South Carolina
Agriculture and Forestry Research

FY 2002

ANNUAL REPORT OF ACCOMPLISHMENTS

SUBMITTED TO CSREES-USDA

March 1, 2003

Clemson University
Clemson, South Carolina

AGRICULTURE AND FORESTRY RESEARCH AT CLEMSON UNIVERSITY

ANNUAL REPORT OF ACCOMPLISHMENTS AND RESULTS

March 1, 2003

A. Planned Programs

Agriculture and Forestry Research spent much of FY 2001 preparing to transition to a project based funding research support system and part of this transition was a detailed review of methodologies for assigning research initiatives to goal areas. Project based funding is now fully implemented, all investments in projects and programs are being managed in research projects for management, reporting and accountability purposes. Budgets are currently being developed for the state fiscal year 2002-2003 which begins July 1, 2002, and Hatch funds will be managed in the same project-based fashion.

AGRICULTURE AND FORESTRY RESEARCH
Planned vs. Actual FTE and Expenditure by Goal Area for FY2002

Goal	Planned FTE's	Actual FTE's	Planned Expenditures	Actual Expenditures
Goal 1	27.23	19	3,038,547	$3,565,029
Goal 2	-0-	8	-0-	240,971
Goal 3	-0-	7	-0-	510,467
Goal 4	13.99	5	1,687,767	224,920
Goal 5	1.49	7	416,153	655,925
Totals	42	46	5,142,467	$5,197,312

1. Goal One : An Agricultural system that is highly competitive in the global economy.

Efforts to improve agrisystems productivity and profitability for South Carolina growers span all the traditional crops from livestock to row crops, as well as new crops that hold promise for the future such as bio-based products.

Clemson research scientists are developing new varieties of plant crops with better flavor, yield, quality and resistance to diseases and pests using selective breeding. They are also studying the genetic make-up of plants on a molecular level and developing detailed maps with markers for significant genes.

Key Theme: Dairy Profitability

The dairy profitability program continue to examine approaches to lowering saturated fat content in milk and designs for a pasture-based feeding system to improve animal health and lower producer costs. Work continues to examine more environmentally sensitive ways to manage livestock waste generated in confined areas. By passing the waste through a settling basin and then through man-made wetlands, solids can be extracted for use as organic fertilizer. Remaining water can be recycled to irrigate pastures. This reduces the amount of waste sent to lagoons and reduces the need for chemical fertilizers, while improving grass production in dry months.

Work has begun to investigate the potential to increase the sustainability and reduce the environmental impact of South Carolina dairy farms by adding vitamin D to dairy cattle diets as a way to increase phosphorus absorption and decrease phosphorous excretion.

This research is funded with Hatch and matching state funds and was state specific.

A license was issued on animal waste treatment

Four technical contributions were issued

Key Theme: Animal Immunology

The animal immunology program drew to a close with the "faculty buy-out program" designed to shift research faculty to teaching responsibilities, and with the termination of the other relevant project.

Key Theme: Aquaculture

The Aquaculture research program continued to improve the Partitioned Aquaculture System (PAS) which combines intensive production techniques with intensive waste management to dramatically increase yields while minimizing environmental impact. Research continues on economically viable production systems for other species, such as crayfish, tilapia, red drum, and southern flounder. Their research uses laboratory facilities, as well as the state's waterways, to study aquaculture, fisheries management, and environmental protection.

This research is funded with Hatch and matching state funds and was state specific.

Two Technical Contributions were issued

Key Theme: Ornamental Horticulture

Since plant growth is influenced by the quality and quantity of light, Clemson scientists are studying ways to manage the light in greenhouses. One study is investigating the use of retractable shade curtains to develop recommended management strategies. Data has been collected and is now being analyzed for 12 different species grown under four different light levels. Another phase of this study will examine the effects of fluctuating shade versus constant shade on plant growth and development.

Another study measured the effects of hanging baskets on light transmitted to the greenhouse bench. This study showed that light transmission was reduced twice as much by closer spacing of the baskets (12" versus 24") and by using green instead of white baskets. In addition, containers with plants reduced light three times more than empty containers; however, the red to far-red ratio was not affected by the presence of plants in the containers. The next phase of this study will be conducted at commercial greenhouses to validate the findings. In addition, contour maps showing the monthly solar radiation across the U.S. have been developed.

In a third study, scientists are studying plants' response to various greenhouse films that filter out specific wavelengths from the sunlight. The experimental far-red light absorbing photoselective greenhouse films are proving to be effective in reducing stem elongation in a wide range of plants. Also, commercially available greenhouse covers with UV blocking ability have been found to reduce disease occurrence and insect populations on greenhouse crops.

If plant growth regulation, insect/disease control, and greenhouse heat reduction can be achieved from greenhouse films, the nursery and greenhouse industry could reduce costs for growth regulating and disease/pest control chemicals, reduce health risks to their workers and consumers, and reduce potential environmental pollution.

This research is funded with Hatch and matching state funds and was state specific.

Key Theme: Field and Vegetable Crops

A split landscape approach is comparing the environmental and economic benefits of innovative crop production practices with traditional practices. The new practices include conservation tillage, narrow row widths, broadcast deep tillage, precision nutrient application, transgenic varieties, and environmentally friendly herbicides. Doublecropped wheat and soybean, corn, and cotton are being studied. Early results indicate that the innovative production systems are both more environmentally and economically friendly than traditional production systems.

The new production practices dramatically reduce the amount of water, sediment, and nutrients that move off site during rainfall events and reduce the cost of grower inputs. Besides conserving and protecting natural resources, these practices may also be of value in reducing problems associated with pollutants in runoff water originating from animal

waste.

South Carolina vegetable growers are in dire need of cultural information to replace traditionally grown crops. A study is underway to develop innovative approaches to produce asparagus, lettuce and cantaloupe in the state's coastal area, thereby providing growers a niche in which they can excel and improve their economic status. These practices may also benefit growers in other areas with similar climates.

Summer forced asparagus production is economically desirable since the product's value is usually much higher in fall compared to spring and early summer. This information will reduce most of the unknowns in production and offer growers new alternatives by providing fundamental information that identifying how and when to produce this crop more efficiently with a minimum of risk.

Demonstration plots established with key growers are providing useful information for vegetable growers in the coastal region of South Carolina. The study is exploring alternative crops that can provide new markets, especially winter crops such as lettuce, radish, leeks, parsley, cilantro, and strawberry. A newsletter and web site share information with interested growers, as well as agricultural agents.
Because of the reduced impact on human health and environmental quality, insect pest management techniques that include use of the insect's own chemical communication signals (pheromones) offer significant advantages over techniques using pesticides alone. Short-term results of pheromone-based control measures have been positive, and the damage caused by pests have been reduced. However, the long-term use of pheromone-based measures has received little attention. Using genetic analyses in identifying the chromosomal location of genes involved in the regulation of pheromones in fruit flies should be pursued. Information about the fruit fly may provide a basis for understanding the pheromone systems of economically important Dipterans and the identification of specific protein sequences involved in pheromone production and perception. As a result, researchers may be able to design specific inhibitors to these proteins that could be manufactured and used to disrupt mating in target species.

A study to develop an integrated pest management plan for vegetables and medicinal plants found that the efficacy of insect viruses in the field can be greatly enhanced and rates reduced by adding of optical brighteners to the virus formulation. This should reduce the amount of virus needed and thereby reduce expense. Knowledge of proper planting dates could prevent damage by certain insect pests and an efficient field scouting method could reduce unnecessary chemical applications. These tactics are recommended as the basis of an effective integrated pest management program for pests of vegetables and medicinal plants.

This research is funded with Hatch and matching state funds and was state specific.

A new variety, the Patriot Sweet Potato, was released.

29 Technical Publications were issued.

Three patents were issued:

- Method of diagnosing Gummy Stem Blight in Plants using a Polymerase Chain Reaction Assay.
- PCR-Based Method for Identifying a Fusarium Wilt-Resistant Genotype in Plants
- Apparatus & System for Plant Production

Goal Two: A safe and secure food and fiber system

Foodborne illnesses in the United States have led to a major cause of economic burden, human suffering, and death (Healthy People 2000 Food Safety Objectives, 1995). While foodborne diseases, their causes and effects are better understood today, emerging risks need to be monitored for several reasons: 1) First, the food supply of the United States is changing dramatically, the conditions under which animals are raised have changed greatly. 2) Second, consumers are changing; there are an increasing numbers of elderly or immunosuppressed persons who are at higher risk of severe illness; an increase in eating food prepared away from home, the public's desire to consume raw, minimally processed, organic or exotic foods, children preparing snacks or part of the family's evening meal, the public's fear of technology, a more mobile population taking food with them and bringing food back from remote destinations or trying to duplicate a food consumed in another part of the world, and the desire to market and sell food products. Finally, new and emerging foodborne pathogens have been identified, which can cause diseases unrecognized 50 years ago. Each year, an estimated 6.5 to 33 million people become ill from microorganisms in food, and an estimated 9,000 of these individuals die.

Consumers are concerned about the safety of their food and only a limited number of them understand the process involved in safe handling and distribution of food. Such limited understanding can lead to hazardous food handling practices. According to the United States Department of Agriculture (1998), foodborne illnesses from meat and poultry alone account for $5.2 to $28.2 billion. Less than 5% reported and only 41% of the organisms are identified. During the fiscal year 1998-1999 South Carolina had an estimate of 150 cases of foodborne illnesses which also included complaints of symptoms related to foodborne illnesses.

A July 1997 United States Department of Agriculture (USDA) study showed that 96 billion pounds -over one quarter of the 356 billion pounds of food produced for human consumption in this country each year- is lost at the retail and food service level. Food security indicates the availability of food, while famine and hunger refer to the effects of the non-availability of food. Famine and hunger are the result of food insecurity. According to the World Bank in 1986, the availability and accessibility of food to meet individual food needs should also be sustainable.

Disposal of acid whey is a costly process to the dairy industry. Clemson scientists are working to increase profitability for the dairy industry and improve food safety and quality by creating value-added products from acid whey, a by-product that is normally treated as waste. Products they are exploring include an antimicrobial food coating material, a flexible film material, and a natural antioxidant containing flexible film material. The antimicrobial film is produced from thermally processed acid whey combined with nisin and lauric acid (natural food-grade biocides); while the flexible film and the antioxidant film is produced from a heat extrusion process.

Another study is investigating new packaging systems and processing techniques to increase the safety and quality of meat products. Scientists exposed fresh beef surfaces to antioxidant impregnated polyethylene films and found that the films with added BHT maintained the red oxymyoglobin pigment two days longer than meat exposed to films not containing the antioxidant. They also found that it may be possible to stabilize the meat flavor by adding honey to meat products via the Maillard browning reaction. This process releases through the natural antioxidant ingredients found in honey.

A third study is investigating the effects of adding salts during meat and poultry product cooking as a means to improve meat-to-film sealant adhesion and investigating the impact of marinating fresh poultry as a value-added process to control yields and flavor impact in ready-to-eat products.

Thirty eight proposals were submitted for funding

Twenty five peer reviewed presentations/performances/exhibits were conducted.

Seventeen technical contributions were issued.

Key Theme: Food Safety

The Food Safety Program focused on the following interrelated research topic areas:

-Packaging and processing effects on safety and quality of poultry products
-Processing and packaging of meat and poultry products for quality enhancement,
-Packaging materials on chitosan and other biopolymers
-Development and efficacy of anti-microbial food packaging materials
-Phytochemicals as modulators of disease, functional properties of a soy protein concentrate produced by ultrafiltration
- Modifying milk fat composition for enhanced manufacturing qualities and consumer acceptability
- Bioavailability and digestibility of food components, food demand, nutrition and consumer behavior,
-Characterization of endothelial cell internalization of Ap4A
-Harvesting and post harvest handling protocols for optimizing active content

-In vitro culture of medicinal plants and investigation of their active ingredients.

Developing reliable methods for producing jenseniin P is a critical first step in evaluating its effectiveness against the agents that are implicated in acne. Work began with ImmuCell to produce sufficient jenseniin P for their purification procedures. Larger-scale (13-L) fed-batch producer cultures reproducibly yielded directly detectable bacteriocin activity; this finding contrasts sharply with results from earlier batch culture methods where activity was detected only after concentration. Activity was detected at day 5 in 13-L cultures and is stable; these results allow for earlier harvest of jenseniin P. Detectable activity was not eluted from producer cells at pH 2.5, 4.0, 8.0 or 10; activity was recovered only in culture supernates. ImmuCell has better facilities to remove cells from large volumes of spent cultures. To permit shipping, we assessed the stability of bacteriocin activity in cultures to shipping conditions. Activity was stable at -20C, 4C and 20C for up to 4 days. Some bacteriocin-resistant producers lack susceptibility to feed-back inhibition and produce higher concentrations of bacteriocins so we are currently attempting to select for jenseniin P-resistant producer variants.

This research is funded with Hatch and matching state funds and was state specific.

Thirty eight proposals were submitted for funding
Twenty five peer reviewed presentations/performances/exhibits
Seventeen technical contributions were issued.

Goal 3: A healthy, well nourished population.

The development of genomic tools for peaches and other fruit will vastly improve practical use of this knowledge for sustainability of the crop. Data on the incidence of uncharacterized viruses, and on other characterized viruses that infect fruit crops, will be used to provide virus-tested sources of propagation material, to identify sources of infection, and to evaluate and implement IPM procedures for the control of these viral diseases in South Carolina and in the Southeast.

Key Theme: Fruit
Because South Carolina fruit growers have experienced several years of drought, Clemson researchers investigated the effects of irrigation and "fertigation" (fertilizer applied through the irrigation system) on peach orchards. The study found that new trees that were irrigated grew 50% more than non-irrigated trees in the first two years. As a result, the irrigated trees produced 100% higher yields the first year and 50% higher yields the second year, and the fruit was also marketable size whereas the fruit on non-irrigated trees was too small to market.

An underground camera system is recording root development in the irrigation study. The scientists plan to use this data to develop recommendations for optimum times to apply fertilizer in irrigated orchards. The study also investigated the use of liquid fertilizer applied through the micro-sprinkler irrigation system, known as "fertigation." A highly soluble formula is applied in small doses four to six times in the spring whereas granular

fertilizers are applied in one or two large doses. When a major rain occurs, some of the granular fertilizer goes to the tree in one big dose, while the rest may be washed away. By comparison, fertigation requires 50% less fertilizer, delivers a more constant level of nutrients, and reduces the environmental impact of agricultural chemicals.

As a result of this study, the scientists expect that the cost to install irrigation equipment can be offset by stronger trees, larger yields, more marketable fruit, and reduced fertilizer costs. In another study, Clemson molecular genetic researchers are working to determine the location of a gene for resistance to root knot nematodes in peach by utilizing data on the *Arabidopsis* genome and known genes and molecular markers from tomato and peach.

Research initiatives are comparing tree training systems, planting densities, and fertigation to maximize yields and profitability per acre. In addition, the scientists are evaluating alternative fruit and nut crops to diversify South Carolina production, including Kaki persimmons, Asian pears, chestnuts, and paw paws.
The scientists are also developing integrated pest management practices to minimize the use of pesticides; producing chromosome maps to identify important genes in fruit production; and improving post-harvest handling technologies to ensure a high quality, safe product for consumers.
Continuing research efforts in peaches include constructing chromosome maps to identify the genes responsible for disease resistance, cold hardiness, fruit quality, and other desirable traits. The scientists are also investigating the use of interstems to delay blooming and are continuing to test the new Guardian™ peach variety developed to withstand nematode damage.
Reflective plastic mulch is still being tested to improve peach and apple harvests by increasing the amount of sunlight reaching the trees' inner branches. This produces more fruit and a deeper red color that commands premium prices.

Clemson scientists continue to work with colleagues at North Carolina State University and the University of Georgia in the Regional Virtual Small Fruit Center. The center provides growers with production and pest management expertise from scientists at all three universities, via a web page based at Clemson.

This research is funded with Hatch and matching state funds and was state specific.

Goal 4: Greater harmony between agriculture and the environment

South Carolina has a wide variety of natural resources. However, the availability and the quality of these vast resources are constantly being diminished by the increasing demands of an expanding population. Based on state reports to the Environmental Protection Agency (EPA) about 49 % of the nation's surveyed rivers, lakes, and estuaries are not clean enough for fishing or swimming (Allen 1995). Although Americans have made tremendous strides in the reduction of point source pollution, non-point source (NPS) remains as the greatest concern for impairment to our water resources. Future use and

management of natural resources will require public education on water quality, wildlife, forestry, and other environmental issues.

Runoff from agricultural land is the biggest source of pollution of water resources. It is estimated that agriculture sources are responsible for 46 % of the sediment, 47% of the total phosphorus and 52 % of total nitrogen discharged into our waterways (Gianessi et al.,1986).

South Carolina has a total land area of 19.3 million acres. Of this, 4.6 million acres is in farmland. Croplands represent 2.5 million acres (53.6 %); woodlands represent 1.46 million acres (35.3 %); pasturelands represent .2 million acres (5.3 %); farmlands in Conservation Reserve and Wetland Reserve represent .2 million acres (4.8%); other lands in farms represent .3 million acres (5.8%).

Small Farms in South Carolina (1-99 acres in size) represent approximately 54.5 % of the total farm population. Educational programs, activities, and demonstrations will target natural resource concerns by addressing small and limited resource farms and farm families.
Changes in land use patterns are impacting the state's resources in unplanned ways. Future wise use of the state's natural resources will require public education of the impacts that current and future land uses have on natural resources. Environmental issues of land, wildlife and water will be addressed.

Key Theme: Water Quality

To help the agriculture industry meet required water quality standards, Clemson scientists are developing tools to assess the content and impact of run-off from agricultural lands. They are developing watershed models for the piedmont region of South Carolina as a way to determine Total Maximum Daily Load (TMDL) limits. They are also assessing the potential economic and ecological costs, benefits, and equity issues associated with TMDL implementation in an effort to link human choices, policy variables, and environmental quality. Measurements will include flow stages and rates, sediment concentrations and properties, water quality values, and biological counts. Descriptive information will include land uses, topography, and soils provided by a Geographical Information System (GIS) analysis.

Another study is focusing on algal blooms in coastal plains watersheds that may be caused by nitrogen run-off from agricultural lands. Scientists are developing and testing a GIS-based water quality model to include an estimate of yearly nitrogen, phosphorus, and carbon balances. Data from this study suggest that riparian zones and slow moving streams can remove nitrate that has been carried from agricultural fields in surface or subsurface flow. However, data on soils collected from riparian areas in the state's coastal plain suggest that their carbon content and pH are too low to permit significant denitrification. This study seeks to facilitate better nitrogen management in the upper

reaches of coastal watersheds that can lead to significant reductions in available nitrogen in the area's waters.

Scientists continue to work on strategies to balance economically viable development with good water quality in South Carolina. The researchers are studying the ways that housing developments, golf courses, agriculture, and urban development can cause movement of fertilizers, pesticides, and other contaminants into surface and ground waters.
Research continues into the use of natural and man-made wetlands to remove and process these contaminants before they enter the state's waterways. These low-cost, low-energy, and low-maintenance best management practices will preserve the quality of our water resources and allow continued economic development throughout the state

Research continues on the use of ozone for disinfecting food processing wastewater. More specifically, work is underway to determine the efficacy of ozone to reduce biochemical oxygen demand (BOD5) and chemical oxygen demand (COD) in food processing plant wastewater that has high concentrations of fat, protein, starch or locust bean gum. These chemical moieties represent different nutritional or additive families commonly used in the food industry. This information is important for determining the resistance of certain microorganisms in food matrices when ozone is employed as a disinfecting agent.

This research is funded with Hatch and matching state funds and was state specific.

Goal 5: Enhanced Economic opportunity and quality of life for Americans

Turf production establishment and maintenance, whether on the sod farm, on the athletic field or on the golf course is an agricultural enterprise that is profitable. Turf is routinely supplied with fertilizers, treated with pesticides to control insects, pathogens and weeds, and is subjected to various agronomic tillage practices. Consequently, environmentally sound practices to forestall pollution of nutrients and pesticides in surface and ground water is being researched to support the continued growth of this industry in South Carolina.

Key Theme: Turf Grass

South Carolina summer temperatures and humidity make it difficult for golf course managers to maintain the bentgrass putting greens that their customers demand. To support the golf and turfgrass industries, and to protect the environment, Clemson scientists are investigating best management practices to care for this valuable turfgrass. Their studies include the use of various soil amendments in golf green construction, the use of above- and below-ground air movement, and the optimum use of fungicides.

The scientists are conducting a long-term evaluation of various soil profile mixes and blends for golf green construction as opposed to the traditional sand-based soils. The soil amendments improve water-holding capacity and drainage, and minimize irrigation waste. This prevents diseases and dry spots and improves the soil oxygen properties needed to maintain healthy bentgrass growth and development. They are also investigating the potential benefits of using above- and below-ground air movement to maintain bentgrass greens. The theory is that, by manipulating soil air movement, soil temperatures and possibly soil gases may be altered to improve bentgrass growth. Measures include soil temperature and moisture at various levels in the soil strata, soil gases, and root length density.

Another study is investigating ways to optimize disease management for bentgrass and over-seeded bermudagrass. Researchers are developing best practice recommendations for fungicide use to control diseases in creeping bentgrass putting greens and studying the influence of diseases on the health of cool-season grass overseedings in commercial turfgrass systems. They are also studying the influence of diseases and disease control strategies on the fall establishment of cool-season turfgrass overseeded into bermudagrass and on the spring transition and health of bermudagrass after transition.

Research continues to improve the quality of turfgrass through breeding and management techniques while they protect the environment by reducing the use of pesticides.

Innovative management techniques are being studied, including a spray that protects warm season grass from frost damage in winter and a subsoil aeration system that protects cool season grass from heat damage in summer. Genetic engineering is being used to develop a Bermuda grass that stays green year-round. Research continues on commercial installations, as well as on research greens at the university's Pee Dee Research and Education Center in Florence and on the main campus.

Three technical contributions were issued.

This research is funded with Hatch and matching state funds and was state specific.

Key Theme: Fire Ants

Research initiatives related to fire ants were ended with the conclusion of several projects and the retirement/reassignment of several faculty. Related technology transfer activities continue.

B. Stakeholder Input Process

Actions taken to seek stakeholder input that encourages their participation:

The Dean and Director of Agriculture and Forestry Research participates in meetings and events of commodity groups and state associations, to include the South Carolina Economic Developer's Association, and meets with special interest groups to continuously engage in the process of identifying research issues and opportunities to serve the stakeholders in the state. The Dean and Director attends the meetings of the Cooperative Extension Advisory Board, and is a member of the South Carolina Agents Association. He also participates in meetings of the various unit advisory boards which are comprised of unit specific stakeholders. Every effort is made to build working relationships with other campus units to gauge the needs of their stakeholders and to take public service research university-wide.

Process used to identify individuals and groups who are stakeholders and to collect input from them:

New stakeholders are identified the Dean and Director at events and meetings across the state and nation, from suggestions provided by existing stakeholders, and through the suggestions of faculty and staff. Input is collected though individual and group discussion sessions. The Dean and Director has commissioned a producers stakeholders survey entitled "Survey of Needs and Opinions of South Carolina Agricultural Stakeholders and Producers." The survey results will be sent to each individual who participates.
The Dean and Director is making plans to invite stakeholders to meet with the program teams for turf, ornamentals, fruit, vegetables and field crops each year as part of the South Carolina Ag Expo.

How collected input was considered:

The Dean and Director reviews comments from stakeholders with the five associate deans who manage all programs reported in the USDA plan of work. This information is used by the Associate Deans as they design and modify programs in their respective areas of responsibility.

C. Program Review Process

There have been no significant changes in the program review process since the five year plan of work.

D. Evaluation of the Success of Multi and Joint Activities

Agriculture and Forestry Research supported 29 MRF (Multi-state Research Funds) projects and invested $3,387,395 on those projects in FY2002. AFR researchers conduct research in MRF projects in all four regions of the country (Southern, Western, Northcentral, Northeast).
While the actual results for FY2002 are not available at this writing, AFR has conducted a systematic and detailed review of the most recent CRIS reports on these research initiatives which were submitted in April of 2002 and has monitored the progress of each

project through site visits, and discussion sessions with the faculty, their respective department chairs and with the appropriate Associate Dean for the goal areas. Without identifying the outputs, outcomes and impacts of each individual project it is clear through an extensive evaluation process that these initiatives are addressing critical agricultural issues which are presented in the five year plan of work.

1. Did the planned programs address the critical issues of strategic importance including those identified by the stakeholders?

By their very nature, regional projects are designed by experts in the respective fields from all of the participating states, normally in the Southern Region to address critical issues identified by faculty and stakeholders in all of the participating states. The Southern Region also runs selected program concepts by identified stakeholder groups.

2. Did the planned programs address the needs of underserved and under represented populations in the state?

AFR faculty participated in regional research projects which addressed youth and family issues, food safety issues and a wide range of plant and animal issues. The research was geared to meet the needs of the state's population, to include those groups considered underserved or under-represented. This was accomplished through stakeholder input, and awareness on the part of research faculty of the needs of all segments of the population. Results will be transferred to these user groups though the Cooperative Extension Service, web based communications mediums, public service announcements and outreach through the county programs.

3. Did the planned programs describe the expected outcomes and impacts?

Each regional project detailed the outcomes and impacts as a part of the application process. These outcomes and impacts were developed at the meetings which set the regional projects in motion. The progress of these regional initiatives is monitored by AFR, the other states and by the Southern Experiment Station Directors.

4. Did the planned programs result in increased program effectiveness and/or efficiency?

The concept of regional research initiatives is built around assembling the best talent to approach a problem and allowing those faculty to develop the research design to maximize the effectiveness of the program in meeting the stated goals, and in achieving the maximum efficiency by utilizing talent and resources from multiple states.

E. Multistate Extension Activities

Not Applicable

F. Integrated Research and Extension Activities
Agriculture and Forestry Research invested $385,086 in integrated Research and Extension Activities.

The areas appearing on Form CSREES-REPT (2/00) below reflect the Hatch funds committed to integrated research and extension activities.

U.S. Department of Agriculture
Cooperative State Research, Education and Extension Service
Supplement to the Annual Report of Accomplishments and Results
Multistate Extension Activities and Integrated Activities
(Attach Brief Summaries)

Institution: Agriculture and Forestry Research
State: South Carolina, Clemson University

Check one: ____Multistate Extension Activities
_X__Integrated Activities (Hatch Act Funds)
____Integrated Activities (Smith-Lever Funds)

Title of Planned Program/Activity	Actual Expenditures FY 2002
Turf Grass	$120,000
Water Quality	32,000
Farm Management	35,325
Marketing	110,156
Information Technology	49, 776
Agro-Ecology Program	51,170
Total	$398,427

Director _____Date _____
Form CSREES-REPT (2/00)

Narrative Summaries:

Turf Grass: AFR provided funds to support cooperative extension staff and programs in selected counties in conjunction with on-going turf research initiatives.

Water Quality: Lab facilities were made available for analysis by the extension waste management initiative team, and selected pieces of laboratory and field equipment were made available to support extension efforts.

Farm Management: Farm services are provided which directly support extension demonstration plots and field days. These activities are ongoing and require a significant commitment of equipment and farm staff to insure quality demonstration plots and field days.

Marketing: The organizational unit which is responsible for all aspects of research and extension public relations/marketing activities is supported jointly by research and extension.

Information Technology: AFR shares the expenses for supporting the information technology office which coordinates computer support at all on and off campus.

Agro-Ecology Program: AFR provides half of the support for the innovative Agro-ecology program, and Cooperative Extension provides a like amount.