crop Science	Horticultural Science
Botany	Genetics

Faculty from these primary departments cooperate and collaborate with faculty from the following departments.

Food Science	Entomology
Plant Pathology	Biological and Agricultural Engineering
Biochemistry	Microbiology
Soil Science	Statistics

Faculty also interact with faculty in the College of Natural Resources. Most projects are multidisciplinary and involve several NC State faculty from different departments. Many projects involve faculty from different universities. Several projects have cooperative links with industry and commodity groups. Most projects have direct or indirect links to foreign countries in Central and South America, Europe, Africa, and Asia. Linkages with international institutes have been extremely important for crop production research.

Target Audiences

The primary audience includes the producers of agronomic and horticultural crops in North Carolina. Farmers and companies in other states and foreign countries who use the products produced in this state also benefit from enhanced germplasm for traits affecting yield and quality.

Program Duration
Long-term, 5 years plus 2 years

Allocated Resources
Following are expenditure and commitment data for 1997-98. Similar expenditures and personnel commitments are expected over the next five years.

EXPENDITURES

Source	Amount
CSREES Funds	$724,123
USDA-CGCA Funds	$222,771
Other Federal Funds	$352,565
State Appropriation	$6,125,954
Non-Federal Funds	$1,021,486
Total	$8,473,899

PERSONNEL COMMITMENT

Scientist years	19.67
Professional years	17.33
Technician years	88.12
Clerical Years	21.47
Total	146.59

Subprogram Area 2b:
Animal Improvement

Statement of Issue
Tremendous increases in the economic impact of animal agriculture have been observed during the last couple of decades, with significant increases noted in both the absolute value of animal production as well as an increase in the percentage of the total agricultural income in the state that is derived from animal production. Among the many factors that have contributed to the substantial increase in animal production are a favorable economic environment and the adoption of modern production practices by animal producers in the state.

Dramatic improvements in the productivity of animals have been observed during the last half of the 20th century. Growth rate and feed efficiency of meat-producing animals, milk production per cow, number of eggs produced per laying hen, etc. have all increased substantially, contributing bountiful quantities of animal protein for our world's population. These increases in production efficiencies have resulted from a fundamental and basic understanding of the genetics and biology of the animals used for human purposes.

Research has clearly shown that our production systems are not close to reaching the biological limits of the animals raised for human use. Additional improvements in the efficiency of

production and in the safety and quality of products for human consumption are achievable through further understanding of the basic genetic makeup of our animals and elucidation of the physiological processes within animals. Investigative approaches that involve understanding the animal genome, preserving genetic diversity, and manipulating growth, digestion and reproduction via genetic and biotechnological strategies will contribute to an economically viable animal production industry and a safe, wholesome food supply for the world's population.

Performance Goals

1. Investigate basic biological systems in animals for the purpose of improving the biological efficiency of animals raised for human use.

2. Modulate life processes in animals in order to enhance the productivity of animals, the safety and wholesomeness of animal products, and reduce the environmental impact of animal production via genetic, nutritional, physiological, biochemical, and managerial manipulation.

3. Investigate the genome of animals and elucidate relationships among the genome, function and structure.

4. Create effective animal models for the study of human and animal diseases via genetic and biotechnological manipulation.

Key Program Components

The major research efforts that will be conducted to meet these four stated performance goals are listed in the following key program components. Knowledge gained and knowledge transferred will be the output/outcome indicators for this performance goal.

 Determination of animal nutrient requirements

 Control and manipulation of the basic reproductive processes in animals

 Mapping of the animal genome, determination of the gene or complex of genes responsible for economically important traits

 Enhancement of animal productivity and reduction of environmental impact

 Improvement in the use of nutrients that regulate growth in animals and determination of the Factors Controlling the Fat-to-Lean Ratio in Animals

 Basic studies of the function and modulation of enzymes and enzymatic function in animals

Internal and External Linkages

Numerous linkages will be required to meet the performance goals. Within each key program component, there is an expectation that linkages will be formed internally within the NC State University community, as well as with partners outside the university. Many of these partners will be other scientists both from within and outside of the university working on similar aspects of

the programs contained herein.

In order to facilitate the activities involved in this plan of work, linkages will be formed among various departments in the College of Agriculture and Life Sciences at NC State University. Among these departments are:

Animal Science	Poultry Science
Zoology	Biochemistry
Crop Science	Genetics
Microbiology	Food Science

In addition, linkages of faculty in the College of Agriculture and Life Sciences with faculty in the College of Veterinary Medicine and College of Physical and Mathematical Sciences at NC State University will be important to accomplish the key program components. Linkages of investigators at NC State University and with scientists at other universities in the state and nation will also be formed. Among these universities are:

North Carolina A&T State University,
University of North Carolina at Chapel Hill,
Duke University,
Michigan State University,
University of Illinois,
University of Kentucky, and
the University of Georgia.

Linkages with pharmaceutical companies such as Novus International, Pfizer, Ely Lilly are also important to facilitate the research requisite in the plan of work. In addition, knowledge transferability to end users involves partnerships with the animal industries such as:

Murphy Family Farms,
Goldsboro Milling,
Purdue Farms,
NC Pork Council
All commodity organizations and related agencies
Carrol's Foods, and
Smithfield Foods.

Target Audiences

The research conducted in this area has many stakeholders and beneficiaries, including the citizens of North Carolina as well as those who live outside the North Carolina state boundaries, both nationally and internationally. Target audiences include, but are not limited to, animal producers, consumers of animal products, the agribusiness community, individuals who maintain animals as pets, scientists and researchers, and students.

Program Duration

Long-term, 5 years plus 2 years

Allocated Resources

Following are expenditure and commitment data for 1997-1998.

EXPENDITURES

Source	Amount

CSREES Funds	$701,320
USDA-CGCA Funds	$1,001
Other Federal Funds	$371,571
State Appropriation	$4,212,962
Non-Federal Funds	$686,128
Total	$5,972,982

PERSONNEL COMMITMENT

Scientist Years	11.53
Professional Years	15.94
Technical Years	49.6
Clerical Years	3.56
Total	80.60

During the next five years, it would be expected that the total commitment in the animal production systems program will remain approximately $6 million adjusted annually for inflation, and that the personnel commitment will remain consistent with the 1997-98 fiscal year. As conditions change and upon the appropriate recommendations from stakeholders, the budget and personnel inputs for this program may change.

Goal 1, Program Area 3:
Plant Protection Strategies

Subprogram Area 3a:
Forest and Horticultural Crop Protection

Statement of Issue
The aim of the Forest and Horticultural Crop Protection subprogram is to develop technology and biological knowledge that will allow the forestry and horticultural industries as well as urban dwellers to produce fiber, food and ornamentals with less damage from pest insects, mites, nematodes, pathogens and weeds in a more environmentally friendly manner while obtaining an adequate economic return. Research in this subprogram is critical to achievement of the AREERA goals of maintaining and improving an agricultural system that is highly competitive in the global economy and enhancing a safe and secure food and fiber system.

Pest insects, mites, nematodes, pathogens and weeds are organisms that are continuously adapting to new conditions or migrating to different localities. Technology must continually change to meet the altered pest, pathogen and weed pressures and to be compatible with changing production systems. As the human population increases more forest, food and ornamental plants are required. Protection of plants from pests, pathogens and weeds allows producers to maintain productivity or to even increase productivity with less cost to natural resources.

Research, both basic and applied, is necessary to assure that plant protection technology remains efficacious, economical and environmentally sound.

Performance Goals

1. Develop and enhance pest, pathogen and weed management technology for growth and production of forests and horticultural plants for greater enjoyment and profitability in an environmentally sustainable manner.

2. Improve understanding of the ecology and genetics of pest, pathogen and weed populations and their interactions with plants and antagonists for more effective integrated pest management.

3. Incorporate resistance to pests, pathogens and weeds into improved, productive cultivars through classical breeding and biotechnology/genomics.

Key Program Components
North Carolina Agricultural Research Service programs that develop and enhance management technology in an environmentally sound manner include the following general approaches:

 Development of alternatives to chemical pesticides such as biological control agents for pest management

 Development of utilization methods for the new pesticides that are derived from natural products that alter the hosts' resistance mechanisms or that can be applied in very low volumes

 Improvement of models and decision assistors that utilize cultural practices, host resistance and physical environmental factors to enhance pest management

 Establishment of a small fruit center that has fostered regional dissemination of best management practices

 The micropropagation unit is furnishing pathogen-tested, true-to-type sweet potato and strawberry cultivars for the region

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

Program Area 7:
Food and Fiber Processing,
Safety and Quality

Introduction
The well being of the United States and its citizens depends 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.

Statement of Issue
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 redoubled 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 must be carried out at the production level, the harvest and marketing level, the processing level and the preparation level. Additionally, with the diverse production system found in North Carolina, the research must be conducted over a broad spectrum of commodities and situations.

Performance Goals
This program area is primarily focused on identifying problems and improving processes in food and fiber production in order to improve safety and quality. Specific goals are to:

1. Identify problems and provide solutions to quality maintenance in storing and marketing fruits and vegetables, field crops and animal products;

2. Ensure that food products are free from toxic contaminants; and

3. Protect food and feed supplies from harmful microorganisms and naturally occurring toxins.

Key Program Components
Research efforts in the general areas of post-harvest handling, storage/processing, packaging, and physiology are being conducted in the departments of Food Science, Crop Science, Horticultural Science, Biological and Agricultural Engineering, Entomology and Biochemistry. Research programs on the risks associated with and control and removal of contaminants in food and feed, including toxic residues from production, microorganisms and natural toxins, are ongoing in the departments of Animal Science, Agricultural and Resource Economics, Biological and Agricultural Engineering, Food Science, Microbiology and Plant Pathology.

Thirty-one state and Hatch projects make up Area 7. Scientists from 11 departments within the College of Agriculture and Life Sciences are involved in five research program areas. Technology for HAACP applications in North Carolina's seafood industry, improved meat processing technologies, surface

sterilization of microbiological contamination, insect damage to economically important crops in storage, and safer packaging systems are but a few of the efforts in this program area.

Internal and External Linkages
This program involves half of the Agriculture and Life Science departments at NC State. Many of the projects are multidisciplinary and multi-departmental. A strong multi-state component also exists, with four regional projects (NE-103, NE-179, S-263, and S-284). These regional efforts involve most of the states in the Northeast, the South, and many in the Midwest. The Center for

Aseptic Processing and Packaging Studies, the NC State Seafood Lab (at Morehead City), and the NC State Meat Processing Lab also provide linkages with other universities, industry partners, producers and regulators.

Target Audiences
Consumers are the primary beneficiaries of this research and development; however, stakeholders include producers, processors, other scientists, agency personnel (NCDA, USDA, FDA), extension agents, regulators and students.

Program Duration
Long-term, 5 years, plus 2 years

Allocated Resources
Following are expenditure and commitment data for 1997-98. Similar expenditures and personnel commitments are expected over the next five years. These expectations continue for an additional 2 years.

EXPENDITURES

Source	Amount
CSREES Funds	$266,683
USDA-CGCA Funds	$57,146
Other Federal Funds	$96,623
State Appropriation	$905,938
Non-Federal Funds	$204,711
Total	$1,531,101

PERSONNEL COMMITMENT

Scientist Years	5.67
Professional Years	4.90
Technician Years	7.22
Clerical Years	4.27
Total	22.06

The largest efforts (as a percent of expenditures) include: new poultry product processing technologies (11.9 percent), management of insects that damage stored agricultural products (8.7 percent), detecting pathogenic organisms in food (8.5 percent), technologies to retain or improve quality during production and post-harvest handling of fruits, vegetables and nuts (8.2 percent), aseptic processing and packaging (6.3 percent), meat quality improvement (5.1 percent), and quality flavor development in peanuts (5.0 percent).

National Goal 3:
A Healthy, Well-Nourished Population

Program Area 8:
Human Nutrition and Human Health

Introduction

A healthy, well-nourished population is one that is productive and can better contribute 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 who 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. 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.

Statement of Issue

Projects in 10 academic departments focus on human nutrition and health issues significant to the well-being of the citizens of North Carolina and to the agricultural economy of the state. Disease prevention and health promotion are at the heart of research within this area. Nutrient availability and absorption coupled with food choices, habits, and consumption are focused issues. Nutrition and linkages between nutrition and disease prevention are issues. Health and safety of citizens are critical, as methods to reduce hazards are examined.

Performance Goals

1. Output indicators will be the level of adoption of human health and hazard reduction research by the private sector and by associate research labs. Economic indicators will focus on food choices, habits and consumption research areas.

2. Focus will be given to food safety issues as related to overall consumer health and well-being.

Key Program Components

Human nutrition research accounts for 62.5 percent of the manpower years within this program area. Human nutrition projects study weight loss programs for post-partum women; Vitamin C supplementation in young smokers as to a beneficial effect on LDL oxidizability, plasma lipid peroxidation and neutrophil function; serum lipid, glucose, insulin and chromium profiles of growing pigs fed high-fat diets using milk proteins with and without chromium; interactions of dietary flavonoids with nutrient antioxidants; bioavailability and absorption of carotenoids from foods; impact of Vitamin C on phagocyte function in aging; and the study of how dietary lipids influence adipocyte growth and development of obesity. Human health is being aided by studies focusing on early disease detection (new coronary heart disease risk assessment method); mechanism comparison between animal and human infections; pathogenesis of *Salmonella*; and vaccine development using computer assisted electron microscopy tomography. Agricultural economics are being examined by better understanding consumer preference relative to real and perceived health benefits. Hazard reductions are being realized by development of textile materials by studying the effects of DNA methylation on mammalian limb development; and by development of insect specific target systems for infestation control.

Seventeen projects make up Area 8, Human Nutrition and Human Health. Represented within

those projects are research efforts from 10 academic departments. Contributing to this area is the increasing evidence that flavonoids play a role in disease prevention and possibly health promotion. The flavonoids are a diverse group of plant secondary metabolites and constitute one of the largest groups of naturally occurring phenols. Potential health effects include anticarcinogenic, anti-inflammatory, anti-allergenic, anti-thrombic, as well as anti-hypertension, anti-arrhythmic, anti-oxidant and hypocholesterolemic. Efforts are focused on understanding interactions of flavonoids with nutrient antioxidants, in vitro and in vivo.

Relative levels of plasma LDL, VLDL, and HDL in blood can now be determined using Nuclear Magnetic Resonance Spectroscopy. This technology also classifies the lipid vesicle according to size. Risk factors have been shown to be related to vesicle size. This developing technology may revolutionize the process of blood analysis and disease risk determination.

A technology for producing vaccines against membrane containing viruses which are vectored by insects has been developed. This technology will work for any membrane containing virus which can replicate or be made to replicate in insect cells. This technology will be exploited to produce vaccines against a variety of human and animal pathogens.

The bioavailability and absorption of carotenoids from foods are being examined. In addition to the well established role of β-carotene as a precursor of vitamin A, a number of the carotenoids present in the human diet possess antioxidant and anticarcinogenic activities. Moreover, they appear to enhance immunocompetence and cell-cell communication by vitamin A-independent mechanisms. Little information is available about the influences of food processing and other components of the diet on the release of these health-promoting compounds from the food matrix and the subsequent absorption, metabolism and molecular functions of the pigments and their metabolites. Model systems being employed assess chemical modifications. Model systems assess chemical modifications of carotenoids during the digestion process, intestinal cell metabolism of carotenoids, and the bioavailability of carotenoids from diverse foods.

Two projects are related to the epidemic of obesity in the U.S. The first is directed towards evaluating the possible impact of weight reduction during lactation on maternal health and infant growth. Failure to lose weight gained during pregnancy within the first year after delivering a child represents a major risk for obesity. Breast-feeding mothers have been discouraged from attempting to lose gained weight for fear that the growth and development of the infant would be jeopardized. Results from this important study clearly show that controlled maternal weight loss (about 1 pound per week) by reducing energy intake and increasing physical activity has no adverse effect on the growth and general health of the breast-feeding infant. From a more basic perspective, relatively little is known about the dietary influences on the development and maturation of fat cells. The effects of various types of dietary fats on the process of adipogenesis of precursor human and mouse cells are being investigated.

Economic studies suggest that organically grown fruits and vegetables could be a new growth industry within the southeast. Consumption habits and food choices, as driven by health promotion, perceived or real, are leading to agricultural economic growth. Economic and sociological models are being examined and developed focusing on these issues involving numerous commodities.

Internal and External Linkages

Multi-Institutional:

The Institute of Nutrition (ECU, NC A&T, NCSU, UNC-CH, and UNC-G)
Food Safety Science Continuum (proposed) (NCSU, UNC, and NC A&T)

Multi-Disciplinary, Multi-Subject:

Food Safety Continuum (proposed)
Pre- and Post-Harvest Food Safety
Food Safety Training - Foodservice Industry
Microbial Adaptation
Rapid and Improved Detection Methods and Biosensors
Molecular Epidemiology
Quantitative Microbial Risk Assessment and Analysis
Consumer Education

Target Audiences

Human nutrition and human health research is intended ultimately for all citizens. The stakeholders include the university research community, the North Carolina Cooperative Extension (state and county programs), state and private medical well-being programs, North Carolina Department of Agriculture and Consumer Science, North Carolina Department of Community Health, North Carolina Department of Environmental Health-Public Health Pest Management, and The North Carolina Department of Health and Human Services.

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The following performance goal identified under Program Area 11 in the original plan has been added to National Goal 3 for 2005-2006 from the original National Goal 5 plan for 1999-2004.

Improved Quality of Life

Statement of Issue

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, they serve as indirect pests through their nuisance value and by destroying the buildings we live in. 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.

Performance Goal

1. 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.

Key Program Components

Performance Goal 1

There will be four different projects associated with this goal. This is a goal that is classified

under the heading of control of insect pests of man and his belongings. Research in this area will include biology, physiology, and management of wood destroying and urban insect pests; insect-specific target systems for the development of novel tools for cockroach control; biology and control of nuisance vector arthropods in North Carolina; and potential vectors of dirofilaria immitis in North Carolina.

Output Indicators:
These performance goals involve research with direct application to the general public. Anticipated outcome indicators include:

- use of nonchemical methods of pest control and/or reduced pesticide use through application of IPM strategies; and

- development of effective methods for controlling insects pests of people and their belongings.

Target Audiences
These efforts are focused on the public at large as results of this research touch the lives of almost every citizen of the state with regard to quality of life. Although efforts are targeted for North Carolina, results of the research often have regional, national and international implications.
Program Duration
Long-term, 5 years, plus 2 years

Allocated Resources
Following are expenditure and commitment data for 1997-1998. Similar expenditures and personnel commitment are expected over the next five years plus an additional two years.

EXPENDITURES

Source	Amount
CSREES Funds	$93,397
USDA-CGCA Funds	$0
Other Federal Funds	$91,647
State Appropriation	$964,000
Non-Federal Funds	$182,514
Total	$1,331,514

PERSONNEL COMMITMENT

Scientist Years	7.64
Professional Years	5.16
Technician Years	4.01
Clerical Years	0.96
Total	17.77

National Goal 4:
An Agricultural System Which Protects Natural Resources and the

Environment

Program Area 9:
Soil, Water and Air Quality
Conservation and Management

Statement of Issue
Food security problems (famine, malnutrition, etc.) occur in regions with high population growth rates and with farming methods that are inefficient and unproductive. In contrast, developed countries utilizing contemporary agricultural technologies are self-sufficient in food production and provide the majority of food exports. As the world population increases toward a projected 12 billion in 2050, our continued ability to produce sufficient food and fiber depends on progressive increases in crop productivity per unit land area. Under increasing production pressure, conservation of our limited natural resources and protection of the quality of our environment can only occur with continued advances in and adoption of agricultural technologies. Therefore, protecting the environment and the quantity and quality of our natural resources is essential for meeting future demands for food and fiber and insuring world food security.

North Carolina's natural resources and climate enable diverse and productive agriculture and forestry systems; however, current and projected urban and suburban growth places considerable pressure on natural resources and the environment. Therefore, sustaining and/or increasing agricultural and forestry production must occur on a declining land resource base. In addition, the public expects that agricultural and forestry enterprises maintain environmental quality and adopt new production technologies and/or environment protection practices to enhance degraded soil, water, or air resources. Therefore, it is essential that agricultural technologies be developed that can enhance agricultural productivity and profitability, while maintaining and even improving the quality of our soil, water, and air resources. North Carolina State University and the College of Agriculture and Life Sciences are responsible to the public for development of appropriate, cost-effective technologies and assist stakeholders to understand and adopt technologies appropriate for insuring environmental quality and natural resource protection.

Performance Goal

The primary goal of this research program is to enhance our understanding of the physical, biological and chemical processes and interactions influencing agricultural and forest ecosystem productivity. The interdisciplinary research projects will advance knowledge of natural processes to enable development of production management and environmental protection technologies that will:

1. enhance productivity;
2. improve input efficiency;
3. conserve natural resources; and
4. improve and protect environmental quality.

Key Program Components
The program area represents interactions between diverse ecosystems (agriculture, forestry, coastal zone), issues (productivity, profitability, resource conservation, environmental quality) and clientele (producers, urban/suburban public, recreation, consumers, etc.). The primary

research focus will be on soil and water quality and management, nutrient and waste management, and air quality. The following list identifies research programs currently being conducted and/or planned for the next five years.

 Soil and water quality and management:
- Soil erosion and sedimentation processes and prevention
- Soil productivity and management
- Soil resource characterization and assessment
- Surface and drainage water conservation and management
- Irrigation water management and systems engineering
- Watershed and estuary protection and management
- Water quality monitoring and modeling
- Wetland and riparian zone characterization, protection, and management
- Water and solute transport and interactions with soil
- Groundwater and surface water quality assessment and protection
- Alternative land uses

 Nutrient and waste management:
- Nutrient, soil, water, and plant interactions
- Nutrient cycling and modeling
- Animal, municipal, and industrial waste utilization and management
- Added value waste product development
- Septic waste management
- Fertilizer use efficiency and management
- Precision agriculture
- Economic assessment of alternative nutrient and waste uses and management practices

 Air Quality:
- Air quality assessment and monitoring
- Soil, plant, atmosphere modeling for nitrogen, sulfur, carbon and other constituents
- Soil, nutrient, and waste management to contaminants
- Waste management systems to reduce odor
- Ecosystem assessment and impacts
- Confined animal production system emissions

Projects involving soil and water quality and management will comprise approximately 50 percent of the personnel and operating resources. Approximately 40 percent of resources will be allocated to nutrient and waste management projects. Projects involving air quality will constitute a total of 10 percent of resources.

These broadly defined projects will result in development of natural resource and environmental management technologies that satisfy the performance goals and meet the technological needs of the target audiences. New technologies in soil, water, nutrient, and waste management will protect surface and ground water resources from contaminants related to input use in agriculture and forest production. Soil, water and air quality monitoring projects will assess impacts of current and emerging technologies on reducing contaminant loading in the environment. These monitoring projects exist in traditional cropping systems as well as in managed turf systems, forestry, and coastal zone ecosystems. These data will quantitatively document the impacts of selected technologies and best management practices on soil, water, and air quality. Cooperation

technology transfer projects with North Carolina State University Cooperative Extension faculty will document the extent of adoption of best management practices by producers, dealers, consultants and other agricultural and environmental professionals.

Internal and External Linkages

The faculty in the College of Agricultural and Life Sciences conduct interdisciplinary research in each program area (see "Allocated Resources"). Faculty conduct cooperative research with scientists in most departments in the College of Agricultural and Life Sciences:

Agricultural Resource Economics	Animal Science
Biochemistry	Biological and Agricultural Engineering
Botany	Crop Science
Entomology	Horticulture
Plant Pathology	Poultry Science
Soil Science	Statistics
Toxicology	Zoology

In addition, College of Agriculture and Life Sciences faculty cooperate with faculty in the:

College of Forest Resources
College of Physical and Mathematical Sciences
College of Engineering

The success of current and future projects depends on interdisciplinary cooperation with scientists at universities throughout North Carolina and many other states. They include:

North Carolina A & T State University	Duke University
University of North Carolina (Chapel Hill)	University of North Carolina (Wilmington)
University of North Carolina (Charlotte)	University of North Carolina (Asheville)
University of Georgia	Kansas State University
Virginia Polytechnic Institute and State University	University of California-Davis
Clemson University	University of South Carolina
University of Tennessee (Knoxville)	University of Florida (Gainesville)
Iowa State University	University of Missouri
Texas A & M University	University of Minnesota
Michigan State University	Ohio State University
Purdue University	University of Illinois
Mississippi State University	Pennsylvania State University

Many scientists and other professionals in industry and with state and federal agencies provide essential cooperation with North Carolina State University scientists. They include:

North Carolina Department of Environment and Natural Resources
- Division of Water Quality
- Division of Air Quality
- Division of Soil and Water Conservation

North Carolina Agricultural Statistics
North Carolina Department of Agriculture and Consumer Services

USDA-ARS	USEPA
USDA-APHIS	NASA

USGS	USDA-NRCS
DOE	DOD
Brookhaven Laboratories	United Soybean Board
U.S. Golf Association	The Fertilizer Institute
National Wheat Growers Association	Potash Corporation of Saskatchewan
Southern States Cooperative	Farmland Industries
DuPont	Monsanto
Novartis	AgChem Equipment Co.
John Deere Inc.	North Carolina Pork Council
Open Grounds farm	Perdue Farms
North Carolina Plant Food Association	Cotton Incorporated
North Carolina Cotton Growers	North Carolina Peanut Growers
North Carolina Corn Growers	North Carolina Soybean Growers
North Carolina Wheat Growers	North Carolina Sweet Potato Growers
North Carolina Tomato Growers	North Carolina Christmas Tree Growers
North Carolina Turfgrass Council	

Target Audiences
Natural resource and environmental protection benefits all citizens of North Carolina. The direct users of research and technology development are the producers, dealers, consultants, and other agricultural and environmental professionals. Personnel in state and federal regulatory agencies and legislators also are important target audiences. The public demands high-quality water and air resources, thus agricultural and forestry production practices must protect environmental quality. The public trusts our ability to protect the environment and to provide quality food and fiber. Therefore, we should continually communicate our progress toward these goals.

Program Duration
Long-term, 5 years plus two years

Allocated Resources
Interdisciplinary soil, water, and air quality conservation and management research programs involve faculty from four colleges (Agriculture and Life Sciences; Engineering; Forest Resources; and Physical and Mathematical Sciences). In the College of Agriculture and Life Sciences, nearly 60 faculty in 14 departments are involved in nearly 150 projects in 11 categories including:

- appraisal of soil resources;
- soil, plant, water, nutrient relationships;
- management of saline and sodic soils;
- alternative uses of land;
- conservation and efficient use of water;
- efficient drainage and irrigation systems;
- watershed protection and management;
- economic and legal problems in water and watershed management;
- adaptation to weather and weather modification;
- remote sensing; and
- alleviation of soil, water, and air pollution and disposal of wastes.

Following are expenditure and commitment data for 1997-98. Similar expenditures and personnel commitment are expected over the next five years.

EXPENDITURES

Source	Amount
CSREES Funds	$1,156,241
USDA-CGCA Funds	$131,693
Other Federal Funds	$1,093,094
State Appropriation	$5,908,681
Non-Federal Funds	$2,194,942
Total	$10,484,651

PERSONNEL COMMITMENT

Scientist Years	24.58
Professional Years	29.83
Technician Years	53.36
Clerical Years	15.62
Total	123.39

Program Area 10:
Forest, Pasture, Wildlife and Fish
Resource Conservation Management

Statement of Issue
Conservation and management of forests, wildlife and aquatic resources require an understanding of the structure and function of the ecosystems which they comprise. This knowledge is especially important in the intensively managed agricultural and suburban landscapes of North Carolina as human influences are pervasive. Of special note are the interfaces between terrestrial and marine environments and the steep and fragile forested ecosystems of the western mountains. Research on the biology and ecology of plant and animal communities provide the basis for developing conservation policies and management practices for these resources. For forest and plant communities fundamental information needs include assessment of soil and water properties, production potential of plants and environmental factors that control or limit production. For animal communities informational needs include population biology, interactions with other animals, and the role of habitat in controlling or limiting the success of populations and communities. Such information on the biology and ecology of forest, wildlife and aquatic species serves as the basis for formulating policies and practices for their management.

Performance Goals

1. To understand relationships between soil fertility and plant communities.

2. To identify biological and physio-chemical factors that influence establishment and growth of trees.

3. To describe physiological mechanisms controlling reproductive biology of fish.

4. To develop improved understanding of the habitat factors the influence the reproduction and survival of terrestrial wildlife.

5. To identify environmental factors that influence the reproduction, recruitment and survival of fish.

Key Program Components
This program area involves 27 projects in 8 departments. Projects encompass work on identifying biological and physio-chemical factors that influence the reproduction, development, growth and survival of plants and animals and elaborating the mechanisms by which these factors do so. The following summary of general themes characterizes the projects.

Assessing Forest Resources: 3 projects in 2 departments are characterizing soil fertility and disease organisms in forests and elucidating their relationships to plants.

Biology and Culture of Forests and Timber-Related Crops: 5 projects in 2 departments are developing further understanding of biological properties that are likely involved in controlling the success of propagation and culture of horticultural trees. These include studies of entomopathogens, soil arthropods, and improved propagation and cultural practices.

Wildlife Studies: 9 projects in 3 departments are studying environmental influences on the biology and dynamics of terrestrial populations. Especially noteworthy are 4 projects dealing with the conservation biology of threatened or endangered species, particularly the influence of habitat upon the reproduction, growth and survival of these species.

Fisheries studies: 11 projects in 2 departments are studying the effects of environmental influences on the reproduction, recruitment and survival of fish species that are commercially or recreationally important. Studies include evaluation of habitat in freshwater reservoirs, assessment of spawning habitat for anadromous fish, and studies of estuarine factors affecting recruitment of juvenile marine species into the fisheries.

Output indicators:
These performance goals generally involve fundamental research on typical ecosystems. As a consequence, the output indicators are principally the dissemination of this information and its use by other scientists. Indicators include the dissemination of knowledge to scientific colleagues, postgraduate and graduate students, undergraduate students and K-12 teachers through peer-reviewed publications, technical publications, seminars, presentations at scientific conferences, classroom instruction, student laboratory training, teacher workshops, and web access to publications. Other audiences are natural resource managers and policy makers.

Internal and External Linkages
This program area includes faculty from eight departments in the College of Agriculture and Life Sciences (Agricultural and Resource Economics, Biological and Agricultural Engineering, Botany, Entomology, Horticulture, Plant Pathology, Statistics, Toxicology and Zoology). Many projects are interdisciplinary and involve faculty from different departments or institutions. Faculty work freely across departmental and college lines. The Department of Zoology is host to the USGS Cooperative Fisheries and Wildlife Cooperative Research Unit, which facilitates interdisciplinary research among several departments and colleges at NC State.

External linkages include faculty from a number of universities including the University of North

Carolina at Chapel Hill and at Wilmington, Eastern Carolina University and Duke University. The National Marine Fisheries Service Laboratory in Beaufort, the N.C. Division of Marine Fisheries and the N.C. Wildlife Commission are partners in several projects. The presence of the USGS Unit in the Department of Zoology facilitates partnerships with several federal agencies, especially on issues of conservation biology and fisheries management.

Target Audience
The national and international community of scientific researchers and teachers is the principal target audience. Other audiences include natural resource managers and policy makers.

Program Duration
Long-term, 5-plus years

Allocated Resources
Following are expenditures and commitment data for 1997-98. Similar expenditures and personnel commitment are expected over the next five years.

EXPENDITURES

Source	Amount
CSREES Funds	$206,344
USDA-CGCA Funds	$11,121
Other Federal Funds	$1,127,393
State Appropriations	$1,288,810
Non-Federal Funds	$413,159
Total	$3,046,827

PERSONNEL COMMITMENT

Scientist Years	7.61
Professional Years	13.45
Technician Years	10.48
Clerical Years	1.52
Total	33.04

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

Overview

The economic base of North Carolina is changing. Basic manufacturing jobs, especially but not exclusively in the textiles industry, are leaving the state. Most of these manufacturing facilities were located in our rural communities, which now must deal with the adjustments associated with un- or underemployed workers. State coffers are experiencing a period of decline, and more efficient use of state resources is essential if retraining and enhanced economic opportunities for our citizens are to be realized. The economic base is changing demographically, as well.

Retirees are finding North Carolina to be a good choice. This implies a changing age distribution in the state with its concomitant challenges and opportunities.

In the farming sector, new technologies and changing consumer demand are raising both expectations and uncertainties. Expectations are high because biotechnology-based, organic and sustainable production systems show promise as potentially a more profitable and less toxic alternative to conventional production systems. Consumers are demanding more locally-produced, safer food. This provides opportunities for production of new crops, which may provide a partial solution for former tobacco farmers. Consumers' preferences are the key to the success of many of the new crops and, thus, are a source of uncertainty to farmers and marketing firms in the state. More information to be able to forecast prices and consumer demand will reduce the uncertainties associated with crop and livestock production in North Carolina.

The urban-rural interface has expanded in North Carolina leading to a special set of issues, including more use of rural roads for commuting into the urban centers by rural residents, issues related to livestock production at the urban-rural interface, and land values, to name a few. Provision of public health and safety are issues to be addressed in the urban-rural interface and in rural areas.

Increasingly, North Carolina's products are subject to national and global market forces. These forces must be studied and accounted for if North Carolina is to become a full partner in these global markets. The quality of life and economic opportunities for North Carolinians, and, indeed, residents of all the Southeastern states, depend on the research outputs generated by the North Carolina Agricultural Research Service now more than ever before.

Program Area 11:

(Special Note: this program area was program area 12 in the original 1999-2004 plan, but has now been changed to program 11 for the 2005-2006 plan update. The original program area 11 has been moved to other national Goals as indicated in additions to Goals 1 and 3)

Individual, Family and Community Economic Development

Statement of Issue

The well-being of rural people and areas in North Carolina remains uncertain. Restructuring of jobs and industries, changes in the age, gender, and racial/ethnic composition of local populations, the devolution of government programs, and changes in how land and other natural resources are used and by whom all affect rural people and communities in North Carolina. Despite growth in the high-tech urban areas, rural North Carolina lags behind. Poverty persists, and its effects are exacerbated by shrinking budgets for public goods and services at the same time that demand grows. Rising awareness of the environmental consequences of new technologies increases demands on rural localities for social, economic and environmental impact assessment. The distinct needs of growing and culturally diverse populations in North Carolina, including the elderly, will create challenges as well as opportunities. At the same time, there is a growing commitment to enhance the quality of life and economic viability of rural families and communities. These trends and changes have a profound impact on rural community structure and organization, on community sustainability, and on quality of life.

Continuing long-term trends, our rural areas lag urban areas in levels of earnings and income, have lower high school graduation rates, exhibit more poverty, have higher rates of infant mortality, unemployment and stress and, in some cases, the gap may be widening. Most population growth within the state is in urban areas. Within rural areas, disproportionate shares of minorities remain economically disadvantaged, although some signs of improving socioeconomic conditions are beginning to appear.

Increasingly, local affairs are influenced by state, national, and global circumstances and policies. Cyclical changes in the economy at the state, national and global levels create uncertainty as to whether local efforts can respond to change. At the same time, long-term economic trends which encourage consolidation and integration of industries have affected rural North Carolina. Maintaining an effective international competitive position for food and fiber produced in the state, especially as new policies and decisions on international trade emerge, is becoming more difficult. Technological advances in communication and transportation have made rural communities more susceptible to national and global changes as a result of being left out. And this is further exacerbated by an increasingly complex web of state, national, and international laws and regulations that affect local businesses and communities.

Recent declines in rates of employment and population growth point to a possible slowdown in the favorable economic conditions prevailing in rural areas of North Carolina during much of the current decade. Employment growth in rural areas has dropped below the rate for urban areas in recent years. Further, this decrease in rural employment growth extends across the state, signaling the continuing shift in economic activity toward our urban areas. However, while some rural areas have growing per capita incomes, and rising weekly earnings in North Carolina indicate the continuation of a positive economic climate, many problems exist. Challenges remain considerable in many rural counties, cities, and towns of the state. Economic shifts are forcing many manufacturing firms to close or depart for overseas locations. Those persons without a post-high school education, or lacking relevant job training, are finding it more difficult to find jobs paying decent wages. And, larger numbers of employers are seeking workers with problem-solving and technology-related skills. Much greater attention will need to be given the workforces of rural areas and to devise strategies that will position them to be full partners in a global, complex economy. Rural workers need improved understanding of their employment options and their training and education opportunities.

Performance Goals

1. Improve domestic and international market potential.

2. Develop new strategies for rural development.

3. Advance understanding of factors that improve individual, family, and community economic and social viability.

4. Provide social, economic, and environmental impact analyses.

Key program components
Research projects will focus on:

- strategies individuals, families, farms and communities use to respond to global

rural restructuring;

 improved methods to measure real consumer prices, wages and business cycles;

 factors contributing to racial earnings inequalities;

 agricultural policy related to quotas, price supports and marketing boards;

 demographic and socioeconomic factors related to rural economic development;

 factors that influence youth development and career aspirations, agricultural injury and substance abuse; and

 changes in the organization of local labor markets.

Output indicators:

 Greater understanding of the impact of family interaction patterns, information acquisition, and resource management practices on individual and family economic social viability.

 Strategies for economic diversification, entrepreneurship, and job creation.

 Enhanced understanding of the factors that influence the state's competitiveness within traditional and emerging markets.

 Increased awareness of employment requirements and opportunities and education and training possibilities.

 Methodologies for social, economic and environmental impacts.

Outcome indicators:

 Increased trade and sustained farm income (or favorable changes in farm income and well-being).

 Economically improved communities.

 Increases in economic, human, environmental social capital.

 Increased youth and service agencies participation in career development programs.

Internal and External Linkages

Multi-State:

Regional Rural Restructuring Project S-276 (NC, AL, GA, IA, KY, LA, MI, OH, SC, TX, WI, Puerto Rico)

Regional Commodities, Consumers and Communities Project NE-185 (NC, KS, MI, MD, WV, WI, CA, NJ, MO, IA, WA, NY, PA and NGOs)

Regional Rural Labor Markets Project S-259 (NC, OH, LA, MD, AL, IA, Puerto Rico SC, MI, KS, WV, AR, TN, MS, GA, USDA-ERS, non-profits and other NGOs)

Regional Rural Economic Development Project NE-162 (NC, AZ, CA, DE, GA, IN, KY, MI, MO, NV, NH, NY, OH, OR, PA, SC, UT, TX, VA, WA, WI, WY)

Multi-Institutional:

NC A&T State University
Brigham Young University
Southern Rural Development Center
Winthrop University
CAFF
AppleSchram Orchard
Food for Lane County
Rural Development Center
Levy Economics Institute
Minnesota Institute for Sustainable Agriculture
Minnesota Food Association
Hartford Food System
NC State Occupational Information Coordinating Committee
N.C. Department of Public Instruction
Duplin and Burke County Schools
Boys' and Girls' Clubs
University of North Carolina-Chapel Hill
East Carolina University
Saint Louis University
National Catholic Rural Life Conference
Illinois Stewardship Alliance
Sustainable Food Center
Appalachian Sustainable Development
SeaChange
Just Food
SLUG
NESAWG

Multi-disciplinary:
Demography, sociology, agricultural economics

Target Audiences
Local and state policy-makers, citizens of the state, state agencies, Cooperative Extension Service (especially rural economic development specialists, and family and consumer science specialists), 4-H and voluntary youth workers, church youth directors, sociologists, economists, demographers and other university scholars.

Program Duration
Long-term, 5 plus 2 years
Allocated Resources
Following are expenditure and commitment data for 1997-98. Similar expenditures and personnel commitment are expected over the next five years.

EXPENDITURES

Source	Amount
CSREES Funds	$125,267
USDA-CGCA Funds	$23,052
Other Federal Funds	$42,788
State Appropriation	$573,941
Non-Federal Funds	$136,460
Total	$901,508

PERSONNEL COMMITMENT

Scientist Years	2.89
Professional Years	4.29
Technician Years	0.86
Clerical Years	4.14
Total	12.18

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 offices 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.

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 has established an NCARS Advisory Council composed of external stakeholders from

diverse backgrounds. The Advisory Council assists NCARS by:

- Advising the Director regarding North Carolina research needs and priorities.
- Assisting in evaluation of current and proposed research activities through program reviews.
- Advocating for NCARS agenda by promoting the importance of agricultural and life science research.

The Advisory Council will meet at least once per year with NCARS administrators, department heads and selected faculty for overviews of research programs and issues, consultation on upcoming state and federal budget items, future concerns, etc.

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 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.

Finally, because the research faculty are also major stakeholders of NCARS, there is a CALS Research Committee, which consists of one elected representative from each department. The committee meets monthly to discuss and make recommendations to the NCARS director relative to policy and resource allocations.

C. RESEARCH PEER AND MERIT REVIEW PROCESS

NCARS Research Project Review

A thorough scientific and merit review of each proposed new or revised research project should be made at the departmental level prior to submission to the NCARS office. This departmental review should consist of two parts: an informal review (PI's responsibility) and a formal review (Department Head's responsibility).

Informal Review

The informal review should be performed on the initiative of the PI through interactions with other faculty, both within and outside of the department, and with various stakeholders outside the university. The stakeholder input may come from routine interactions with individuals or with groups at meetings, conferences, field days, etc. Keep in mind that primary stakeholders vary greatly between different research projects within NCARS. PI's developing projects with a specific commodity or industry orientation (i.e., swine nutrition, corn breeding, vegetable production, dairy foods) should interact with appropriate representatives of these groups. PI's

developing projects of a basic, discovery nature (i.e., geminivirus replication, yeast proteasomes, RNA-protein interactions) may consider other university scientists or industry researchers working in a similar area their primary stakeholders and therefore, should consult with them for this informal review.

Consultation with faculty and stakeholders during the informal review phase should include inquires regarding both the scientific soundness of the proposed research and the relevance to the appropriate stakeholder groups' needs. In this formative stage, comments and suggestions from other faculty and stakeholders may be more productive and useful than those received later through the formal review process. All input should be considered and appropriate adjustments made as the research project outline is developed.

Formal Review

The Department Head must provide for a formal review of all proposed new and revised research project outlines prior to submission to NCARS. This review must be done by at least three faculty members with general knowledge of the proposed research subject area. At least one of these reviewers must be from outside the PI's home department. If the proposed research involves complex, unusual, and/or extensive statistical procedures, the outline should also be reviewed by the departmental statistical liaison. Each reviewer should be asked to comment on the research being proposed from two perspectives: (1) the scientific soundness of the hypothesis, objectives and procedures described in the outline; and (2) the relevance, or merit, of the research based on the previous work and present status of current work described in the outline and the reviewer's own knowledge of the needs in this research area.

The Department Head's office will send the draft outline to the selected reviewers asking for their comments within a specified time frame. The Department Head should request that the comments be submitted both to his/her office (to be retained in the project's file) and to the PI. The PI should then make appropriate revisions and submit the revised outline to their Department Head with an explanation regarding any reviewer comments that are not addressed in the revision. The Department Head should confirm that comments were appropriately addressed and make a final determination on the relevance of the proposed research. After Department Head approval and completion of the necessary CRIS Web Forms, the final project outline should be forwarded in electronic form to NCARS for processing.

Multistate Research Project Review

Multistate research projects originating in the Southern Region that NCARS faculty are participating in receive merit and peer reviews according to guidelines established by the Southern Association of Agricultural Experiment Station Directors (SAAESD). These guidelines can be found at the following URL: http://www.msstate.edu/org/saaesd/infobook/guide/guide.htm Similar review processes exist for multistate projects originating in other regions.

Proposed multistate research projects that will not be processed through the SAAESD will receive merit and peer review by the following tentative process. Final guidelines will be developed as experience is gained by the partner institutions in working with multistate projects under AREERA. Project PI's will submit a written project proposal conforming to an outline format typical for the institutions involved. At the very least, the proposal will contain a title,

justification, review of key literature, objectives, procedures, duration, personnel (with time commitments and funding arrangements (at least for the first year). The institution with the highest resource commitment to the project will take the lead in coordinating the review. The process will be an amalgamation of local peer review procedures. Upon mutual agreement, the administrators of the project PI's will decide on the number of reviewers and the home institution of these reviewers. If a multistate project includes an extension component, then appropriate extension reviewers will be included in the review panel. Multistate projects may run for up to five years and must include an annual review of progress towards achieving objectives.

D. MULTISTATE, MULTIDISCIPLINARY RESEARCH ACTIVITIES

North Carolina Agricultural Research Service research faculty are active participants in 22 Southern Region Multi-state Research Projects and 14 additional Multi-state Research Projects administered in the North Central, North East and Western Regions. The project numbers, titles, total expenditures and total personnel efforts are shown in the following table. The expenditure of $3.22 million is well over 25 percent of North Carolina State University's Hatch regular and Hatch Multistate Research Fund allocations. Details of these multistate projects are on file with the Cooperative State Research, Extension and Education Service's Partners office.

In addition to these Multi-state Research Projects, NCARS has formal agreements in four other multistate research collaborations. These are listed below with a brief description of each.

- Peanut Variety and Quality Evaluation Project. A cooperative agreement is in place between NCARS and the Virginia Agricultural Experiment Station (VAES) at Virginia Polytechnic Institute and State University for the field evaluation and joint release of Virginia-type peanuts. These peanut selections are primarily bred by NCARS breeders, then evaluated in field trials managed by VAES researchers. Selections are evaluated, selected and approved for release by an advisory board composed of NCARS and VAES faculty and peanut growers and processors. NCARS annually provides one-half of the funds required to manage the field trials.

- Multistate Waste Management Consortium. A cooperative agreement is in place between NC State University, Iowa State University, Michigan State University, Purdue University, University of Missouri and Oklahoma State University to encourage collaborative projects in animal waste management. The members of this consortium each agree to allocate at least $75,000 annually to competitively awarded research projects on animal waste management that are jointly submitted by researchers from two or more of the member institutions. A panel of scientists from the six institutions plus USDA, EPA and animal agriculture industry representatives review and select proposals for funding.

- Southeastern Small Fruit Center. A cooperative agreement is in place between NC State University, University of Georgia and Clemson University to develop a web-based means of sharing and delivering research and extension information to the tri-state area related to the strawberry, blueberry, grape and bramble industries. NC State is providing the center director and assistant director (.20 SY and .20 TY); Clemson, the webmaster (1.0 TY); and Georgia, the web server and additional support funds. The center will also act as a coordinating body and clearinghouse for research and extension activities and industry

needs related to small fruit production and marketing.

 Tomato Variety Improvement. A cooperative agreement is in place between NC State University and Clemson University for the improvement of fresh and processing tomato varieties for North Carolina and South Carolina production and marketing. An NC State breeder, stationed at the Mountain Horticultural Crops Research and Extension Center in Fletcher, N.C., is partially supported by funds allocated annually from Clemson University. In exchange, his tomato breeding program includes developing varieties with characteristics specifically favorable to South Carolina growers and field tested in South Carolina.

NCARS Multi-State, Multi-Disciplinary Projects (1998)
Total Expenditures and Commitments

Project Number	Project Title	Total Funds	Total Effort
NC 136	Improvement of Thermal Processes for Foods	$105,130	1.60
NC 140	Rootstock and Interstem Effects on Pome- and Stone-Fruit Trees	$934	0.00
NC 168	Advanced Technologies for the Genetic Improvement of Poultry	$151,845	1.40
NC 205	Ecology and Management of European Corn Borer and Other Stalk-boring Lepidoptera	$11,516	0.20
NE 060	Genetic Bases for Resistance and Immunity to Avian Diseases	$27,524	0.20
NE 103	Postharvest Physiology of Fruits	$49,524	0.50
NE 123	Functional Properties of Food Proteins	$335,728	5.10
NE 148	Regulation of Nutrient Use in Food Producing Animals	$24,961	0.10
NE 162	Rural Economic Development: Alternatives in the New Competitive Environment	$8,488	0.00
NE 179	Technology and Principles for Assessing and Retaining Postharvest Quality of Fruits and Vegetables	$143,080	2.90
NE 184	Development of New Potato Clones for Environmental and Economic Sustainability in the Northeast	$27,962	0.30
NE 185	Commodities, Consumers and Communities: Local Food Systems in a Globalizing Environment	$32,958	0.18
S 009	Plant Genetic Resources Conservation and Utilization	$19,314	0.20
S 183	Phenology, Population Dynamics and Interference: a Basis for Understanding Weed Biology and Ecology	$60,197	0.50
S 222	Fruit and Vegetable Supply Chain Management, Innovations and	$180,225	4.10

Project Number	Project Title	Total Funds	Total Effort
	Competitiveness		
S 233	Genetic Relationships of Growth and Reproduction in Diverse Poultry Populations	$68,210	3.00
S 257	Classifying Soils for Solute Transport as Affected by Soil Properties and Landscape Position	$184,851	2.09
S 259	Rural Labor Markets in the Global Economy	$96,382	2.90
S 261	Interior Environment, Energy Use in Poultry and Livestock Facilities	$290,770	3.40
S 262	Diversity, Interactions of Beneficial Bacteria and Fungi in the Rhizosphere	$79,712	1.60
S 263	Enhancing Food Safety Through Control of Foodborne Disease Agents	$11,200	0.10
S 265	Development and Integration of Entomopathogens into Pest Management Systems	$142,319	3.70
S 266	Parameter Sensing and Control Systems for Drying Agricultural Commodities	$155,924	1.80
S 267	Biological Control of Selected Arthropod Pests and Weeds	$277,980	4.00
S 270	Utilizing Potassium Buffering Capacity to Predict Cotton Yield Response to Potassium Fertilizer	$1,175	0.00
S 272	Development of Textile Materials for Environmental Compatibility and Human Health and Safety	$13,278	0.11
S 273	Development and Application of Comprehensive Agricultural Ecosystems Models	$86,686	0.48
S 275	Animal Manure and Waste Utilization, Treatment and Nuisance Avoidance for a Sustainable Agriculture	$4,907	0.00
S 276	Rural Restructuring: Causes and Consequences of Globalized Agricultural and Natural Resource Systems	$148,638	2.40
S 278	Food Demand, Nutrition and Consumer Behavior	$228,283	1.40
S 280	Mineralogical Controls on Colloid Dispersion and Solid-phasespeciation of Soil Contaminants	$53,502	0.30
S 282	Managing Plant-parasitic Nematodes in Sustainable Agriculture with Emphasis on Crop Resistance	$13,887	0.00
S 283	Develop and Assess Precision Farming Technology and its Economic and Environmental Impacts	$86,010	0.00
S 284	Genetic Enhancement of Health and Survival for Dairy Cattle	$11,726	0.00

Project Number	Project Title	Total Funds	Total Effort
W 168	Seed Biology and Technology Investigations	$77,051	0.20
W 186	Genetic Variability in the Cyst and Root-Knot Nematodes	$11,312	0.10
Total		**$3,223,189**	**44.86**

2005-2006 Update
NCARS has 30 operational multistate projects that includes 28 that are Hatch funded. These projects will extend into and beyond the plan update planning period.

NCARS Multi-State, Multi-Disciplinary Projects (2004 and succeeding years)

0198714
NC00114
S-1014 Hatch
Hesterberg, D. L. 1182 Soil Science Mineral Controls on P Retention and Release in Soils and Soil Amendments

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0198697
NC00131
NC-131 Hatch
Mozdziak, P. E. 1870 Poultry Science MOLECULAR MECHANISMS REGULATING SKELETAL MUSCLE GROWTH AND DIFFERENTIATION

0183454
NC00133
W-1133 Hatch
Phaneuf, D. J. 0807 Economics & Business BENEFITS AND COSTS OF RESOURCE POLICIES AFFECTING PUBLIC AND PRIVATE LANDS

0198606
NC00168
NC-1008 Hatch
Petitte, J. N. 1870 Poultry Science ADVANCED TECHNOLOGIES FOR THE GENETIC IMPROVEMENT OF POULTRY

0184483
NC00183
NE-183 Hatch
Sutton, T. B.; Walgenbach, J. F.; Unrath, C. R. 1760 Plant Pathology MULTIDISCIPLINARY EVALUATION OF NEW APPLE CULTIVARS

0173463
NC00205
NC-205 Hatch
Van Duyn, J. W. 0910 Entomology ECOLOGY AND MANAGEMENT OF EUROPEAN CORN BORER AND OTHER STALK-BORING LEPIDOPTERA

0187912
NC00291
S-291 Hatch

Baughman, G. R.; Brake, J. T.; van Kempen, T. 8547 Biological & Agr Engineering Systems for Controlling Air Pollutant Emissions and Indoor Environments of Poultry, Swine, and Dairy Facilities

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0184794
NC00292
S-292 Hatch
Sheldon, B. W. 1870 Poultry Science The Poultry Food System: A Farm to Table Model

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0187254
NC00295
S-295 Hatch
Keener, K. M.; Sheldon, B. W. 1120 Food Science Enhancing Food Safety Through Control of Foodborne Disease

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0186960
NC00296
S-296 Hatch
Schulman, M. D. 2011 Sociology, Anthrop & Soc Work Rural Labor Markets: Workers, Firms and Communities in Transition

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0187378
NC00299
S-299 Hatch
Whisnant, C. S.; Washburn, S. P.; Whitlow, L.; Hopkins, B.; Fellner, V.; Benson, G. 0331 Animal Science Enhancing Production and Reproductive Performance of Heat-Stressed Dairy Cattle

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0187622
NC00302
S-302 Hatch
Benson, D. M.; Cubeta, M. A. 1760 Plant Pathology Biological Control of Soilborne Plant Pathogens for Sustainable Agriculture

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0187995
NC00303
S-303 Hatch
Orr, D. B. 0910 Entomology Biological Control of Arthropod Pests and Weeds

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0188491
NC00305
State
Bowman, D. T. 0423 Crop Science Development of Genetic Resources for Cotton

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0195015
NC00600
NE-60 Hatch
Qureshi, M. A. 1870 Poultry Science Genetic Bases for Resistance and Immunity to Avian Diseases

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0198561
NC007250
State
Estes, E. A. 0807 Economics & Business Fruit and Vegetable Marketing Innovations and Demand Assessment

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0090126
NC00836
NC-136 Hatch
Sandeep, K. P.; Swartzel, K. R.; Daubert, C. R.; Keener, K. M.; Farkas, B. E. 1120 Food Science IMPROVEMENT OF THERMAL AND ALTERNATIVE PROCESSES FOR FOODS

0190909

NC01000
S-1000 Hatch
Westerman, P. W.; Ogejo, J. A.; Cheng, J.; Bottcher, R. W.; Van Kempen, T. A.; Mikkelsen, R. L.; Zering, K. D. 8547 Biological & Agr Engineering Animal Manure and Waste Utilization, Treatment and Nuisance Avoidance for a Sustainable Agriculture

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0191648
NC01001
S-1001 Hatch
Neal, J. C. 1450 Horticultural Science Development of Plant Pathogens as Bioherbicides for Weed Control

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0191225
NC01003
S-1003 Hatch
Isleib, T. G. 0423 Crop Science Variety and Quality Evaluation of Virginia-Type Peanuts

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0191931
NC01004
S-1004 Hatch
Parsons, J. E.; Beasley, D. B. 8547 Biological & Agr Engineering Development and Evaluation of TMDL Planning and Assessment Tools and Processes

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0191159
NC01006
S-1006 Hatch
Watson, D. W. 0910 Entomology Insect and Manure Management in Poultry Systems: Elements Relative to Food Safety and Nuisance Issues

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0194557
NC01007
S-1007 Hatch
Cheng, J. 8547 Biological & Agr Engineering THE SCIENCE AND ENGINEERING FOR A BIOBASED INDUSTRY AND ECONOMY

0194420
NC01008
S-1008 Hatch
Washburn, S. P.; McDaniel, B. T.; Clay, J. S. 0331 Animal Science Genetic Selection and Crossbreeding to Enhance Reproduction and Survival of Dairy Cattle

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0194177
NC01011
NE-1011 Hatch
Renkow, M. A.; Danielson, L. E. 0807 Economics & Business Rural Communities, Rural Labor Markets and Public Policy in North Carolina and the Southeast

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0194571
NC01014
NE-1014 Hatch
Yencho, G. C. 1450 Horticultural Science Development of New Potato Clones for Improved Pest Resistance, Marketability, and Sustainability in the East

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0198607
NC01018
NE-1018 Hatch
Blankenship, S. M. 1450 Horticultural Science Postharvest Biology of Fruits

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NC01019
S-009 Hatch
Stalker, H. T. 0423 Crop Science Plant Genetic Resources Conservation and Utilizaton

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0194558
NC01108
NE-1008 Hatch
Rohrbach, R. P.; Stikeleather, L. F.; Boyette, M. D. 8547 Biological & Agr Engineering Assuring Fruit and Vegetable Product Quality and Safety Through the Handling and Marketing Chain.

0083973
NC01840
NC-140 Hatch
Parker, M. L. 1450 Horticultural Science ROOTSTOCK AND INTERSTEM EFFECTS ON POME AND STONE FRUIT TREES

E. INTEGRATED RESEARCH AND EXTENSION ACTIVITIES

Research and extension activities are integrated within the College of Agriculture and Life Sciences at the administrative, programmatic, departmental and faculty levels. The directors of the N.C. Agricultural Research Service (NCARS) and the N.C. 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.

Programmatically, research and extension activities are integrated formally in a number of key areas through the efforts of faculty serving in the role of research and extension coordinator or as a center director. Examples of programmatic areas where this has been particularly successful are water quality, animal waste management, integrated pest management, sustainable agriculture, air quality, small fruits and specialty crops. 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 whom have research or extension appointments.

The most complete integration of research and extension occurs at the individual faculty level. Over 100 of the 350 college faculty with research appointments also have extension appointments. In fact, most of these split-appointment faculty have 50 to 80 percent 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 agribusiness through development, field testing and demonstration.

Since all faculty with research/extension split appointments 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. The following table shows the total expenditures and personnel commitments during 1998 for these projects under the NCARS research program areas and subprogram areas. The total expenditure of $7.68 million exceeds NCARS's total Hatch allocation.

NCRS Research/Extension Split Appointments (1998)
Total Expenditures and commitments

National Goal Total NCARS Program Area and Subprogram Area	Total Funds	Effort
1. An Agricultural System that is Highly Competitive in the Global Economy		
1. Technologically Integrated and Sustainable Crop and Livestock Production Systems		
Crop Production Systems	$593,896	7.22
Animal Production Systems	$1,059,067	11.06
Biological Systems	$7,588	0.10
2. Plant and Animal Germplasm, Genetic Resources and Conservation, and Plant Improvement		
Crop Improvement	$288,577	3.18
Animal Improvement	$588,006	8.05
3. Plant Protection Strategies		
Forest and Horticultural Crop Protection	$944,461	13.95
Agronomic Crop Protection	$992,671	9.14
4. Animal Diseases and Animal Health	$224,746	3.38
5. Farm Business Management, Economics and Marketing	$264,611	4.61
6. Product Development	$321,184	4.90
2. A Safe and Secure Food and Fiber System		
7. Food and Fiber Processing, Safety and Quality	$195,489	2.00
3. A Healthy and Well-Nourished Population		
8. Human Nutrition and Human Health	$72,908	1.30
4. An Agricultural System Which Protects Natural Resources and the Environment		

9. Soil, Water and Air Quality Conservation and Management	$947,360	11.47
10. Forest, Pasture, Wildlife and Fish Resource Conservation and Management	$193,614	1.99
5. Enhanced Economic Opportunity and Quality of Life for Americans		
11. Improved Quality of Life	$763,386	4.09
12. Individual, Family and Community Economic Development	$218,280	3.28
Grand Total	**$7,675,824**	**89.72**

E. NCARS Integrated Research and Extension Activities (Plan Update)

Integrated Program Plans

In 2004, 70 faculty members with research and extension appointments are conducting research projects. Of this total, 67 are supported by Hatch appropriated funds. Those integrated projects that share Hatch funding with other Extension funding are listed. These projects will be in effect during the 2005-2006 plan years.

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

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

Integrated Project	***Project #***
Production Strategies For Improved Vegetable Production and Alternative Crops For Diversification	**6596**
Weed management for small fruits and vegetables	**6327**
Genetic and production environmental influences on processing and planting quality of nutritionally enhanced soybean seed	**6632**
Management of Arthropod Pests of Turf and Peanut	**6502**
Ecology and management of European corn borer	**0205**
Plant nutrition programs for mountain crops	**6558**
Weed management and growth regulators for agronomic crops	**6417**
Cultural Management of Strawberries and Grapes	**6324**
Using Remote Sensing to Manage Nitrogen In a Corn-Wheat-Soybean Rotation	**6425**
Development and refinement of strategies for peanut production in NC	**6466**
Developing New Crops and Sustainable Production Systems For Vegetables and Medicinal Herbs	**6595**
Rootstock and Interstem Effects on Pome and Stone Fruit Trees	**1840**
Farming System Impacts on Strawberry and Tomato Diseases and Soil Microbial Ecology: Short and Long-Term	**6641**
Small fruit production systems	**5830**

Integrated Peach Disease Management	**6160**
Management of Arthropods in Fruit and Vegetables	**6402**
Crop Improvement Strategies	**6515**
Apple Disease Management	**6223**
Processes Limiting Pollen Development and Release Under Heat Stress in Tomatoes and Other Crop Plants	**6623**
Small Fruit Diseases and their Control	**6747**
Biological Control of Arthropod Pests in Weeds	**0303**
Development, Evaluation and Promotion of Underutilized and Novel Ornamental Plants	**6137**
Disease Management in Ornamental Crops	**6364**
Assessing Farming System Sustainability and Research Support for Organic Agricultural Production	**6625**
Price Risk Management Strategies in Food and Grains Marketing	**6510**
Mycotoxins and their effects on dairy cattle	**6348**
Genetic improvement in pork production systems and understanding genotype by environmental interaction	**6496**
Enhancing Production and Reproduction Performance of Heat-Stressed Dairy Cattle **Improving reproduction and management of dairy cattle**	**0299**
Risk aversion, risk shifting and alternative payment mechanisms in settlement of broiler contracts	**6527**
Fish Food Ingredients Produced By Solubilization/Reprecipitation	**6616**
Use of alternative supplements in grazed, hayed and ensiled forage systems for beef cattle	**6480**
Nutritional Strategies to Improve the Growth, Productivity, and Profitability of Dairy Cattle	**6605**
Nutrient requirements of swine for profitable production	**6495**
Maximization of laying hen performance Economic Return, and Egg Quality	**6184**
Mountain aquaculture research	**6153**
Strategies to Increase Meat Goat Production	**6701**
Integrating Crops and Livestock Systems	**6602**

GOAL 2
A SAFE AND SECURE FOOD AND FIBER SYSTEM

Transport phenomena in agricultural and biological processes	**5885, 6482**
The poultry food system: A farm-to-table model	**0292**

GOAL 3
A HEALTHY, WELL-NOURISHED POPULATION

Insect and manure management in poultry systems: Elements	**1006**

relative to food safety and nuisance issues	
Biology and control of nuisance vector arthropods in North Carolina	**6479**

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

Environmental nursery crop production	**6224**
Precision agriculture for agronomic crops and nitrogen management for corn in Eastern North Carolina	**6652**
Evaluation of Tillage Practices, Organic Production, and trickle Fertigation for Nutrient Management	**6648**
Evaluation and Modeling of Riparian Buffer Performance in the Neuse River Basin	**6609**
Development of Plant Pathogens as Bioherbicides for Weed Control and Weed Management in Landscapes	**1001**
Improving Sediment and Erosion Control Measures	**6559**
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**
Agriculture and ground water quality	**6577**
Animal Manure and Waste Utilization, Treatment and Nuisance Avoidance	**1000**
Improved Efficiency of Water Reuse Aquaculture Systems	**3975**
Aquaculture of Southern Flounder and Improved Water Quality Management of Ponds in Eastern NC	**6387**
Development of Tools for Assessing Environmental Impact and Remediation of Agricultural and Development Activities on a Watershed Scale	**6568**
Integrated vegetation management in non-cropland environments	**6305**
Community-Wide Impacts and Management of Septic Systems	**6372**

GOAL 5
ENHANCED ECONOMIC OPPORTUNITY AND QUALITY OF LIFE FOR AMERICANS

Implications of Technological and Social Changes for the Food System	**6465**
Economics of Socially Optimal Pork Production	**6706**
The public economics of fast growing regions	**6532**
Sports Fisheries Enhancement in Multiuse Reservoirs	**6270**
Rural Communities, Rural Labor	**1011**

Markets and Public Policy in North Carolina and the Southeast	

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HATCH EXPENDITURES for Integrated Research Extension projects in 2003 are listed below. Similar allocations and expenditures will exist in the update plan years to meet and exceed the 25% minimum initial plan target.

FOR INTEGRATED RESEARCH-EXTENSION ACTIVITIES
by National Goal Area

	FY 2003
GOAL 1: **An Agricultural System that is Highly Competitive in the Global Economy**	**$1,025,393.97**
GOAL 2: **A Safe and Secure Food and Fiber System**	**$24,966.85**
GOAL 3: **A Healthy and Well-Nourished Population**	**$88,424.68**
GOAL 4: **An Agricultural System Which Protects Natural Resources and the Environment**	**$715,315.27**
GOAL 5: **Enhanced Economic Opportunity and Quality of Life for Americans**	**$99,491.13**
Total	**$1, 953,591.91**