

**Virginia Tech and Virginia State University
Agricultural Research and Extension
FY 2006 Annual Report of Accomplishments and Results**

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A. Introduction

Mission

Virginia Cooperative Extension (VCE) and the Virginia Agricultural Experiment Station (VAES) enable people to improve their lives through research and an educational process that uses scientific knowledge focused on economic, social, and environmental issues and needs.

Vision

Building on the strength of our agriculture, natural resources, family and community heritage, we enable people to shape their future through research-based educational programs. Recognizing that knowledge is power, we serve people where they live and work. Audiences help design, implement, and evaluate needs-driven programs. We are a dynamic organization that stimulates positive personal and societal change leading to more productive lives, families, farms, and forests, as well as a better environment in urban and rural communities. Our goal is to:

- Develop and transfer new knowledge in applied and basic life sciences.
- Perform relevant, objective, and timely research.
- Help clientele improve their lives.
- Use a systems approach to programming, with task-oriented work teams that respond to the needs of individuals, groups, and organizations.
- Provide residents with prompt access to information and programs through innovative human and technological systems.
- Work with the disenfranchised and underserved who need special attention by targeting resources to programs for low-income groups, those outside the dominant culture, dysfunctional families, limited-resource farmers, at-risk youth, and others.
- Fully integrate a culturally diverse paid and volunteer staff in planning, implementing, and evaluating programs.
- Collaborate with public and private partners to better utilize our resources, heighten our impact, and reach a more diverse audience.
- Capitalize on the respective strengths of Virginia State University and Virginia Tech as partners in supporting the Extension mission.
- Recruit, manage, and reward faculty, support and volunteer staff to reflect each person's uniqueness and value.
- Have an open and positive administrative environment, based on shared leadership that maintains organizational integrity while providing opportunities for all staff members to fully realize their potential.
- Minimize administrative costs and direct our resources to research and educational programming.

Planning and Reporting Framework

Program Development. VCE and VAES address a broad range of problems and issues facing the Commonwealth through focused research and educational programming. This is planned and reported in VAES through the College of Agriculture and Life Sciences electronic Faculty Annual Reporting System (eFARS), including long-range goals made operational by annual program plans and reports. Research and Extension program plans are built on the identification of strategic issues through situation analysis, accomplished with the help of local Extension Leadership Councils (ELC's). Situation analysis involves collaboratively determining problems that exist at local, regional, and state levels and then determining those of major public concern. The situation analysis becomes the background and rationale for deciding which problems and issues can be addressed with VAES and VCE resources.

VAES/VCE Goals. Strategic goals form the foundation for research and educational program development. Goals are determined with the involvement of ELC's, cooperating agencies, local governments, and other stakeholders and partners.

Our strategic goals:

- Virginia's agricultural, forestry, and agribusiness firms will be competitive and profitable.
- Virginia's youth will be educated leaders for the 21st century.
- Virginia's natural resources will be enhanced.
- Virginians will have a high-quality, safe food supply.
- Virginians will enjoy a good quality of life.

Educational Programs. VCE educational program plans serve as a communications and planning tool for developing, delivering, and reporting VCE programs. They are used to communicate information about VCE client-focused programs internally and to external audiences, such as the state and federal government officials.

Once approved, the educational programs plans are available on the VCE intranet, to ensure all staff may review them. Personnel respond or "buy in" to the appropriate educational programs by indicating the programs they plan to deliver. At the end of the programming year, an annual report is prepared for each educational program. In addition, staff are able to amend or update their buy-in annually or as often as needed.

Research Objectives. The primary goal is to develop relevant basic and applied research data to form the basis for Extension programming. A wide range of long- and short-term research projects are undertaken to provide a continuous flow of new knowledge and seamlessly provide science-based information to enhance the quality of life for citizens.

Educational Objectives. Objectives describe the level of change expected in the target audience and/or the problem as a result of implementing the program. The following categories represent four types of change that may occur:

- Reactions – Changes in people’s awareness and response to educational programming and information related to the problem.
- Knowledge or skill change – Changes in people’s knowledge, understanding, or abilities related to the problem.
- Practice change – Changes in people’s behavior related to the problem.
- End results – Broader changes in people’s situation related to prevention, reduction, or solution of the problem itself.

Reactions, knowledge/skill, and practice changes focus on people. End results can focus on people or solving a problem. An objective expecting an end-result often takes many years to achieve.

Research Strategies. VAES has six key program areas:

- Agricultural Profitability and Environmental Sustainability
- Food, Nutrition and Health
- Biodesign and Bioprocessing
- Green Industry and Specialty Crops – including nursery and turf
- Infectious Diseases
- Community Viability

These program areas support key national goals by addressing local, regional, and national problems through relevant basic and applied research. Research-based information and solutions to specific issues are then brought to people through VCE educational programs.

Educational Strategies. Educational strategies are the methods used with target audiences to achieve the objective and address the problem. Some examples of strategies include panels, group discussions, tours, lectures, workshops, seminars, and demonstrations. Educational strategies also include programming efforts aimed at racial/ethnic groups, women, and/or other previously underserved or underrepresented groups specifically targeted for special attention by the program.

Reporting Requirements

All Extension faculty (agents, specialists, and administrators) and program assistants submit individual program reports. Also, county/city employees who are supervised by VCE and conducting Extension programs submit annual program reports. Summary reports are developed from the individual reports.

All research faculty are required to propose peer reviewed Experiment Station project submitted to United States Department of Agriculture/Cooperative State Research Education and Extension Services (USDA/CSREES), and entered into the Current Research Information System (CRIS). Researchers prepare annual progress and termination reports (AD-421), reviewed by the VAES director before being submitted to CRIS. In addition, all research and Extension faculty are required to submit an annual report through eFARS. This locally developed system documents teaching, research, and Extension accomplishments and impacts for unit and college review.

Updates to eFARS in 2006 streamlined reporting on key themes, full time equivalent faculty (FTE's), and funding.

Data Summary for 2006 Programs

A summary of contact and volunteer data from the VCE contact reporting system by Extension program area is presented in Table 1. There were 10,923,564 contacts in VCE programs from January 1, 2006, through December 31, 2006. This included 43,018 volunteers assisting Extension staff in delivering programs during the reporting period. The total value of volunteer time contributed to VCE educational programs (1,302,445 hours estimated at a value of \$18.04 per hour according to the Virginia Employment Commission) was \$23,496,107 for this reporting cycle.

**Table 1. Contacts and Volunteer Data by Program Area
(January 1, 2006, through December 31, 2006)**

Program Area	Total Contacts	Percent of Total	Volunteers	Percent of Total	Volunteer Time (hrs)	Percent of Total
4-H	2,422,791	22 %	20,320	47 %	745,563	57 %
ANR	7,433,888	68 %	7,653	18 %	270,038	21 %
CV	99,317	1 %	395	1 %	11,504	1 %
FCS	854,145	8 %	7,557	18 %	95,302	7 %
Admin.	113,423	1 %	7,093	16 %	180,038	14 %
Totals	10,923,564	100 %	43,018	100 %	1,302,445	100 %

There were 447,264 extended learners who spent at least four hours (six hours for 4-H membership) per year in VCE educational programs. A variety of delivery modes, including conferences, workshops, home-study courses, Web-based, and other distance-delivered programs, public fairs, home/family shows, and exhibitions, were used in these programs. A total of \$19,261,270 external dollars supported these programs in four program areas.

B. National Goals

Goal 1: To achieve an agricultural production system that is highly competitive in the global economy.

Providing abundant, safe, nutritious, and affordable food is the first priority for a society to assure a prosperous and sustainable future. Research and education programs focused on successful agricultural systems are fundamental to the security and viability of people and their communities. Agriculture systems must be profitable, environmentally sound, and research-based to sustain necessary levels of production and ensure future supplies of food as well as other key products.

Agricultural education and research focused in many areas from the utilization of crops for renewable fuels to adding value to livestock and horticultural products to developing new high performance varieties. Extension and research initiatives developed alternative uses for crops and agricultural wastes, reduced production costs, and created regional marketing systems to increase production incentives.

New investments in plant and animal research are vital to compete effectively in export markets and to achieve harmony between agriculture and the environment. The agricultural industry needs proven production methods which are profitable and will not harm the environment. Gains in agricultural productivity and efficiency increasingly rely on genetic and biotechnology research and solutions.

Agriculture is Virginia's largest industry generating 36 billion dollars per year or 12 percent of all sales. Virginia farms are more efficient today and typically growing larger or smaller. Ninety-eight percent of Virginia farms are owned and operated by families.

New research, innovation, entrepreneurship, and multidisciplinary approaches will ensure agricultural profitability and environmental sustainability. Therefore, the two Land-Grant universities in Virginia work together through Agriculture Research and Extension Centers (AREC) and the Virginia State University (VSU) Agriculture Research Station (ARS) to assure competitiveness for Virginia's agriculture in a global economy. The Commonwealth's agriculture continues to be challenged by pressure from urbanization, low commodity prices, reductions in farm support programs, increased energy and labor costs, new environmental regulations, and a lack of understanding by the public of the value of local agricultural enterprises.

Research activities at the two Land-Grant universities account for approximately 300 Current Research Information System (CRIS) units with at least 60 percent of that portfolio focused partially or wholly on topics related to Goal 1. The effort to achieve and maintain a globally competitive agricultural production system requires a continuing commitment of resources, hard-working and dedicated people, a focused vision, and a resolve to succeed. State and federal partners join forces in this important work.

Research and Extension outputs generated for this goal included 127 refereed journal articles, one book, 15 book chapters, 60 numbered Extension publications, and 140 other reports.

This section highlights accomplishments of Virginia Tech (VT) and VSU in 2006 to achieve an agricultural production system that is highly competitive in a global economy. Themes included in Goal 1 include:

- Agricultural Competitiveness
- Animal Production Efficiency
- Aquaculture
- Biobased Products
- Biotechnology
- Diversified/Alternative Agriculture

- Invasive Species
- Niche Markets
- Plant Health
- Plant Production Efficiency

Many of the efforts reported under the key theme on agricultural competitiveness also apply to animal production efficiency. A number of the activities and impacts reported under diversified/alternative agriculture also apply to niche markets and finally, many efforts reported under plant production efficiency also apply to agricultural competitiveness. The interdisciplinary nature of the work makes it difficult to report efforts to only one key theme.

Key Themes

Agricultural Competitiveness

Basic Research

Hair Sheep Genetics. Enthusiasm for the use of wool-free, parasite-resistance hair sheep in easy-care production systems is growing throughout the U.S. In research conducted at the Southwest Virginia AREC, two hair sheep types, the Katahdin and Dorper, were compared to crossbred Dorset ewes (a wool breed) for over four years in annual lambing with low-input production. Katahdin ewes weaned 26 percent more lambs than the other two types of ewes and produced over 20 percent more kilograms of lamb. These experiments identified genetic resources that can optimize ewe performance in both intensive accelerated and extensive low-input production. In a related collaborative study with the Katahdin hair sheep breed, data from six private flocks were used to demonstrate a strong genetic basis for resistance to internal parasites in this breed and procedures for industry genetic evaluation of parasite resistance were implemented in the U.S. National Sheep Improvement Program.

Applied Research

Chemical Thinning of Apples. The Virginia apple industry contributes \$235 million annually to the state's economy. However, profitable apple growing is a challenge because apples are prone to biennial bearing characterized by heavy bloom and overcropping in the 'on' year and low or no cropping in the 'off' year. In the 'on' year, a heavy crop results in small and poor quality fruit at harvest worth little when sold as fresh or processed fruit. For example, the fresh apple price is more than \$17 per bushel for fruit above 7.6 cm in diameter but less than \$8 per bushel for fruit about 5.7 cm in diameter. Currently, chemical thinning is the only feasible method fruit growers use to improve fruit size, color, and quality, increase return bloom, and reduce alternate bearing habits of apple trees, thereby increasing growers' return. However, chemical thinning results are extremely variable and difficult to predict or control from lack of understanding of the modes of action of chemical thinners, and how environmental factors effect the ultimate thinning response. In 2006, the effect of temperature on the efficacy of chemical thinners naphthalene acetic acid (NAA) and ethephon in thinning apple fruit was examined using potted 'Golden Delicious' apple trees in environment-controlled growth rooms. NAA, applied at 10 mm stage of fruit development, had no effect on apple fruit thinning when air temperature was 15.6 °C or 60 °F. However, fruit thinning caused by NAA increased when increasing air temperature from 15.6 °C to 26.7 °C. When applied at 20 mm stage of fruit development, ethephon effectively thinned

apples, and its thinning effect was not affected by increasing day/night temperature from 21.1/10 to 32.2/21.1 °C. The effect of fruit size at application time and cultivars on the efficacy of chemical thinners was also examined in the field. For ‘Golden Delicious’ apples, chemical thinners such as NAA, ethephon or the combination of 6-benzyladenine (6-BA) and carbaryl effectively thinned apples when fruit size was 6.7 to 21 mm in diameter. However, chemical thinners had no effect on fruit thinning when fruit size was greater than 28 mm in diameter. For ‘Gala’ and ‘Pink Lady’ apples, chemical thinners, applied at an average fruit size from 9 to 16 mm, effectively thinned apples but did not effectively thin apples when fruit size was smaller than 9 mm or greater than 16 mm in diameter. Based on these results, apple growers have a more defined recommendation and expectation when using chemical thinning.

Extension Programs

Virginia Beef Quality Assurance Program. The average beef herd in Virginia has 25 cows and is a small farm business. According to Virginia livestock sale surveys, a large percentage of cattle producers do not receive competitive prices for small groups of inferior animals. Small beef producers need increased market access with value based incentives. Extension developed the Virginia Beef Quality Assurance (BQA) Program to educate and certify beef producers in best management practices that improve the safety and quality of beef. One thousand three hundred and nine Virginia beef producers obtained initial or recertification during 2006. The total number of certified producers in Virginia is 3,707 which makes Virginia a national leader in BQA and certified producers. The program addresses critical issues of food safety, biosecurity, and increased market access opportunities for 3,707 Virginia producers. For example, 2006 workshops held in Central Virginia, were attended by 355 producers. As a result, these producers participated in a special production and marketing sale certifying the genetics and health of their animals. The calves averaged \$7.87 per hundred weight over state graded sale averages for the same week.

Adding Value with Virginia Premium Assured Heifers. Adding value to Virginia’s beef cattle operations is critical to the sustainability of Virginia agriculture and rural communities. An educational, management, and marketing program was developed by VCE to teach producers proper management of replacement beef heifers using current research. In 2006, 2,500 heifers were enrolled by beef producers in the program. Marketing of 1,150 Virginia Premium Assured Heifers (VAPAH) at auction resulted in gross sales of \$1,368,542. An additional 250 VAPAH heifers were sold by private treaty. Heifers developed and sold through the program averaged \$1,265 and increased net income by \$100 per animal compared to non-VAPAH values. For eleven Southwest Virginia farmers in Carroll and Grayson counties with lower farm incomes due to changes in the tobacco industry, this program provided additional income. Their cattle were sold to five states. Participating producers sold 84 head of bred VAPAH for a gross of \$117,096 or an average of \$1,394 per head. This exceeds the regional average by \$300 per head.

Marketing Beef Genetics for Small Producers. Virginia’s small and moderate size producers need opportunities to buy and sell quality beef sires. Producers need herd bulls to meet the specific needs of their cow herds. Virginia’s Bull Evaluation Program (VBEP) is an education, management, and marketing program for small and modest size beef producers that provides a cooperative arrangement for proper management and competitive marketing of beef genetics. The VBEP is the largest single source of beef genetics in the Commonwealth, enrolling 2,485

beef bulls from over 115 beef producers in Virginia and surrounding states since 2001. Marketing of qualifying bulls at auction contributed \$3.3 million in sales.

Increased Values and Marketing Options. A collaborative effort between VCE, the Virginia Cattlemen's Association, the Southeast Livestock Network, and beef cattle producers provided training and certification for Virginia beef producers to allow them to market feeder cattle as USDA Process Verified. Extension agents and beef industry leaders received in-depth training and became certified to implement USDA Process Verification standards through the program. Training and certification of beef producers carried out by agents allowed producers to market feeder cattle certified as export-eligible through the USDA Process Verification standards. Since August, 2006, 200 Virginia beef producers enrolled as USDA-approved suppliers. These producers marketed 5,195 USDA Age Verified cattle, contributing \$197,410 in value-added income.

Expanding Sheep Marketing Opportunities. Sheep numbers significantly increased in Scott County from 500 to 1,700 breeding animals over a ten year period according to Virginia agricultural statistics. With renewed interest in sheep, producers working with VCE formed an association to explore and consider alternative marketing options. Extension and the association of 193 members conducted a producer survey demonstrating that 25 percent of the respondents wanted local sales and marketing avenues developed. Extension assisted the sheep association in developing a direct sales opportunity by working with a local grocery chain. Producers can sell sheep to the grocery chain for \$3.00 per pound chilled carcass weight, year round. As a result 116,000 pounds of lamb was sold for approximately \$348,000. When compared to weekly sales at New Holland Pennsylvania, producers received an average premium of \$29 per hundred pounds for an added value of \$33,640 returned to producers. A recent producer survey also led to the development of a business plan and further regional market development.

Assessing Virginia's Farm Land Based on Use Value. More than three-quarters of Virginia's counties and cities adopted enabling legislation for use value taxation for farm and forest land owners with qualified practices. These landowners can defer real estate taxes on their land based on the difference between the properties' fair market value and the value in use as farm and/or forest lands. Local property taxes for this qualified land are based on capitalized net returns of a representative farm creating a value in use for all qualified land. The Agricultural and Applied Economics Department and VCE calculated and distributed these values in cooperation with the Virginia Department of Forestry and the Virginia Department of Conservation and Recreation to the 92 counties and cities as participating jurisdictions for use by the Commissioner of the Revenue when setting local use values and the subsequent levy from qualified lands. This program provided data and documentation to jurisdictions to determine deferred land values of \$13,480,967,642 which is the difference between the fair market value and the value in use. This contributed to a reduction in total deferred real estate taxes for farm landowners of \$111,938,247 for fiscal year 2004, the most recent available statistics.

Adding Value to Virginia Cattle. Adding value to Virginia's beef cattle operations is critical to the sustainability of Virginia agriculture and rural communities. Adopting improved health, management, and marketing practices for Virginia feeder cattle will add value to the Commonwealth's second largest agricultural commodity. In 1997, Extension specialists

partnered with the Virginia Cattlemen's Association (VCA) to develop a program encouraging the use of scientifically-based cattle health and management procedures for feeder cattle. The Virginia Quality Assured (VQA) program is a cooperative effort with the VCA, Virginia Department of Agriculture and Consumer Services, the College of Veterinary Medicine, and VCE. Educational programs and marketing opportunities were offered in all locations with beef cattle producers. As a result, producers that enrolled and handled cattle in this manner were eligible to market their calves through the VQA certified feeder cattle program. In 2006, 2,966 calves were marketed through the VQA program. This represents a 20% increase over 2005. Producers received a \$38.23 premium per calf resulting in \$495,690 of additional income for Virginia beef producers. In the ten years of the VQA program, producers have marketed 62,000 head of feeder cattle resulting in \$ 1.85 million in value-added income. For farmers in Southwest Virginia who have seen income from burley tobacco drop by sixty-five percent, participation in the VQA feeder cattle program resulted in critically needed income. In three Southwest Virginia counties over 1,200 VQA certified cattle were sold in 2006 for average premiums estimated at \$39 per head.

Organic Milk Enterprise Development. Consumers are increasingly demanding organic dairy products and some producers are establishing or transitioning to organic milk production. Nationally, organic food production has grown 17 percent this past year and organic milk is offered by most supermarkets and national chains. Producers considering transitioning to organic operations need knowledge and assistance to succeed. Extension trained 35 agents and specialists from three states in organic dairy production. As a result, 25 VCE agents and specialists assisted producers with organic dairy enterprise development. Over the past twelve months, more than 200 individuals attended one or more Extension classes dealing with organic milk production. Sixty-one percent of producers surveyed indicated they gained valuable information to aide in decisions and actions made on their farm. Ninety percent of industry representatives surveyed reported the training helped them better serve those transitioning to shipping organic milk. Agents and specialists have worked directly with 50 producers and 12 of them established and/or transitioned to organic dairy farms.

Developing Markets for Pasture-Bred Beef. (see Multistate Extension description on page 91)
Virginia Beef Quality Assurance Program. (see Multistate Extension description on page 93)

Source of Funding: Hatch, Smith-Lever, state funds, local funds, grant funds

Scope of Impact: State, national

Underserved Audiences: Small producers

Animal Production Efficiency

Basic Research

Improving Poultry Nutrition. Growth regulation in animals is controlled by feed intake and nutrient absorption. Thus understanding the expression of genes involved in feed intake regulation and nutrient uptake could increase understanding of these physiological processes. Genetic selection for juvenile body weight or for growth on different diets has resulted in different lines of chickens. Chicken line A has been selected on a corn-soy based diet and line B has been selected on a wheat-based diet. These lines show different growth rates when fed corn-

soy or wheat-based diets. A long term selection experiment for body weight in chickens resulted in two lines of chickens, high weight select (HWS) and low weight select (LWS) that show a nine-fold difference in body weight at eight weeks of age. The HWS chickens are hyperphagic and the LWS chickens are hypophagic. These studies investigated differences in the expression of genes involved in regulating feed intake and nutrient uptake in these divergently selected lines of chickens. The results of these studies show selection for body weight or growth on different diets impacted the expression of the peptide transporter, PepT1 mRNA. PepT1 is a transporter protein that transports di- and tri-peptides but not tetra-peptides or free amino acids. In both cases the slower growing chicken line show elevated levels of PepT1 mRNA. In contrast, expression of selected amino acid and sugar transporters and the feed intake regulating hormones were not changed as a result of selection. These results suggest inclusion of small peptides in feed may improve growth. Understanding the molecular mechanism that controls uptake of nutrients required for optimal growth will result in reduced costs of feed and a reduction in the amount of nitrogen secreted as waste.

Implementation of a Novel Feeding Approach with Pregnant Thoroughbred Mares.

The nutrient requirements of pregnant mares increase with the length of gestation. Nutrients in the grass of the horse pastures may be low or deficient for meeting this increase in requirements. Pregnant mares are not fed fortified concentrates until close to foaling to prevent gaining too much weight. Excess body fat increases the chance of dystocia (difficulty foaling) and adversely affects foal survival rate. The typical feeding rate of a commercial concentrate for a pregnant mare is six to eight pounds per day, which, if given to mares in adequate body condition causes them to gain too much weight. If fed below the recommended feeding rate, not enough of the supplemental vitamins and minerals are supplied. Further, group fed mares have excessive loss of feed from dumping of feed pans and scatter of concentrate. Manufacturing a product larger in size that when dumped on the ground could easily be picked up by the horse would eliminate waste. Lack of any commercial feed that fits the needs of group fed gestating mares necessitated formulation of a novel concentrate by the Middleburg AREC. Feed is being manufactured by a local feed mill in extra large pellets with a low feeding rate and a high vitamin, mineral, and essential fatty acid content. Mares at the Middleburg AREC fed the specially formulated concentrate have weights in a healthy range and improved quality of hoof and coat. Waste of concentrate is minimal and low feeding rates have resulted in dramatically reduced feeding costs.

Enhancing Poultry and Turkey Feed. Adding feed grade enzymes to the diets of broilers and turkeys has increased digestibility of currently used feedstuffs. This research found an increase in body weight and feed efficiency when supplementing the starter diet of broilers with a mixture of feed grade enzymes to 16 days of age. A better understanding of the effects of supplementing feed grade enzymes on other host response variables such as endogenous enzyme activities and intestinal bacteria populations is needed to further develop their use. A study was conducted to investigate the effects of feed grade enzymes on growth, intestinal enzyme activities and intestinal microflora in broilers. Although there was no affect on body weight gain of broilers when supplementing usual feed grade enzymes, enzymes and age altered selected intestinal enzyme activity and bacterial populations in the lower intestinal tract. These alterations may indicate the response from feeding enzymes is increasing digestibility of currently used feedstuffs. The bird may adapt to the increased nutrients available by increasing selected enzymes to utilize these nutrients for maintenance and growth. Alterations in gut bacterial

populations indicate enzymes may play a role in influencing the development of a beneficial microbial population and could be an alternative to feed grade antibiotics.

Exploring Split Weaning Systems. Split-weaning systems can be accomplished with conservative use of expensive artificial milk-replacer (167 mL per pig per day for 11 days) with little or no detriment to weanling pig health and performance. This research has shown that nursery pen cleaning and disinfection between pig groups is essential when utilizing feeding programs without sub-therapeutic antibacterial feed additives. Use of the traditional by-product additive, spray-dried plasma protein, in phase I diets is not essential for adequate performance because pigs not given supplemental plasma display compensatory growth in later nursery phases. Removal of spray-dried animal plasma from weanling pig diets could save up to 40 cents per pig in feed costs or approximately \$400 per 1,000 weaning pigs placed on farms.

Crossbreeding for Health Persistence. This crossbreeding trial is designed to measure the effects of crossbreeding on growth and development of heifers, health, general fitness, fertility, and survival, as well as the traditional measures of productivity of cows under research conditions. This information is critical at a time when many dairy herds are practicing crossbreeding without the benefit of recent research results. This research found significant additive and maternal effects in Holsteins and Jerseys for dystocia and calf mortality. As a result, differences have been documented in growth rates of purebred Holstein and Holstein cross heifers over pure Jerseys, with no evidence of Holstein or Jersey maternal effects in weights at any age. The study of relationships of persistency of lactation with fitness traits revealed diseases affect persistency more strongly than persistent lactations affected incidence of disease. Diseases that affect persistency and occur early in lactation delay and reduce peak yield, leading to more persistent lactations. Diseases that affect persistency and occur late in lactation reduce late lactation yield, producing less persistent lactations. These relationships differ from some reports. However this is the first health-persistency study to use a measure of persistency independent of yield. Measures of persistency are used in breeding programs to reduce diseases. Persistency measures related to yield might reduce the incidence of disease by reducing milk yield.

Applied Research

Reducing Cow Replacement Costs. Dairy producers pay nearly 1,200 dollars net to replace a cow and 600 dollars to replace a female calf. In this study one-third of calves were afflicted by more than one incident of respiratory or digestive disease. These afflicted calves (150 per year in a 1,000-cow herd) cost an extra \$45 in rearing expenses due to a one and a half month delay in first calving and entry into the milking herd. Calves born in the spring and afflicted were delayed two months. Calves that survived and entered the milking herd at two years of age did not leave the herd sooner than other cows. Although there is a cost of delayed calving, once these heifers calve it is not necessary for managers to cull them or discriminate against them based on their prior illnesses, a savings of managerial time and \$1,200 replacement cost for each cow. If and when they calve, they will survive their first lactation relatively normally.

Understanding Laminitis in Horses. Laminitis is a painful and debilitating disease of the foot in horses and ponies with economic and animal welfare implications. By the time clinical signs are recognized, significant damage has occurred to the hooves and treatment options are limited. Research must be directed towards defining predisposing risk factors for laminitis so effective

countermeasures can be implemented. The most common form of this condition is pasture-associated laminitis or grass founder. However, specific risk factors for this form of the disease have not been investigated. This study addresses why some horses and ponies develop the disease and others kept under identical management conditions do not. It will determine why pasture-associated laminitis is more common at certain times of the year. This research found insulin resistance is a major predisposing condition for laminitis, and seasonal peaks in laminitis incidence in the spring and fall are related to the accumulation of nonstructural carbohydrates (NSC) in pasture forages. Intake of pasture with high NSC content may increase risk of laminitis through exacerbation of insulin resistance in animals with an insulin resistant phenotype. Avoiding factors that contribute to insulin resistance, such as obesity and consumption of diets high in NSC, may reduce the risk of developing laminitis.

Improving PLMS Criteria and Evaluating Nutritional Countermeasures Against Laminitis in Horses. The equine industry is concerned about a metabolic syndrome in horses and ponies that increases risk of disease. However, neither the existence of this syndrome nor the prevalence of component risk factors, such as obesity and insulin resistance, has been substantiated. This information is needed to design nutritional and lifestyle countermeasures that promote disease avoidance. Faculty and graduate students at VT collected morphometric and metabolic data from horses and ponies to define risk factors consistent with a metabolic syndrome that predict an increased risk of laminitis, a crippling disease of the foot. An epidemiological study determined the prevalence and risk factors for obesity in horses, and the prevalence of insulin resistance and disturbance to lipid metabolism. These studies examined the relationships between adiposity, insulin resistance, and inflammation, and evaluated the effects of nutritional and lifestyle interventions for mitigation of obesity and associated morbidities. A pre-laminitic metabolic profile in apparently healthy ponies was defined on the basis of high body condition score (obesity), plasma triglyceride concentrations, and a proxy measure of insulin resistance. Meeting more than three of these criteria identified animals prone to laminitis, with a total predictive power of 78 percent. In a random sample of 300 mature horses, approximately 20 percent were classified as obese and 10 percent fit the diagnostic criteria for pre-laminitic metabolic syndrome (PLMS). More than 50 percent of the horses were sedentary, suggesting lack of physical activity may cause obesity. The PLMS identified horses and ponies required special management for avoidance of laminitis, such as avoiding high dietary sugar and starch that exacerbates insulin resistance.

Reproductive Technologies in Small Ruminants. The VSU-ARS conducted research to improve the reproductive efficiency of goat and sheep. In 2006, experiments evaluated the estrus response and timing of ovulation in goats and sheep treated with the reproductive hormone, PG600 as a source of gonadotropin following progesterone administration. Results from this experiment showed no effect of species on the incidence of estrus within the 96 h. However, time to first estrus after gonadotropin treatment was shorter in does than ewes. The induction of ovulation in the ewes was also dose-dependent with all ewes receiving standard treatment ovulating while less than half ovulated when they received the half dose. Results from this experiment suggest a species specific response to PG600.

Extension Programs

On-line Cow-Calf Management Course and Cow Camp. Many new beef producers enter the industry annually. Most new producers have little formal training in animal science or beef production. Increasing the basic knowledge of Virginia beef producers is needed to enhance competitiveness of the industry. In addition, exposure to a formalized beef production education program enhances visibility for VCE and creates a community of lifelong learners. Extension created the Virginia Cow-Calf Management Course to teach beef cattle production methods and skills to beginning to mid-level beef producers. The course is a distance learning program with an optional two day hands-on workshop called VT Cow Camp. In 2006, 53 producers completed the management course and 39 participants attended Cow Camp. Since 1999, 800 producers have completed this course. Based on follow-up surveys the gross value of increased beef production as a result of this program is approximately \$1.5 to \$1.8 million, annually.

Reducing Risks in Equine Enterprises. Virginia was the 12th largest equine state in 2005, with 239,000 horses. According to the Virginia Agricultural Statistics Service, equine sales provided 100 million in 2002 in cash receipts. As the horse industry expands, education for equine owners is needed on successfully operating a businesses including environmental sustainability. Extension organized and conducted education on managing the risks of equine enterprises. Topics included liability law, insurance, barn safety, agricultural stewardship, business planning, farm labor, and taxation. Eighty equine business owners participated in the workshops from Virginia and surrounding states. The conference evaluation revealed 94 percent of attendees considered the information useful to very useful. The majority of participants planned to implement management tools learned, develop business plans (84 percent), protect water quality (62 percent), review liability issues (98 percent), review barn safety protocol (94 percent), review insurance policies (86 percent), develop labor records (57 percent), and review tax issues (90 percent).

Improved Livestock Facilities and Breeding Stock. Beef cattle represent the primary agricultural enterprise in Southwest Virginia. Bland, Dickenson, Grayson, Lee, Russell, Scott, Smyth, Tazewell, Washington, and Wise counties have approximately 5,500 herds with 279,000 cows and calves. To remain competitive and sustainable, producers must meet health and genetic standards demanded by the industry. Lack of facilities and genetic merit of breeding animals restrict many procedures from meeting these standards. Extension organized a program. Grants of \$913,500 from the Virginia Tobacco Commission were used for cost-share improvements in breeding stock and livestock handling facilities. Extension agents assisted producers in improving herd genetics and cattle handling facilities. Three hundred twenty beef producers improved their herd bulls, heifers, and handling facilities. Livestock sales in 2006 resulting from this program netted producers an additional \$76,695 from the sale of 1,813 feeder calves.

Reducing Mastitis and Improving Milk Quality. Research shows elevated somatic cell counts cost dairymen \$200 per cow per year in reduced milk production and treatment. Elevated somatic cells counts coupled with high bacteria counts represent a further loss of income from missed quality milk premiums. Herds on the Dairy Herd Improvement test in Virginia posted an average cell count of 340,000, 70 percent over the recommended benchmark of 200,000. Extension offered a mastitis and milking management clinic in cooperation with local industry on managed milking programs and mastitis prevention. In addition, a milk quality field study to

monitor gains in milk quality was conducted. Forty-eight dairy producers took part in the mastitis and milking management clinic representing 24 farms. Eighty percent of the surveyed producers reported they would implement the practices on their home farm.

Beef for the Future - Making the Grade. Beef cattle are the largest agricultural enterprise in Southwest Virginia. Cattle producers have requested additional training in nutrition, genetics, and marketing. The Beef for the Future training provided by VCE agents in Washington and Russell Counties developed educational sessions for cattlemen on animal husbandry. The Beef for the Future Course provided strategies for producers to incorporate into current operations. Of the course participants surveyed, 88 percent stated they could do a better job selecting a bull by using performance data and they expected progeny difference. Ninety-six percent stated they had a better understanding of how forage testing and feed analysis could be used to improve animal nutrition, and 96 percent realized that livestock marketing groups provide producers valuable services in the marketplace. All of the participants responding realize crossbreeding is an important tool that adds pounds to calves and 100 percent know calf birth weight and heifer pelvic size are the two main factors that influence calving difficulty.

Changing Milk Practices Improve Yield and Value. Producers have minimal control over the price they are paid for milk. In years, like 2006, with very low milk prices producers struggle to find ways to increase profit margins. Extension held milk quality seminars and workshops to share research and emphasize practices that enhance milk quality. News articles including a Milk Quality Forum were featured on the cover of the Virginia Dairy Magazine. In the last four years, 600 producers and industry representatives attended milk quality seminars. In 2006, fifteen producers reported they implemented changes that improved milk quality and increased quality premiums as a result of these efforts. One producer said he has significantly reduced preliminary incubation and somatic cell counts by changing the order and attention paid to prepare cows in the parlor. These changes increased quality premiums, net income, and milk production.

Agriculture Diversification Using Freshwater Shrimp as an Alternative Enterprise in Tobacco Growing Regions. (see Multistate Extension description on page 92)

Beef Cattle Process Verification and Marketing. (see Multistate Extension description on page 94)

Meat Goat Quality Assurance Program. (see Multistate Extension description on page 93)

National Animal Identification. (see Multistate Extension description on page 93)

Professional Dairy Heifer Grower's Association. (see Multistate Extension description on page 93)

Controlling Invasive Species in Pastures on Reclaimed Coal-Mined Land. (see Integrated Research and Extension description on page 108)

Small Ruminant Parasite Control. (see Integrated Research and Extension description on page 108)

Source of Funding: Hatch, Smith-lever, state funds, local funds, grant funds

Scope of Impact: State and national

Underserved Audiences: Small producers, equine owners, beginning farmers

Aquaculture

Applied Research

Advancing Virginia Fish and Shellfish Technologies. The U.S. is the world's leading importer of marine shrimp. Shrimp imports contributed significantly to the U.S. trade deficit. Shrimp aquaculture in the U.S is limited by the high cost of coastal land and cold winters. Recently U.S. researchers developed technology to produce marine shrimp in enclosed, recirculating aquaculture systems (RAS). However, the commercial feasibility of shrimp production in RAS is limited by high capital and the operating costs of these systems. One factor that limits the profit potential of indoor shrimp production systems is low culture densities. The low production rates achieved to date in shrimp recirculation systems is in part due to marine shrimp being benthic creatures that do not use the water column effectively. Another factor affecting productivity of these systems is that shrimp have an inefficient digestive system and do not efficiently utilize pelleted feeds. To address these problems, VT's fish and shellfish technologies research team worked with Blue Ridge Aquaculture to design a pilot shrimp production facility to test technologies to raise the carrying capacity of shrimp recirculating systems to commercially viable densities and test the feasibility of reducing feed costs by using fish wastes from a tilapia recirculating facility as a nutrient source for shrimp production. Studies will test the feasibility of adding additional horizontal substrates to shrimp production systems to improve utilization of the water column and allow for higher stocking rates. In addition, research will determine if tilapia wastes can be used as a supplemental feed to reduce feed costs. The team is also testing the feasibility of producing marine shrimp larvae in a 100 percent closed recirculating larval rearing system using artificial seawater. If successful, inland shrimp hatcheries can be set up nearly anywhere, providing a reliable supply of specific pathogen free postlarvae. By increasing production per unit area and reducing feed costs, the cost of producing shrimp should be dramatically reduced, and lead to commercially viable shrimp RAS.

Extension Programs

Improving Productivity of Farm Ponds for Aquaculture. Many Virginians have farm ponds that need management for use as a recreational fishery and alternative uses such as small scale aquaculture. Extension specialists at VSU cooperating with agents held workshops in Southside Virginia on pond management. In 2006, four workshops provided training on water quality and pond improvement. The water from 100 ponds was tested and results given to clients with recommendations improving water quality. Information on cage culture of catfish or trout was also provided. The workshops resulted in 50 percent of the attendees taking steps to improve the water quality of their pond and eight follow up visits to analyze ponds for recreational and aquaculture uses. Workshop attendees also indicated they would try cage culture fish production in their ponds.

Aquatic Weed Management Education. Virginia has more than 70,000 ponds of various sizes. Management costs reported for some storm drainage ponds exceeds \$20,000 per acre. Education on prevention of aquatic weeds related to new Environmental Protection Agency (EPA) restrictions on the use of aquatic herbicides is lacking. The misuse of chemicals for aquatic weed control is an environmental issue and concerns about using triploid grass carp for control of succulent vegetation also exists. VSU conducted aquatic weed certification training for Extension agents, pond owners, and land managers to encourage successful, environmentally

sound, and economic weed control. Weed prevention was stressed and biological solutions were recommended for long-term control. Over 200 individuals gained aquatic environment management guidance for long term weed prevention. The program created an annual estimated savings of more than \$300 per acre for a total pond area of more than 1,000 managed acres. Grass carp stockings were also successful in controlling duckweed and other weeds in more than 40 acres that in the past received constant chemical control.

Source of Funding: Hatch, Smith-Lever, state funds, local funds, grant funds

Scope of Impact: State and national

Underserved Audiences: Small producers, former tobacco growers

Biobased Products and Processing

Basic Research

New Approaches to Bioenergy Production. Depletion of natural resources, especially fossil fuels, and the resulting accumulation of atmospheric carbon dioxide, endangers human sustainability. The transition from a fossil carbon-based economy to a sustainable biomass carbon-based economy will be an important endeavor in the 21st century. The main technological challenges for biological conversion from recalcitrant lignocellulose, the most abundant renewable biomass, to fermentable sugars are ineffective lignocellulose pretreatment and high prices of cellulose. This research of cellulosic ethanol focused on developing cost-effective lignocellulose fractionation technology, generating higher specific activity cellulase by biomolecular engineering, and understanding and characterizing the relationship between cellulose characteristics and cellulase activity. This understanding of the relationship between solid cellulose characteristics and cellulase activities could lead to a breakthrough in cellulase engineering. Hydrogen will become the future energy carrier to replace gasoline and ethanol. The research team invented a new technology that converts starch and water to hydrogen and carbon dioxide using a group of enzymes at mild reaction conditions. With technology improvements, this technology could support mobile applications.

Biodiesel Production. Biodiesel produced from vegetable oil, fat, or other waste oil resources can sustain resources, lessen emissions, and offer biodegradability. Biodiesel production will expand in the next few years. However, the high feedstock cost, high manufacturing cost, and the need to dispose of a waste byproduct glycerol limits its economic feasibility. There is a need to improve the production process and find alternative methods for disposal of glycerol. In the current biodiesel production processes, strong base or acid are used as catalysts. The associated problems include glycerol recovery, waste treatment and the energy intensive nature of the process. Bio-catalysis by lipase could produce the same products as chemical-catalysis process without the associated problems mentioned above. The technology could be used for transesterification of feedstocks from low cost waste oil resources, which could offset the high feedstock problem of biodiesel production. However, two technical obstacles, the slow reaction rate and high cost of the catalyst, hinder the commercial application. In the provisional patent application, a new lipase-based biodiesel production process that aims to overcome those obstacles was proposed. The new process features production of biodiesel and lipase simultaneously in a biphasic system, where glycerol produced from transesterification process is used as the carbon source to produce lipase in the aqueous phase. Lipase produced by the

microorganism in the aqueous phase supplies the catalysts for the transesterification process in the oil phase. The reaction rate is expected to be much faster than the normal lipase-catalyzed transesterification process.

Extraction of Transgenic Proteins and Biopolymers. Recovering valuable proteins from biomass feedstock before conversion to bioenergy may be the linchpin for economical competitiveness of biofuel. Proteins are valuable components of biomass, but are not used in the biofuel conversion processes. There is a great potential for generating additional revenue from plant proteins before their conversion to biofuel. This study examines the feasibility of using polyelectrolyte precipitation to recover protein from tobacco leaves. Beta-glucuronidase (GUS) was used as a model acidic protein. The research showed polyelectrolyte precipitation compares with anion exchange chromatography in separating GUS from tobacco extract. This will potentially lead to more extensive use of this technique in recovering proteins from biomass feedstock. These findings could have an enormous economic impact as energy production from biomass is not yet economical and needs additional revenue to balance the high production cost. This research could provide the technology for recovering valuable native plant proteins for biofuel to be more economically competitive.

Developing Polymers. The synthetic polymers industry represents \$200 billion of the U.S. economy each year. These polymers also comprise about 11 percent of landfill composition. With petroleum prices rising and environmental effects of non-degradable materials a concern, there is a need to develop polymers from other sources such as agricultural and biological feedstocks. For instance, there are about 2.5 billion pounds of poultry feathers discarded from poultry processing in the U.S. each year. These feathers are usually disposed of at a cost to the poultry industry and passed on to consumers. In addition, polymers can be made from biological feedstocks through microbial conversion of the feed. The current disposal method involves converting as much of the feathers as possible into feather meal, a low nutritional value animal feed sold at a loss. The rest is either land filled or burned. The former is not cost effective and the latter is neither cost effective nor environmentally friendly. This research seeks to use feathers, composed entirely of the structural protein keratin, in new and novel ways. The research showed that feathers can be easily converted into a bio-based, biodegradable plastic; or polymer with exceptional properties. The polymer can be made at a competitive cost with traditional synthetic, petroleum-based polymers. The polymer can be sold at a profit by the poultry industry, eliminating disposal costs and generating a new revenue stream.

Applied Research

Biofuel Production from Agricultural Feedstocks. Biomass conversion to ethanol has been promoted as a sustainable energy supply to reduce green house gas emissions, boost rural economies, and reduce the country's dependence on foreign oil. But there are no commercial facilities featuring enzymatic hydrolysis of cellulose due to the large size, and capital cost required for a positive cash flow using most feedstocks. Investors are reluctant to invest large amounts of capital on first-of-a-kind technology without substantial risk mitigation. Research results prove that paper sludge conversion likely represents the lowest cost opportunity to realize a commercial facility with positive cash flow, in essence, a pilot plant that one could not afford to shut down. In particular, the total investment of less than \$4 million estimated cost is from a combination of the large negative feedstock cost, small scale, a relatively simple process, and

utilization of preexisting infrastructure. Paper sludge conversion to ethanol appears to be uniquely well-suited to serve as a point-of-entry and proving ground for nascent industries based on enzymatic hydrolysis of cellulosic biomass.

Exploring Canola as an Alternative Crop. Agricultural producers need options to diversify production, enhance the agricultural economy through value-added products, and develop a self-supporting and sustainable farming system. Local canola plots were established by VSU to evaluate its potential as an alternative crop, a source of bio-fuels, and as a rotational option in current production systems. Canola has proven to be a viable cropping alternative, a source of fuel, and a wildlife friendly option for hunters and game enthusiasts. It provides producers with options to diversify their cropping system and market their resources in non-traditional ways such as hunting and wildlife observation.

Extension Programs

Bio-Energy Research Impacts Economic Development. (see Integrated Research and Extension description on page 118)

Source of Funding: Hatch, Smith-Lever, state funds, local funds, grant funds

Scope of Impact: State, national, and international

Underserved Audiences: None

Biotechnology

Basic Research

Agricultural Applications of Plant and Microbial Biochemistry. Plants utilize the sun's energy to synthesize glucose for fuel for living organisms. Glucose and other sugars are also perceived by organisms through specific signal transduction pathways that monitors the fuel status within the cell. This research identified a gene from plants required for normal glucose sensing. This study found this gene produces a protein that forms a putative glucose-sensing complex containing other known signaling proteins. By investigating the function of this gene researchers will discern how it functions in plants and whether manipulation of the gene can impact overall plant growth. As plant biomass becomes an important strategy for agricultural crops and biofuels, it is important to understand the molecular genetic controls that plants and other organisms use in glucose-sensing.

Manipulating the Properties of Wood. The U.S. forest products industry employs over 1 million people and produces thousands of paper, fiberboard, lumber, and engineered wood products with an estimated value, in 2004, of \$243 billion in U.S. sales. Xylem is the wood-forming tissue in plants and the raw material for the forest products industry. The structure, arrangement, and relative proportions of the xylem cell types, determine the physical properties of woods and their suitability for specific applications. Little is known about the genetic mechanisms that regulate wood formation. This research uses Arabidopsis and poplar to study wood formation. Arabidopsis is a good choice for these studies because its genome has been fully sequenced and several unique resources have been developed for facilitating rapid characterization of genetic mechanisms. An Arabidopsis gene can be used to reduce the length

and number of xylem cells. By investigating additional xylem genes from poplar, scientists should be able to manipulate economically important aspects of wood structure.

Exploring Metabolic Pathways for Production of Cystine and Methionine. The free-living soil bacterium *Azotobacter vinelandii* takes up a variety of sulfur-containing compounds, reduces the sulfur atom, and incorporates it into the amino acids cysteine and methionine. These two amino acids are needed for production of nitrogenase, the enzyme that reduces atmospheric dinitrogen gas to ammonia, an essential building block of amino acids. Amino acids are used for production of proteins and other critical biomolecules. Despite the key roles played by sulfur-containing compounds, the reactions by which these compounds are taken up and converted to cysteine and methionine in *A. vinelandii* are incompletely defined. This research will define these reaction pathways, and contribute to understanding the global cycles for sulfur and nitrogen. This work is relevant to better understand bacterial physiology and crop production, since fixed sources of nitrogen are generally limiting for plant growth. This research uses bioinformatics, biochemical, and genetic approaches to define the metabolic pathways needed for production of cysteine and methionine from sulfur-containing compounds found in the environment.

Agricultural Applications of Animal Biochemistry. Animals and populations vary genetically in their capacity to respond to environmental challenges, such as toxicants. This variation affects animals' fitness or well-being in a contaminated environment and where the mechanism of resistance is known, it may be possible to select strategies to heighten resistance to toxicants in various populations, including humans. Major genes were identified that affect liver function, although polygenic variation for resistance to toxicants has also been reported. Using mice as a model species, this research program tests whether animals vary genetically in their response in liver activity to two types of challenges: an inducer found in Brassica vegetables known to heighten the activity of a family of liver enzymes beneficial for liver detoxification and a natural environmental toxicant associated with the fungal infection of tall fescue swards. In two experiments, a polymorphic strain of mice was screened for variation in liver activity in response to these environmental challenges. In the first experiment, mice were dosed for various lengths of time with these two challenges, or a control treatment, and then killed and their livers collected. In the second experiment, mice were dosed with the same amount of substrate as in the first experiment, or twice that amount, for 11 days; the control treatment was also used. Bioassay procedures were used to assess enzyme activity levels (quinone reductase, UDP glucuronosyl transferase, GSH-transferase and, possibly, a cytochrome-p450). Quantitative real-time polymerase chain reaction was used to assess the expression of 30 candidate loci of interest. The laboratory analyses are currently underway with final results not yet available. However, based on these forthcoming results, consideration will be given to develop resource populations for toxicogenomic research. This resource should allow scientists to assess the use of major genes and polygenic variation in selection programs to enhance tolerance to environmental toxins.

Breeding Genetics. Major genes affecting animal performance, including fitness and disease resistance, were identified and have tremendous potential to affect selection programs. As part of an international research collaborative, researchers are assessing the potential benefits and risks of incorporating these major genes into breeding programs. One component involves devising strategies to incorporate animal genotypes at the prion protein (PrP) locus, which affects their resistance to scrapie, into breeding decisions. Focusing strictly on PrP genotypes may be risky if

avored alleles are antagonistic to other economically important traits or are sufficiently rare that their selection increases inbreeding and reduces genetic variability. Commercial sheep populations typical of those participating in cooperative breeding schemes in the United Kingdom were simulated to investigate the effect of selection on PrP genotypes on PrP allele frequencies, inbreeding, and genetic gain in a performance trait under selection. Different PrP selection strategies were modeled including selection against the VRQ allele and in favor of the ARR allele. Animals carrying the VRQ allele are most susceptible to scrapie, while those carrying the ARR allele are more resistant. Animals were selected on their PrP genotype before selection on the performance trait, resulting in a weaker intensity of selection on performance under PrP selection. This led to a reduction in rates of genetic gain and inbreeding when applying PrP selection. Over 15 years of selection in favor of the ARR allele led to loss of up to four years of genetic gain when ARR allele frequency was low. Most loss in gain occurred within the first five years. However, assuming realistic initial PrP frequencies, selection against VRQ genotypes had little impact on gain for performance and on inbreeding. This study indicates that eradication of the VRQ allele or fixation of the ARR allele within 15 years of selection was possible only with PrP selection targeting all breeding animals. Selection programs based on PrP genotypes are being implemented internationally for increasing resistance to scrapie. The knowledge obtained from this research is key in the development of these breeding strategies.

Sources of Funding: Hatch, grant funds

Scope of Impact: State, national, and international

Underserved audiences: None

Diversified/Alternative Agriculture

Basic Research

Development of Specialty Beans. Soybean is Virginia's largest row crop with production of 15 million bushels in 2005 that contributed over 85 million dollars to the economy. However, Virginia soybean growers suffer from price decline, from \$7.67 per bushel in 2003 to \$5.50 per bushel in 2005 from increased worldwide competition. Most Virginia soybeans were manufactured for animal feed and oil production at low prices. In addition, the average yield of Virginia soybean is approximately 13 bushels less than the national average per acre. This means the production return for soybean growers is only 70 percent of domestic competitors. Efforts are required to develop value-added soybean that could grow in Virginia to improve economic return for Virginia soybean producers. Soybean contains the highest concentration of isoflavones among agricultural commodities and significant amounts of natural antioxidants. Both soy isoflavones and antioxidants are highly prominent ingredients for health promoting functional food or nutraceutical preparations. These natural and beneficial ingredients are promising value-added factors for soybean and soy-based products. This research identifies Virginia soybean cultivars with high levels of isoflavones and/or natural antioxidants and developing technologies for purifying those ingredients from soybeans. This project will develop novel value-added soybean varieties through the integration of field and laboratory work including DNA fingerprinting and genomics. Identification, segregation, and marketing of value-added soybean with consistently high beneficial components could be worth up to \$0.2/bushel, with 10 percent of Virginia soybean production from value-added cultivars and a potential total impact of \$300,000 annually.

Enhancing Economic Return with New Soybean Varieties. VSU scientists are developing varieties of vegetable soybeans suitable to Virginia and the Mid-Atlantic region. These efforts will help farmers diversify farm operations and increase profits by meeting the increased domestic and international market demand for fresh and frozen vegetables. Despite the demand for vegetable soybeans, there are limited numbers of suitable cultivars for planting. In 2006, two new soybean cultivars had higher yield than nine other genotypes in Petersburg and Surry. A research article on the genetic variation of green pod yield and quality among soybean genotypes from this research has been published in the Journal of Crop Improvement.

Tepary Bean Traits. A new project on biological nitrogen fixation and seed composition traits of tepary bean is underway at VSU-ARS. The research will identify bradyrhizobial bacteria suitable for efficient biological N fixation with tepary bean and develop tepary bean as a summer legume cover crop to meet N needs of succeeding wheat crop. Availability of a short-duration legume crop produced in rotation with winter wheat could enhance wheat farmers' income, provide an environment-friendly source for organic wheat production by providing biologically-fixed N, diversify agriculture, and help reduce pollution of surface and underground water. The genetics of tepary bean will be studied using Amplified Fragment Length Polymorphism (AFLP) markers to lay a foundation for future breeding research. Experiments will also be conducted to study composition of tepary bean seeds to evaluate for use as a food and feed crop.

Applied Research

Optimizing Strawberry Productivity. Local and regional strawberry nursery plant production has expanded this industry to cooler climates. Traditionally, fresh dug plants were the only available plant type. They originated from nurseries servicing milder locations of the country with digging and delivery dates out of sync with Virginia's planting dates. As a result of the growing industry in the southeast, many east coast and a few western nurseries now provide plug and freshly dug plants. Environmental conditions vary greatly between these locations with unknown consequences on productivity of the plant. A collaboration formed in 2004 between the horticulture program at North Carolina State University and the small fruits program at the VT Southern Piedmont AREC. Trials were established to investigate the effect of nursery source on yield and productivity of the standard commercial cultivar Chandler. Nursery sources in North Carolina, Virginia, California, Colorado and Canada contributed material for testing. Differences in vegetative growth and yield over the two years of research identified exceptional sources for use by growers in the Southern Piedmont of Virginia and Coastal Plain of North Carolina. An increase of 22 percent in fruit production and 15 percent in fruit size was found between the best and poorest performing sources. In terms of profitability, this translates to an approximate increase of \$6,000 in gross returns per acre.

Evaluation of Ground Wood Chips as a Substitute for Pine Bark and Peat Moss in Container Plants. Peat moss and softwood bark have provided the primary base for most greenhouse and nursery substrates for 30 years. These materials are excellent substrates but their future availability is uncertain. The environmental concerns of mining peat moss and the increasing costs of this substrate could limit availability and use. Also, the availability of softwood bark of consistent quality is often a problem from the variety of methods used to harvest, process, and store bark. In addition, potential movement of the lumber and paper industry to other countries or the practice of burning bark for energy could limit the supply of

softwood bark. This research investigated the potential use of ground pine trees as a container substrate and has shown nursery and greenhouse crops grow well in freshly ground loblolly pine trees. If ground fine enough the pine chips hold ample water for growth, possess excellent aeration and water drainage, and do not contain toxic nutrient or salt levels. Ground pine tree chips can be purchased for \$5 per cubic yard, well below the cost of pine bark and peat moss. This would reduce plant production costs and increase grower profits. Pine trees are renewable, reasonably priced, geographically widespread, and offer an economical alternative to peat and pine bark.

Extension Programs

Agriculture Diversification using Freshwater Shrimp as an Alternative Enterprise in Tobacco Growing Regions. (see Multistate Extension description on page 92)

Forum for Rural Innovation. (see Multistate Extension description on page 91)

Regional Horticulture Conference Reaches Appalachian Growers. (see Multistate Extension description on page 91)

Regional Viticulture In-service. (see Multistate Extension description on page 94)

Adding Value to Woodlands with American Ginseng. (see Integrated Research and Extension description on page 107)

Baby Lima Beans as Alternative Crop. (see Integrated Research and Extension description on page 107)

New Business Options with Plants. (see Integrated Research and Extension description on page 102)

Onions Offer a Source of Revenue for Southwest Virginia Producers. (see Integrated Research and Extension description on page 104)

Production of Fresh Cut Flowers in Virginia. (see Integrated Research and Extension description on page 107)

Organic Vegetable Production. (see Integrated Research and Extension description on page 108)

Source of Funding: Hatch, Smith-Lever, state funds, local funds, grant funds

Scope of Impact: State and Mid-Atlantic region

Underserved Audiences: Small producers, limited-resource producers

Invasive Species

Basic Research

Cross-Species Movement of RNA and Parasitic Plants. An intriguing new paradigm in plant science is that systemically-mobile messenger RNAs (mRNAs) play a role in coordinating development. Specific mRNAs move through the plant's vascular system, relaying information to distant tissues. However, despite its potential significance for plant growth regulation, mRNA trafficking remains poorly understood and challenging to study. Dodders are parasitic plants that obtain resources by drawing from the vascular system of a host plant, and have direct connections to host cells. Because dodder forms a perfect graft between itself and its host, this research uses this parasite, normally considered an invasive weed, as a new tool for understanding mobile mRNA. This research shows certain mRNAs move across species boundaries from a tomato host to the plant parasite, lespedeza dodder (*Cuscuta pentagona*). The

results point to a new level of interspecies communication, and raise questions about the ability of parasites to recognize, use, and respond to mRNAs acquired from their hosts. The work provides new insight into parasitism and a new approach to studying mobile mRNA.

Applied Research

Herbicide-Resistant Weeds. The rise of herbicide-resistant weed populations contributes to increased herbicide use and may limit use of environmentally favorable chemicals. Understanding how weeds develop resistance improves scientist's ability to delay resistance development and deal effectively with resistant populations. Research was conducted to evaluate the molecular basis for herbicide resistance in several biotypes of smooth pigweed. Herbicide target site genes were sequenced from eleven populations of smooth pigweed. Ten of these populations had mutations previously identified as resistance-conferring in other weeds. However, one population had a mutation not previously reported in weeds and this mutation was used to generate herbicide-resistant plants as proof that it caused the resistance. This work resulted in two scientific publications and one patent application.

Source of Funds: Hatch, grant funds

Scope of Impact: State specific

Underserved Audiences: None

Niche Markets

Basic Research

Breeding Soybeans for Specialty Markets. Specialty soybeans can receive price premiums of \$0.05 to \$1.00 a bushel. Growing specialty soybeans is promising because of proximity to ports allows export of whole soybeans for food, they can raise agricultural profitability, including reduced use of pesticides, fossil fuels and fertilizers, they can increase soil conservation, and are an ideal cropping system. Agricultural profitability and sustainability are increased with development of new crop varieties resistant to environmental stress and emerging diseases, and by raising per-acre productivity through increased yields and herbicide resistance. This soybean breeding program selects high-yielding soybeans through extensive testing in diverse locations within Virginia. Development of herbicide resistant soybean and refinement of crop management protocols and crop agro-ecosystems sustain environmental specialty soybeans grown in Virginia do not compete with conventional soybeans grown more cheaply in the Midwest. The Crop and Soil Environmental Science Department's soybean breeding program develops new varieties of specialty soybeans for Virginia and the region. Lines or varieties of soybeans were released or are being developed with high sucrose, higher protein, low linolenic fatty acid, low indigestible carbohydrates, and those for food with enhanced flavor and quality. This includes study of the genetics of special traits, and many years of selection and testing through conventional plant breeding. Soybean acreage in food-grade soybeans is increasing in Virginia. Adapted low linolenic fatty acid varieties will be released in the next three years.

Dietary Capsaicin Potentiation of Intestinal Immunity in Chickens. Intestinal diseases present a variety of problems for the poultry industry, including economic loss, impact on bird health or production, or human health concerns, and understanding immune mechanisms of the gut related to these pathogens is limited. This research evaluated non-antibiotic alternatives for

intestinal disease resistance in commercial broiler chickens and their effect on intestinal tissue integrity and immune response. Dietary administration of a natural plant product, capsaicin, increased resistance to Salmonella in broiler chickens, with no negative impact on live performance. Other experiments provided evidence of mast cells responding to coccidia in broiler chickens, which aids in characterizing the complex intestinal response to this disease. Live performance and intestinal responses showed a live vaccine was effective at inducing intestinal immunity to coccidia, and genetic selection could also play a role in the response of broilers to this disease. This research contributes to understanding the host-pathogen interaction and role of mucosal immunity to help develop vaccines and genetic selection to control coccidiosis. This research also provided evidence for potential alternatives to antibiotics in feeding programs in chickens, which addresses needs of niche market poultry producers as well as increasing public concern with antibiotic resistant microorganisms and impending removal of antibiotics from food animal production.

Applied Research

Forage Utilization by Different Classes of Cattle. In Virginia, 145 out of every 100,000 people die of coronary heart disease every year. Limiting how much saturated and trans-fats is consumed lowers the risk of coronary heart disease. Foods with higher conjugated linoleic acids (CLA) and omega-3 fatty acids content reduce heart disease. The determination of forage intake is critical for the correct determination of animal and pasture productivity. This research tests new feeding strategies combining better forages and supplements that enhance productivity of pastures and animals, provide an alternative niche market to their products, and decrease labor costs for beef producers. Infrequent supplementation decreases labor requirements and maintains animal health and performance. Grass finished beef cattle provide a high value niche market for beef producers. Grass-fed beef is healthier from leanness and higher CLA and omega-3 fatty acids content. CLA present in beef of pasture-finished cattle may serve a functional food role in the diet with benefits for consumers and beef producers alike.

Extension Programs

Southwest Virginia Value-Added Beef Initiative. The economics of traditional production of farm commodities in Southwest Virginia has become increasingly challenging with drastic reductions in tobacco, increasing competition, and production costs. Value-added products provide possible alternatives, yet clear information is needed on the costs and benefits of these alternatives so a conference on value-added beef opportunities was proposed for Southwest Virginia. By request VCE worked with Grayson County beef producers and other partners to apply for a USDA grant to conduct a feasibility study for a value added beef industry in Southwest Virginia. Extension then led efforts to organize a committee to assess development of a collaborative value added beef effort with a local branded product to be marketed and sold by a regional grocery store chain. With Grayson LandCare and others, \$23,000 in USDA grant funds was secured for a feasibility study of value added beef slaughter, processing, and marketing needs. The study will be completed in spring 2007. Two hundred people attended the Value-Added Beef Conference and post-event surveys revealed increases in knowledge related to value-added beef opportunities and technical skills for 90 percent of respondents. As a result, the Value-Added Beef Exploratory Committee will develop a regional organization and pilot a local, branded, value added beef product with production potential of 200,000 pounds per year.

Direct Marketing Program for Limited-Resource Producers. Small-scale vegetable producers find it difficult to compete with larger farm operations. With the high cost of production and low commodity prices received at wholesale markets, the profit margin for these producers is low. Many small-scale producers have mastered the production aspects of their crops but lack the know-how and skills to develop sound marketing plans. VSU's Small Farm Outreach Program implemented a community outreach and risk management education program funded by the Risk Management Agency, USDA, in 24 Virginia counties. Educational programs and training helped limited-resource producers improve farm profitability, promote sustainability, and enhance on-farm risk management skills. This program trained and assisted producers in identifying and establishing direct markets for their products. In August 2006, a two-day direct marketing educational tour was conducted. Forty current and potential small-scale producers traveled by bus to the Shenandoah Valley Region of Virginia to visit diverse farm operations using direct marketing strategies to increase farm profits. As a result, twenty producers who participated in the tour adopted one or more of the marketing strategies identified. For example, one limited-resource producer in Southeast Virginia incorporated value-added products, such as, smoked meats and canned goods into to his operation resulting in the doubling of sales in one year and projected sales of more than \$10,000 for 2007.

Allegheny Highlands Agriculture Center. (see Multistate Extension description on page 92)

Teff Grain as a Viable Forage and Cash Crop. (see Integrated Research and Extension description on page 103)

Source of Funding: Hatch, Smith-Lever, state funds, local funds, grant funds

Scope of Impact: State and regional

Underserved Audiences: Small and limited-resource producers, tobacco growers

Plant Health

Basic Research

Understanding Plant Diseases through Genomics. Agricultural productivity is significantly and consistently reduced by plant pathogens, with annual worldwide losses estimated at tens of billions of dollars. One promising approach for reducing disease is to develop plants with improved genetic resistance to disease. This requires a comprehensive understanding of the genes and molecular pathways that regulate the outcome of plant-pathogen interactions. Little is known about how plants respond at the molecular level under conditions where the pathogen can evade the immune system and successfully colonize the plant. VT scientists initiated a functional genomics project to identify plant susceptibility genes that contribute to successful pathogen infection. Experiments focus on the interaction between the model plant *Arabidopsis* and its natural downy mildew pathogen *Hyaloperonospora parasitica*. Using a variety of approaches 17 *Arabidopsis* genes associated with successful infection by *H. parasitica* were selected and developed mutant lines containing non-functional copies of these genes. If these genes are important for successful pathogen infection, mutations in these genes would impair the ability of the pathogen to cause disease. Initial characterization of these mutants revealed two genes that fulfill this criterion. The long-term goal is to identify plant genes exploited by pathogens in diverse plant species including crops, and to design alterations where these plant genes no longer work for the pathogen's benefit, and provide passive resistance.

Bacterial Disease. Bacterial plant pathogens cause substantial yearly losses in yield and quality of tomato on the Eastern Shore of Virginia and tomato and many other crops around the world. No efficient and safe control of bacterial diseases exists since bacteria readily adapt to pesticides like copper or antibiotics by becoming resistant to these compounds. Another way of controlling bacterial diseases is to breed varieties of crop plants with resistance against bacteria, but also in this case bacteria adapt and develop means to cause disease even on these new varieties. Every plant species will never be attacked by a bacterium that causes disease on a different plant species, for example a bean pathogen will never attack tomato. Scientists are trying to decipher the molecular basis of this kind of resistance, often referred to as nonhost resistance. They compare different variants of very similar bacteria that cause disease on different plant species, the molecular differences between these variants, and how plants respond differently to these variants at the molecular level. Understanding the molecular basis of nonhost resistance will lead to potential engineering of durable disease resistant crop plants. This will have a profound economic impact on the tomato growers in Virginia and on agriculture around the world.

Fighting Infectious Disease. Infectious diseases of humans, animals, and plants cause immeasurable economic damage and human suffering. The bacteria, viruses, and fungi that cause infectious diseases change continuously to adapt to new hosts. A well-known example is the bird flu virus H5N1 that infects humans, but is feared to mutate to acquire the ability to be transmitted between humans, which would lead to a flu pandemic possibly causing millions of human deaths. This research investigates the molecular mechanisms that are the basis of how pathogenic bacteria adapt to new hosts. The research uses the plant pathogen *Pseudomonas syringae* as a model. By using a plant pathogen, the basic molecular mechanisms common to human and plant pathogens can be studied without incurring the risk and cost of working with human pathogens.

Atmospheric Microbial Communities. Agricultural ecosystems are shaped by interactions with atmospheric microbial communities (AMCs) time-stamped consortia of microscopic life forms moving through the atmosphere from near and faraway places. AMCs may participate in a myriad of biological, chemical, and ecological processes in agricultural ecosystems, yet little is known about their structure, dynamics, and function. Some AMCs contain high-risk plant pathogens transported over long distances in the atmosphere, threatening agriculture from inside and outside the borders of the country. The ability to characterize, monitor, and forecast the composition and role of AMCs in agricultural ecosystems is essential for developing innovative, rational, and informed approaches to managing these important habitats. In 2006, a program was launched to explore atmospheric microbial communities in agricultural ecosystems, tens to hundreds of meters above the surface of the earth. The project goals are to discover and characterize microbial communities in the atmosphere and study their dynamics and functions in agricultural ecosystems. The project aims to elucidate the potential ecological functions and roles of AMCs in agricultural ecosystems, identify unique phylogenetic properties that may confer adaptation and survival of microorganisms in agricultural ecosystems, assist in predicting the distribution and spread of AMCs over time and space across large-scale biological and meteorological gradients, forge new discoveries of novel microbes in an under-sampled and relatively unexplored ecological setting, and invent the future of the new field of aerogenomics. In 2006, 16 AMC-sampling flights were conducted and AMCs were characterized from these flights using genomics and bioinformatics tools. New microbes were discovered during the sampling missions. The findings demonstrate that AMCs house a tremendous amount of

biological diversity, and may be the source of genomic innovations and novel ecological functions. This work impacts growers and producers of agricultural commodities and improves the retention of students in agriculture and engineering. A live 'blog' will soon involve K-12 students in the project through interactive online question and answer sessions.

Characterizing a New Threat to Wheat Production in Virginia. *Cephalosporium stripe* (CS), a devastating disease of wheat, resulted in multi-million dollar losses to growers and producers in the U.S. In May/June 2006, CS was observed in a single commercial wheat field in Riner, Virginia, the first report of the disease in a commercial wheat field in Virginia. The potential impact of the disease on wheat is unknown. In 2006, a program was launched to develop a practical disease management plan for CS in Virginia wheat. Should CS become a significant problem in Virginia wheat, it will be necessary to identify important sources of disease resistance. A number of Virginia wheat varieties were tested for their resistance to CS, but the research team has not yet identified important sources of resistance to CS. This work on CS directly impacts growers and producers of wheat in Virginia, and could save stakeholders in Virginia hundreds of thousands of dollars annually.

Cost Effective Management of Summer Bentgrass Decline. An economic impact survey of the golf industry in Virginia reports the industry generates approximately \$3.1 billion of direct, indirect, and induced economic impact. Most golf courses in Virginia establish bentgrass putting greens for their exceptional quality and consumer demand. A limitation of bentgrass is the summer decline from disease causing pathogens and heat stress. A research program was developed to address summer bentgrass decline caused by disease and heat stress. Phosphite-containing products effectively control diseases involved in summer bentgrass decline. One of these fungicides recently emerged from patent protection, and some of the newer products are available at a significant cost savings. Virginia golf course superintendents asked if the newer products have similar efficacy to the industry standard products. This project evaluated phosphite-containing products against summer bentgrass decline to determine the effectiveness of these products versus industry standards, and to evaluate any potential cost savings. Three field trials evaluated phosphite-containing products against summer bentgrass decline, while two growth chamber trials were conducted on campus. Two of the field trials were located on golf courses with cooperation from the local golf course superintendents. The studies found that most of the products provided comparable control as compared to industry standards.

Extension Programs

Increased Resistance to Disease. Gray leaf spot (GLS) is endemic to Virginia, particularly in the Piedmont, Western Virginia, and under center pivot irrigation in the eastern part of the Commonwealth. Serious losses have occurred in the U.S. corn belt as well. Yield losses of 60 percent to 80 percent are not unusual for a susceptible hybrid. Extension evaluated corn germplasm, hybrids, and inbreds for resistance to GLS under no-tillage production and new sources of resistance have been identified and characterized. The GLS resistant hybrids have been recommended to producers and consistently result in 20 to 60 percent yield increases over GLS susceptible hybrids. Use of GLS resistant hybrids identified by this program annually saves Virginia corn farmers \$16,000,000 in potential grain losses on approximately 300,000 acres.

Weather-based Decision Aids for Disease Management in Peanut and Cotton. Weather effects planting, crop management, timing of disease outbreaks, and harvest planning. Decision aids were developed to provide a data base for crop advisories and delivery of other information during the growing season until completion of harvest. The Peanut/Cotton InfoNet (www.ipm.vt.edu/infonet) and Peanut Hotline provided Extension agents and growers with daily updates of information to manage peanut and cotton in Southeastern Virginia in 2006. Included were advisories for control of early leaf spot and Sclerotinia blight of peanut, soil temperatures for timely planting of cotton and peanut, heat unit reports for growth and maturation of cotton and peanut, and frost advisories during peanut harvest. Soil temperature reports and weather forecasts enabled growers to avoid planting in periods of risk for chilling injury during seed germination and to plant in periods conducive for seed germination and crop emergence. Peanut leaf spot advisories saved growers three applications of fungicide at \$18 per application for an estimated \$293,400 on 16,300 acres. Sclerotinia blight advisories provided early warnings for disease outbreaks and improved the efficiency of scouting for early disease detection and control. Heat unit reports provided information for optimizing yield and planning the expected time of harvest. Frost advisories enabled growers to avoid freeze damage when peanuts are inverted in windrows and subjected to freezing temperatures while seed is at high moisture. Peanuts had a value of \$355 to \$450 per ton in 2005 without freeze damage, which causes development of off-flavors. Freeze damage reduces the value to as low as \$100 per ton. The Peanut/Cotton InfoNet and Peanut Hotline were accessed 4,643 times in 2006.

Source of Funding: Hatch, Smith-Lever, state funds, local funds, grant funds

Scope of Impact: State, national, and international

Underserved Audiences: Small producers, tobacco growers

Plant Production Efficiency

Basic Research

Ex-Ante Analysis of Research Strategies to Increase Tolerance to Abiotic Stresses. Drought is a costly threat to agriculture, with annual global economic costs in the tens of billions of dollars. The consequences are more severe in developing countries that depend heavily on rainfed agriculture. Drought losses in these regions tend to exacerbate poverty. Thus, technologies that alleviate drought have the potential to significantly benefit the world's poor. This research generated a novel framework to quantify the farm-household benefits of yield-variability reductions from drought tolerance research. The method was applied to maize, rice, and wheat research in high and low drought risk environments in eight low-income countries. The Consultative Group of International Agricultural Research used the results to demonstrate that public-private partnerships to produce less drought prone cropping systems can generate substantial economic gains for households in high drought risk areas.

Applied Research

Improving the Profitability and Sustainability of Peanut Production. With congressional approval of the 2002 Farm Bill, the market value of Virginia-type peanuts fell from \$600/ton to the current market rate of \$355 to \$450 per ton. As a result, the peanut acreage in Virginia dropped from 58,000 acres in 2002 to 16,000 in 2006. The high cost of producing Virginia-type peanuts at marginal profitability accounts for the dramatic fall in peanut production, while the

continued production of runner-type peanuts has not been threatened in the Southeastern U.S. Three field trials in 2006 were conducted to compare the profitability of six Virginia and six runner-type varieties in conventional and strip tillage. Additional opportunities to improve profits were found by strip tillage instead of conventional tillage which reduced input costs an estimated \$29 per acres. If runner-type peanuts are grown, the cost of land plaster application at \$35 per acre can be eliminated since small seeded peanuts do not require supplemental calcium. At recommended seeding rates of 100 pounds per acre for runner-types and 120 pounds per acres for Virginia-types, seed costs for runners (\$0.63/lb) compared to Virginia-types (\$0.66/lb) saves an additional \$16 per acre when runner-types are planted. Overall, these findings demonstrate the value of peanut production can be increased by \$132 to \$181 per acre for Virginia types and \$214 to \$237 per acre for runner types through selecting superior varieties, strip tillage, and recommended crop management practices. Furthermore, these data indicated that production of 3,000 pounds per acre of superior Virginia-type peanuts would require a contract valued at \$37 to \$55 per ton above the current rate of \$355 per acre to equal the profitability of superior runner-type varieties. For example, nine producers planted 33 percent (660 acres) of the total peanut acres in Isle of Wight to the new runner type peanut. With a 2006 production yield advantage of 1,200 pounds per acre on these specific acres, these growers profited an additional \$150,000 (1200/A X 0.185 X 660 A) versus growing Virginia type peanuts.

Cotton Variety Selection. (see Integrated Research and Extension description on page 103)

Extension Programs

Cash Hay for Virginia's Equine Industry. In Southeastern Virginia, changes in agricultural policy, low commodity prices, increased input costs, and urbanization are forcing peanut and cotton producers out of farming. In Southside Virginia where tobacco production has long been a profitable enterprise, the tobacco buyout allowed many smaller producers to exit production while existing growers face lower farm incomes. One of Virginia's fastest growing segments of agriculture is the equine industry. In 2001, there were more than 170,000 horses valued at \$1.46 billion in Virginia. Direct expenditures to support horses in Virginia exceed \$500 million annually. Each year, Virginia's horses consume over 470,000 tons of hay valued at approximately \$100 million. Much of this hay is imported from other states. Cash hay production for Virginia's equine industry could offset some lost revenue from reductions in peanut and tobacco production. Extension conducted a series of workshops across the tobacco and peanut areas of Virginia on profitably planning and marketing hay for the equine industry. Two hundred seventy-five participants gained knowledge to make informed decisions about entering the cash hay business. Evaluations from the 275 attendees 89 percent strongly agree and agreed the workshop "was a good value."

Cotton Variety Selection. (see Integrated Research and Extension description on page 103)

New Business Options with Plants. (see Integrated Research and Extension description on page 102)

Development and Dissemination of Disease Resistant Small Grain Varieties. (see Integrated Research and Extension description on page 105)

Evaluation of Burley Tobacco Breeding Lines for Blue Mold Resistance and Yield. (see Integrated Research and Extension description on page 105)

New Barley Varieties Result in Exports and Potential New Markets. (see Integrated Research and Extension description on page 105)

Northumberland/Lancaster Soybean Variety Trials. (see Integrated Research and Extension description on page 102)

Peanut Production and Maturity. (see Integrated Research and Extension description on page 103)

Preventing Gray Leaf Spot Disease with No-Tillage Production. (see Integrated Research and Extension description on page 109)

Selecting and Characterizing Cold Tolerant Bermudagrasses. (see Integrated Research and Extension description on page 115)

Soybean Variety Test and Demonstration Plots. (see Integrated Research and Extension description on page 103)

Utilization of Naturalized Forage Species. (see Integrated Research and Extension description on page 102)

Source of Funding: Hatch, Smith-Lever, state funds, local funds, grant funds

Scope of Impact: State and international

Underserved Audiences: Tobacco producers

Funding and FTE's

Federal Smith Lever Funds: \$2,642,990

Federal Hatch Funds: \$1,175,880

State Matching Funds: \$7,651,327

Local Government Funds: \$4,828,246

Grant and External Funds: \$12,993,697

FTE: 207.11

Goal 2: To provide a safe and secure food and fiber system.

Safe, nutritious, and affordable food is important for all citizens. Food safety and security issues impact all levels of food production, processing, handling, delivery, and consumer systems. Farmers, producers, processors, distributors, retailers, and consumers are all acutely aware of the elevated importance of food quality and safety in agricultural products.

Part of this context includes the impact of animal and plant diseases on food supplies, trade and commerce, human health, and well-being in every part of the world. The risk of foreign animal and emerging diseases has increased in recent years. Examples include avian influenza, bovine spongiform encephalopathy, Salmonellae, and Escherichia coli O157-H7. Outbreaks cause economic and health effects, threaten food security, shake confidence in the food supply, and influence long-term consumer eating habits. Mycotoxins produced as byproducts of plant disease like deoxynivalenol (DON) pose health threats for humans and domestic animals and eliminate marketing options. Fresh produce and other commodities have been linked to outbreaks of foodborne illness. Response delays in food emergencies can also lead to increased human health losses and those associated with animals, crops, businesses, markets, and labor.

Research and Extension programs holistically address the systems that produce a safe and secure food system from the farm to processors and consumers. Programs specifically focused on farmers included the development of disease resistant plant varieties, processes to prevent microorganism growth, techniques to reduce contamination, and efforts to access information to reduce diagnosis and control delays. Studies were conducted to determine environmental links and farm production practices and their relationship to foodborne illness pathogens. Virginia Cooperative Extension (VCE) also trained producers and worked with the State Veterinarian and Virginia Department of Agriculture and Consumers Services (VDACS) to establish a voluntary system to protect the food animal industry and allow an immediate trace back to identify and contain disease outbreaks. As a result of VCE programs, 3,850 farms and animal premises were registered in Virginia in this tracking system.

Research and education related to safe food production included food microbiology studies on foodborne pathogens, microbiological spoilage, prevention and control of contamination during processing, thermal and non-thermal processing, and development of methods to detect microorganisms and their toxins. Food processing and handling research and Extension programs also focused on control of major foodborne pathogens in primary agriculture systems through application of innovative processing technologies, antimicrobials, sanitation, Hazard Analysis and Critical Control Point (HAACP) strategies and Good Agricultural Practices (GAPs). Researchers and specialists helped food processors identify sources of contamination and develop strategies to prevent future problems. New and existing food businesses also received product development and process training to market safe, quality products. VCE programs trained and certified producers, processors, distributors, and government inspectors in safe food handling techniques.

As a result of recent disasters including Hurricane Isabel and Hurricane Katrina, the Governor's Office of Commonwealth Preparedness and the Virginia Department of Emergency Management identified a need for improved communications and education before, during, and after emergencies. VCE was asked to serve as a state liaison in 24 high risk communities to provide education and assist in insuring accurate and clear communications among local, state, and federal officials. Extension provided educational programming in emergency preparedness including agricultural damage assessment in 90 communities in 2006. VCE information and education prevented delays and minimized losses in income, crops, and markets, by insuring local communities and state and federal communications were clear and local needs were accurately assessed and reported.

On the consumer side, each year, as many as 76 million Americans experience foodborne illness, and an estimated 5,000 deaths are linked to contaminated foods. As consumers increasingly rely on others to prepare food, the importance of a knowledgeable and skilled work force in food production, processing, and handling is critical for preventing foodborne illness. VCE trained and certified professional food handlers with the ServSafe program and trained volunteers with the Feeding a Crowd program to minimize foodborne disease risks for consumers. VCE also trained limited-resource families to promote food safety. The Expanded Food Nutrition Education Program and Smart Choices Nutrition Education Program also instructed limited-resource families in the principles of safe food handling and processing (see Goal 3).

Research and Extension outputs generated for this goal included 67 refereed journal articles, one book, seven book chapters, 31 numbered Extension publications, and ten other reports.

This section highlights the 2006 accomplishments of Virginia Tech (VT) and Virginia State University (VSU) in assuring Virginia has a safe and secure food and fiber system. Themes for Goal 2 include:

- Food Accessibility and Affordability
- Food Handling
- Food Quality
- Food Safety
- Foodborne Pathogen Protection
- Food Security

Efforts reported in food handling, food quality, and food safety addressed at least two of these themes but were listed under only one key theme.

Key Themes

Food Accessibility and Affordability

Extension Programs

Virginia Food and Beverage Association. The Virginia Food and Beverage Association (VFaBA) is the only association that brings Virginia food companies together for education, networking, and support. Interaction of 88 food companies with research, Extension, and regulatory agencies is vital to maintain a stable core of food processors while supporting growth of new food enterprises and companies. Extension provided key leadership for the association's needs including communications, training, organization, planning, and the annual meeting and professional improvement conference. As a result, VFaBA membership grew 400 percent to 88 members. Food businesses surveyed reported needs for continuing education including seminars, conferences, networking opportunities, and technical support to improve their work.

Source of Funding: Smith-Lever, state funds

Scope of Impact: State-specific

Underserved Audiences: Small businesses, small producers

Food Handling

Extension programs

Virginia Food Processor Technical Assistance Program. Food processors in Virginia need guidance on product formulation and regulation to produce safe and wholesome food products that comply with state and federal laws. Extension provided technical assistance in analyzing food products and processes and making recommendations for formulation and processing. Processors participating in this VCE program file required processing documents with the Food and Drug Administration (FDA) to sell their products. They learn federal, state, and local regulations for processed food products, compliance modifications in formula and/or process,

and wholesomeness of food products. As a result, 214 food products produced by 49 Virginia food businesses were analyzed and recommendations provided. Seventeen of the tested products had significant food safety issues that left uncorrected, may have resulted in unsafe food in the marketplace. Thirty-eight products had significant quality issues that may have resulted in significant economic loss for the processor. VCE acted as a FDA recognized Process Authority for 169 products. In three cases, VCE was instrumental in aiding Virginia food processors in correcting deficiencies cited during FDA inspections, which prevented enforcement action such as fines and injunctions.

Protecting Food from Contamination. Since 1995 the number of licensed blue crab processors in the Mid-Atlantic Region declined 40 percent. At the same time a number of blue crab processors expanded their business by incorporating value added processing such as pasteurization. Pasteurized products are refrigerated and have a higher quality than canned products destined for nonrefrigerated shelf storage. In 2006, technical assistance in plant layout, facility logistics, equipment design, equipment purchase, safety consideration, thermal process regimes, and equipment use training was provided to blue crab processors as they established a crabmeat pasteurization processing area. Resource support provided by the VT Seafood AREC, resulted in one blue crab processor adding capacity to an existing facility to produce 1,200 lbs of value-added pasteurized crabmeat per day. The retail value of a one-pound can of crabmeat depending upon grade and time of year sells for approximately \$10 for Special to \$25 for Jumbo Lump.

Servsafe Education Economic Value Determined. Between 2003 and 2006, 16 foodborne illness outbreaks were reported annually in Virginia mostly from improper food preparation. According to the National Restaurant Association, the average cost of a foodborne illness outbreak to an establishment is approximately \$75,000. These 16 annual outbreaks equate to \$1.2 million in total costs to establishments from foodborne illness in Virginia. According to the U. S. Census, Prince William County, accounts for approximately 4.9% of Virginia's population. Because of this, it is reasonable to associate 4.9% of the annual \$1.2 million in total costs to restaurant establishments in Prince William County equaling \$58,800. In 2006, VCE conducted the Servsafe food safety handling program throughout Prince William County for 75 food service employees to prevent foodborne illness. If one foodborne illness outbreak occurred per individual from lack of training and improper food handling by individuals who completed this course, the potential total cost to restaurant establishments could be \$5,625,000 in Prince William County. A benefit-cost ratio of these services provided by VCE in Prince William County indicates Servsafe, lead to a benefit-cost ratio of 95.66 to 1. This ratio potentially means that for every one dollar spent in training of safe food handling procedures, \$95.66 are saved by restaurant establishments when correcting foodborne outbreaks in Prince William County.

Food Safety Education for Food Handlers. To prevent foodborne illness, VCE and the Virginia Department of Health provided food safety training for food service owners, managers, supervisors, and workers in school cafeterias, caterers, restaurants, child-care centers, hospitals, and nursing homes. This year, 75 percent of 1,614 participants received certification from the National Restaurant Association Educational Foundation for successful completion of the ServSafe course. These food service personnel demonstrated knowledge of foodborne disease prevention. When asked about food safety practices they implemented within three to six months

after the training, 100 percent of participants implemented at least one new practice. Some of these practices have also increased in frequency.

Food Managers Improve Food Safety. Food safety impacts restaurants, direct market agricultural vendors, child care centers, hospitals, catering services, temporary food mobile units, occasional quantity cooks in churches, and other food establishments. Virginia health code requires someone on site during operation who can demonstrate knowledge of proper food handling in restaurants. In one county, there are 500 food establishments and new facilities opening regularly. There is no local ordinance requiring a certified food manager be on the premises at all times. Extension with the county health department provided eight ServSafe Food Sanitation courses to train food managers. The eight-hour course is offered, in lieu of the 16-hour format, since food managers prefer less employee time away from work for training. Costs were also less with this format and scores of participants were comparable to former classes offered over 16 hours. Two hundred and one food managers were trained in food safety in the eight-hour ServSafe Food Sanitation Course. Eighty percent received certification from the National Restaurant Association, with an average passing score of 88 percent. As a result, the county has 160 additional certified food managers knowledgeable of proper food handling. The Health Department reports food establishments with trained food managers improved proper food handling and showed improvement in facility inspection scores.

Dairy Food Safety Practices. (see Multistate Extension description on page 96)

Good Agricultural Practices. (see Multistate Extension description on page 95)

Needs Assessment of Sanitation Training for Food Processors, Wholesalers, and Warehouse Operators. (see Multistate Extension description on page 96)

Train-the-Trainer Workshops on Good Aquaculture Practices. (see Multistate Extension description on page 96)

Source of Funding: Smith-Lever, state funds, local funds, grant funds

Scope of Impact: State specific

Underserved Audiences: Urdu, Greek, Chinese, Spanish speaking audiences, small businesses

Food Quality

Basic Research

Novel Materials for Preventing Photo-Oxidation of Milk. The food industry is actively looking for new methods to increase product stability, product shelf life, and increase marketability of foods through the use of nutraceuticals. Some beverages packaged in clear containers are susceptible to light oxidation which can affect the sensory quality of the product by the time it reaches the consumer. Light can cause degradation of vitamins and other compounds with potential health benefits. Some compounds added to beverages for potential health benefits may also help control quality damage caused by light. Beverage systems with added protein and phospholipids undergo photo-oxidation, resulting in detectable sensory quality changes. Lutein fortification of a colloidal beverage may inhibit the formation of hexanal produced from ultra violet light and broad spectrum full light. Beverages with light susceptible components should be protected using ultraviolet light-blocking materials to maintain sensory and nutritional quality. Understanding the effects of specific light wavelength regions on

degradation of functional components will assist in creating more stable and higher quality foods that provide potential health benefit above basic nutrition. This information will help manufacturers select packaging materials that provide better quality protection.

Extension Programs

Analytical and Technical Support for the Seafood Industry. The seafood industry in Virginia needs technical support to remain competitive in a global marketplace. The Virginia Seafood Agricultural Research and Extension Center provides this support through Extension programs to help industry produce safe and wholesome products. During the past year, 1,273 microbiological analyses were conducted for 13 Virginia companies. These analyses included food testing, and processing plant environmental tests to determine microbial numbers present on food, food contact surfaces, and environmental non-food contact surfaces. Sanitation and cleaning protocols for control of *Listeria monocytogenes* were recommended and implemented for several plants. Work also included shelf life studies and safety evaluations for new seafood products, microbial evaluations for imported crab meat samples, studies to validate 12 thermal processes for seafood processing firms, individual customized sanitation audits for five companies, and collection and evaluation of seafood products from a company to determine whether or not the products posed a human health threat. As a result, the 13 companies produced safe, wholesome products, and met federal and state inspection requirements.

Improved Food Processing Technologies Increase Wine Quality and Product Value. (see Integrated Research and Extension description on page 106)

Source of Funding: Hatch, Smith-Lever, state funds, local funds, grant funds

Scope of Impact: State and national

Underserved Audiences: Small growers and businesses

Food Safety

Applied Research

Microbiological and Chemical Safety of Raw Foods Sold on the Internet. The VSU's, Agricultural Research Station (ARS) continued to implement projects in food safety. One of these projects examined the microbial and chemical quality of raw meats, nuts, frozen beans, and honey sold through the Internet. In 2006 research was conducted to compare the microbial quality of frozen edamame to other varieties of frozen beans sold at grocery stores in Virginia. The microbial quality of frozen edamame was similar to other varieties of frozen beans. Rinsing and shelling raw edamame caused a reduction of total aerobic mesophile, yeast and mold, and coliform counts. Blanching for 60 seconds reduced background microflora. Strict sanitation and effective blanching practices can ensure safety of frozen edamame. Results of this research were presented at a Virginia Cooperative Vegetable Workshop organized for local producers.

Managing the Impact of Wild Birds on Food Safety and Farm Hygiene. On-farm food safety management is critical for food and public health protection. Previously, on-farm food safety practice focused on land history, water source, manure composting, agricultural chemicals, worker hygiene, and animal health. Although wildlife has been considered a source of contamination, no report clearly assessed the impact of wild birds on foodborne pathogen

transmission or methods for managing this risk. This research project at VSU-ARS will determine the pathway and manageability of foodborne pathogen transmission by wild birds on farmlands. Small ruminant farms will be used as experimental models for this investigation by manipulating the feeding space of both farm animals and wild birds. Experimental tests will be conducted to provide preventive approaches to bird-related contamination. It is anticipated that this project will generate knowledge of bird control and pathogen transmission with widespread applicability for improving agricultural practices.

Extension Programs

Enhancing Food Safety. Food safety impacts consumers at restaurants, direct market agricultural vendors, child care centers, hospitals, catering services, temporary food units, occasional quantity cooks in churches, and other food establishments. Extension provided workshops on safe food handling practices for food vendors at fairs, festivals, fund raising events, and temporary food events. Department of Health specialists believe food safety education helps ensure safe food handling practices at temporary events, especially with a limited number of environmental health specialists to conduct inspections. Extension offered Feeding A Crowd, a six hour training program to certify temporary food vendors in the New River Valley. One hundred fourteen temporary food vendors participated and 108 received certificates for successful completion. Participants who successfully complete the course can serve food without being inspected by the Health Department. In 2006, VCE and the Virginia Department of Health completed three ServSafe short courses in Central Virginia as a response to this concern. Additionally, Feeding a Crowd, was provided to volunteer and civic groups. Sixteen people successfully completed the ServSafe National Restaurant Associations Certification Exam in 2006. Surveys of the Feeding a Crowd class showed 78 percent learned a great deal about controlling time and temperature during food handling and 71 percent learned a great deal about foodborne pathogens.

Good Agricultural Practices. (see Multistate Extension description on 95)

Produce Food Safety. (see Integrated Research and Extension description on page 109)

Source of Funding: Hatch, Smith-Lever, state funds, local funds, grant funds

Scope of Impact: State specific and multistate

Underserved Audiences: Small growers and food processors

Foodborne Pathogen Protection

Applied Research

Evaluation of Use of Fish Waste to Produce Vegetable Crops Free of Harmful Pathogens.

One of the greatest issues surrounding the production of seafood products in enclosed, recirculating systems is the removal and elimination of waste. Several large recirculating aquaculture ventures currently produce vegetable crops in the fish waste and market these crops as organic. Farmers have utilized livestock waste for crop production for decades, and recently the issue of food safety has received increased scrutiny. In this study fish waste will be used to produce vegetable crops in a hydroponic system and compared to the growth of plants using traditional hydroponic methods. Plants will be evaluated for the presence of harmful microorganisms to ensure food safety. After the vegetables are determined to be safe for human

consumption, these vegetables will also be evaluated for off-flavors and odors. Fusarium head blight (FHB), caused by the fungal plant pathogen *Gibberella zeae* (Gz), is a devastating disease of wheat and barley in the U.S. Since 1990, wheat and barley farmers in the U.S. have lost over \$4 billion due to FHB epidemics. Grain infested with Gz often contains mycotoxins such as deoxynivalenol (DON), threatening the health of humans and domestic animals. Even very low levels of DON in raw grain can render food or feed unfit for consumption. Concerns about DON continue to mount, as does a growing need to develop and expand diagnostic laboratories for mycotoxins. New technologies for the rapid and early detection of mycotoxins in food and feed need to be developed and implemented, and diagnostic services must be accessible and available to growers and producers to determine resulting mycotoxin contamination. In 2006, a regional diagnostic laboratory for mycotoxins was launched at VT to implement sensitive and accurate methods to accurately detect and quantify DON and other mycotoxins associated with FHB in wheat and barley, provide analytical services necessary to develop new cultivars of wheat and barley with reduced potential for DON contamination, facilitate DON testing that will improve chemical and cultural practices necessary to reduce mycotoxin contamination in wheat and barley, and develop analytical methods to determine the mycotoxin production potential of populations of Gz in the eastern U.S. The ultimate goals of this program are to develop innovative strategies to detect, monitor, and control mycotoxin contamination in wheat and barley and to understand the mycotoxin production potential in eastern populations of Gz.

Early Warning Systems for High Risk Plant Pathogens. Improved technologies are needed to anticipate, prevent, prepare for, and respond to the introduction of high-risk plant pathogens (HRPPs) into the U.S. Many HRPPs are transported over long distances in the atmosphere, threatening agriculture in the U.S. The ability to detect, monitor, and forecast the movement of HRPPs in the atmosphere is essential for establishing effective quarantine measures, preventing the spread of plant disease, and preventing potentially damaging events targeted at agriculture and the food supply. In 2006, a program was launched at VT to enhance the protection and safety of the nation's agriculture and food supply and to develop new strategies to anticipate, prevent, and respond to agricultural threats of HRPPs. Autonomous (self-controlling) aircraft were designed, tested, and implemented to study the movement of HRPPs in the atmosphere, tens to hundreds of meters above the surface of the earth. The program cuts across traditional boundaries of scientific disciplines, blending advanced technologies in biology and engineering. In 2006, over 50 sampling flights were conducted tens to hundreds of meters above agricultural fields in Virginia. The findings permitted a regional evaluation of disease spread potential for Fusarium head blight and tobacco blue mold, assisting wheat, barley, and tobacco growers and producers by providing an early warning system for these diseases. This work led to measurable improvements in management of agricultural ecosystems through emergency control measures, infrastructure and human resources, and reporting and communication. The research team developed new tools necessary for on-site detection of HRPPs collected from the atmosphere and identified limits of long-distance transport for HRPPs. This work continues to assist in predicting/forecasting the distribution and spread of HRPPs in the atmosphere.

Source of funding: Hatch, grant funds

Scope of impact: State and national

Underserved audiences: None

Food Security

Extension programs

Safeguarding Animal Health. Due to increasing food safety concerns, higher risks of agri-terrorism, and increases in zoonoses, the National Animal Identification System was initiated to reduce the incidence and risks from foreign animals and emerging diseases. Extension partnered with the State Veterinarian and VDACS to provide targeted educational programming to increase knowledge and understanding of voluntary premise registration and animal tracking systems. As a result of the educational program 3,850 animal premises were registered in the Virginia Animal ID System. This is a 45 percent increase over 2005 registrations. State and federal animal health officials also have new information and tools to utilize in case of an animal emergency. This will reduce delays in emergency response and prevent losses in livestock, markets, and labor.

Checking for Mycotoxins in Food. Fusarium head blight (FHB) caused by a fungal plant pathogen is a devastating disease of wheat and barley in the U. S. Since 1990, U.S. wheat and barley farmers lost over \$4 billion due to FHB epidemics. Infested grain often contains harmful mycotoxins such as deoxynivalenol (DON), producing a health threat for humans and domestic animals. Even low levels of DON in raw grain can render food or feed unfit for consumption. There is a growing need to develop and expand diagnostic laboratories for mycotoxins throughout the U. S. New technologies for the rapid detection of mycotoxins in food and feed need to be developed, and diagnostic services must be available to growers and producers. In 2006, a regional diagnostic laboratory for mycotoxins was created to implement sensitive and accurate methods to accurately detect and quantify DON and other mycotoxins associated with FHB in wheat and barley. The lab also provided analytical services to develop new cultivars of wheat and barley with reduced potential for DON contamination, facilitated DON testing to improve chemical and cultural practices to reduce mycotoxin contamination in wheat and barley, and developed analytical methods to determine the mycotoxin production potential of populations in the eastern U. S. In 2006, 3,200 samples were analyzed for mycotoxins from 120 growers and producers of wheat and barley in five states. In the coming years, the program will assist wheat and barley producers in four more states. In Virginia in 2006, 500 samples were analyzed for 16 growers, producers, and university researchers. As a result, Virginia wheat and barley can compete in national and global markets. The lab has also broadly improved food safety and security in the eastern U.S. by providing accurate and timely analysis and recommendations.

Source of Funding: Smith-Lever, state funds, local funds, grant funds

Scope of Impact: State and multistate

Underserved Audiences: Small growers

Funding and FTE's

Federal Smith Lever Funds:	\$111,661
Federal Hatch Funds:	\$49,679
State Matching Funds:	\$323,254
Local Government Funds:	\$203,984

Grant and External Funds: \$548,959

FTE: 8.75

Goal 3: To achieve a healthier, more well-nourished population.

Health, nutrition, and wellness education issues are at the forefront of modern-day American life. Family and Consumer Science (FCS) Extension agents, specialists, researchers, and consumers understand that food, nutrition, and health is an important pillar program that helps Virginians develop wellness life skills. Virginia Cooperative Extension (VCE) FCS programs and research emphasize the well being of families, individuals and communities. Extension's holistic approach to strengthening Virginia's families, including those with limited resources, assists youth and adults put research-based health, diet/nutrition, and exercise knowledge to work in their lives. Extension education programs address problems, issues and concerns associated with quality of living across the lifespan that directly impact human health and living standards. These concerns, coupled with other critical issues such as the aging population, childhood overweight, and disease prevention, provide a broad base for research and programming opportunities addressed through both Land-Grant systems, Virginia Tech (VT) and Virginia State University (VSU) and result in healthier, more productive citizens.

The risk of cancer, cardiovascular disease, elevated blood pressure, and obesity are major contributors to growing health care expenditures in Virginia and can be lowered significantly by appropriate diet and an active lifestyle. Research shows good diabetes management can help reduce or delay complications and thus, the cost of diabetes. Extension specialists and FCS agents and specialists throughout Virginia conducted Dining with Diabetes workshops related to the management of this disease, resulting in participants reporting more consistent blood glucose levels at the end of the eight-week program. Another intervention program offered to Virginia residents Fitting Together the Pieces of Diabetes, teaches lifestyle management skills to reduce or delay complications, thereby lowering health care costs associated with diabetes.

Chronic disease intervention programs successfully implemented by Extension agents across the Commonwealth include Healthy Lifestyles for a Healthier You, Healthy Living, Appalachian Cooking Lite, Active Aging, Eat Better, Move More, and Worksite Wellness. The diversity of audiences reached through multiple delivery methods includes immigrants, aging seniors, low literacy youth and adults, Hispanic, and Spanish speaking populations. Many agents work with local leadership councils and community groups to plan health fairs that include screening blood pressure and body mass index, and provide educational materials to create awareness and motivate behavior change. In many parts of Virginia, FCS agents work with school health advisory boards and wellness committees in developing system-wide plans to address nutrition in the school lunch program, food served or sold at school events, and physical activity. This helps schools achieve federal mandates to develop wellness policies.

Nutrition and health education programs have been directed to all age and income levels. The segment of the population over the age of 65 is growing at a rapid rate. Educational programs based on raising nutrient intake improve the health of older Virginians, support independent living, and reduce their risk of disease and disability. Exercise programs are also important to

maintain a healthy lifestyle. Steps to Family Fitness, a 10-week program uses a holistic family-centered approach to address the need for physical activity in daily life. Maintaining a Healthy Lifestyle, emphasized nutritious eating by following the Dietary Guidelines and to increase physical activity using pedometers

Nationwide data show that overweight has increased two to three times among American youth in the past 30 years. Overweight children are more likely to suffer from serious health problems such as Type II diabetes and asthma. Healthy Weights for Healthy Kids (HWHK) was developed for Extension educators with hands-on, user-friendly curriculum to prevent overweight. This curriculum provides an experiential learning adventure in nutrition, physical activity, and body image for children focused specifically on childhood overweight. This program showed significant increases in health knowledge, attitude, and behavior scores for most students.

Significant resources are devoted to assisting limited-resource families through the Expanded Food and Nutrition Education Program (EFNEP) and the Smart Choices Nutrition Education Program (SCNEP). The EFNEP works with young families and their children to provide education on good nutrition practices, prepare nutrient dense foods, and prevent food insecurity toward the end of the month. The SCNEP serves people with incomes at 130 percent of the poverty guidelines and/or receive food stamps. They learn good nutrition practices, sound food safety behaviors, how to prepare nutrient dense foods, and how to keep from running out of food toward the end of the month.

Extension and research efforts assist families and communities with critical issues related to economic stability and self-sufficiency, positive growth and development of human capital, and improved food and nutrition for a healthy, productive society.

Research and Extension outputs generated as part of this goal include: 106,893 extended learners, 6, 200 volunteers who contributed 70,050 hours, \$272,104 teaching grants, \$1,588.607 in research grants, and \$4,220,308 in Extension grants.

This section highlights the 2006 accomplishments of VT and VSU in achieving a healthier, more well-nourished population. Key theme areas in this goal include:

- Human Health
- Human Nutrition

Reports in this goal fit both key themes since nutrition and health programs address both themes at the same time.

Key Themes

Human Health

Basic Research

Development of Nutraceuticals from Peanut Skins. Since peanut skins are largely a wasted resource to peanut processors, identifying and extracting the polyphenols with nutraceutical and

food additive applications could have a significant financial impact on the value of peanuts. Laboratory studies identified and quantified chemicals with potential nutraceutical importance in peanut skin extracts and determined optimal extraction solvents. Studies were also conducted to determine the antioxidant activity of skin extracts in a cooked meat model system. These studies show peanut skin extracts have significant antioxidant activity in cooked meats. They have also shown peanut skin extracts contain resveratrol and many other important nutraceutical chemicals. Many of the identified chemicals in this study have not been previously studied or identified.

Identification of a New Stearoyl-CoA Desaturase Isoform in Production Species with Homology to a Human Enzyme. Stearoyl-CoA desaturase (SCD) is an enzyme involved in converting saturated fatty acids to monounsaturated fatty acids. Monounsaturated fatty acids are important as energy stores but also have roles in regulating cellular functions. Several SCD genes were identified in rodents and two genes were identified in humans. Fatty acids are very important for brain and neural tissue development in neonatal mammals, including human infants. Typically, rodents are used as models of human disease and development. The genome of rodents includes several SCD genes not all of which are analogous to the human genes. In particular, the human SCD gene is not represented in the genome of rodent species. This research identified a new SCD gene in the genomes of cattle, pigs, and sheep. This gene is analogous to the human SCD gene not represented in the rodent genome. Studying this gene and its importance for brain development has been greatly enhanced by this discovery. Until now, there was no model for studying this gene. Sheep are commonly used as models for the pre-natal development of human fetuses and pigs are commonly used as models for the neonatal development of humans. Identifying this gene in these species could lead to greater understanding of the importance of specific fatty acids for brain development.

Validation of Exopeptidases as Anti-Malarial Drug Targets. Malaria is one of the most deadly human infectious diseases, killing one to three million people annually. The victims are mostly children in tropical and subtropical regions of the world. Individuals from malaria-free countries such as the U.S. who travel to endemic regions are also at risk. The emergence of drug resistant strains of malaria hampers management of this disease, and new malaria drugs are urgently needed. This VT research focuses on characterizing essential biochemical processes in the malaria parasite to be exploited in the search for novel anti-malarial drugs. Specifically, this efforts works towards understanding the biochemical basis for the parasite's uptake and degradation of the oxygen-carrying protein hemoglobin during its residence in the host's red blood cells. These studies on the inhibition of the malarial enzyme dipeptidyl aminopeptidase 1 led to the identification of several moderately potent inhibitors of parasite growth. On the basis of this evidence, researchers are moving ahead to better understand the biochemistry of the enzyme to develop more potent inhibitors. In addition, this work to discover and characterize malarial aminopeptidases has implicated two of these enzymes directly in hemoglobin catabolism. These efforts expanded knowledge of the parasite's metabolism of human hemoglobin, and revealed possible new therapeutic approaches.

Applied Research

Delivering Omega-3 Lipids through Dairy Beverages for Improved Health. Dairy beverages constitute 62 percent of beverage consumption in the U.S. and offer a rich source of vitamins,

minerals, and bioactive proteins. Dairy products are recognized for health benefits from this mix of bioavailable nutrients, including reduced risk of osteoporosis and increased potential for weight loss. However, dairy products are low in omega-3 fatty acids beneficial for heart health, bone health, and reduced risk of cancer. Food sources of omega-3 lipids, including fatty coldwater fish, walnuts, and flaxseed oil, are not commonly consumed in the American diet. Combining the benefits of omega-3 lipids with the bioavailability and benefits of components found in milk and other dairy products can deliver important functional components. The market for omega-3 lipid enriched dairy beverages is growing rapidly in Europe and Canada whereas the U.S. lags behind in the development of dairy product innovations. However, quality deterioration occurs quickly in omega-3 lipids from a high potential for oxidation. Researchers in the departments of Food Science and Technology and Human Nutrition, Foods and Exercise developed a novel dairy beverage, called 'flaxmilk.' The beverage incorporates milled flaxseed into a chocolate flavored milk base to deliver approximately 1.4 g omega-3 lipids, 1.2 percent fat, and 11.2 g protein in 8 fluid oz of the beverage. A team of researchers conceptualized strategies for effectively incorporating and stabilizing extracted lipids into dairy systems. This research identifies critical extraction and processing stages that cause oxidation and strategies for prevention of oxidation of these heart healthy lipids. The flaxmilk product received a positive response from 62 consumers evaluating the product, with a mean score equivalent to 'likes moderately' on a nine-point hedonic scale. Females liked the product more than males. Eighty-five percent of participants indicated they would consume the product daily if it yielded positive health benefits. However, flaxseed has a gritty texture that negatively affects consumer response. This could be overcome by including an omega-3-rich lipid into the dairy system rather than using milled flaxseed.

Extension Programs

Managing Diabetes and Combating Heart Disease. According to the Center for Disease Control and Prevention (CDC) more than 20 million Americans have diabetes, the sixth leading cause of death in the U. S. The financial impact of diabetes is nearly \$132 billion a year. The yearly health care cost for a person with diabetes in 2002 was \$13,243 compared with \$2,560 for a person without diabetes. Research shows good diabetes management can reduce or delay complications and the cost of diabetes. Lifestyle management can minimize the debilitating effects of diabetes by reducing the level of blood sugar in the body with careful meal planning, exercise, foot care, and appropriate understanding and use of medications. To address this, 115 people participated in a diabetes management series offered by VSU and learned skills to reduce or delay complications and the cost of diabetes. As a result, 66 percent of participants reported more consistent blood glucose levels by the end of the eight weeks and 100 percent indicated they felt confident about keeping their diabetes under control through diet, exercise, and proper monitoring. In addition two participants lost weight. A lifestyle education series and cooking school entitled Dining for Diabetes was another response to reducing the impact of diabetes. Throughout the Commonwealth, 167 individuals with diabetes and family members participated. As a result, participant evaluation comments indicate confidence in preparing healthy meals for someone with diabetes, confidence in the ability to change diets to control carbohydrate intake, increased use of monounsaturated oils, and increased use of herbs and spices in place of salt. A nine percent average decrease in blood sugar levels from the first to the second test took place. This was significant since a one percent reduction in blood levels lowers the risk of diabetes complications by 40 percent. Additionally, in one county, an advisory group was formed to

develop long range plans on diabetes education. A third Extension response, to combating diabetes and heart disease was the implementation of Steps to Family Fitness to help inactive adults start or expand a regular exercise program. Participants determined their present exercise level and choose an exercise goal for a ten week period. After the program, 47 percent of the participants completed an evaluation and/or exercise log which revealed they all increased exercise during the 10 week period. On average participants exercised 4.7 days/week for 36 minutes. All the reporting participants made one positive dietary change including, “watching fast food consumption,” “reading food labels,” “eating fruit daily,” “drinking water instead of soda,” and “controlling portions.”

Healthy Weights for Healthy Kids. Nationwide data show overweight has increased two to three times among American youth in the past 30 years. Currently, 31 percent of children and adolescents are at risk for overweight and 19 percent are considered overweight. Children who are overweight are more likely to suffer from high blood pressure, high cholesterol, Type II diabetes, asthma, sleep problems, and lower self-esteem. HWHK provides Extension educators with hands-on, user-friendly curriculum to prevent youth overweight. HWHK builds on the experiential learning model, where children “learn by doing” and is one of the first Extension-based education initiatives focused specifically on childhood overweight. In addition, professional and paraprofessional FCS/4-H Youth Development staff delivering the HWHK program assist Virginia schools in developing and implementing wellness policies to address childhood obesity. Thirteen thousand youth were reached through this program in Virginia. A recent study of 311 youth in HWHK showed statistically significant increases in health knowledge, attitude, and behavior scores for most students. Improvements in health, attitudes, and behaviors were modest, however. Experiential-based lessons were found to be useful for delivering health lessons in nutrition, physical activity, and body image. The model of experiential learning used in this study was found to be most appropriate for fourth and fifth graders.

Addressing Chronic Diseases and Healthy Lifestyles for a Healthier You. Data released by the CDC show 70 percent of Americans die of a chronic disease each year. Chronic diseases, such as cardiovascular disease, cancer, and diabetes, can be delayed or prevented through proper nutrition and regular physical activity. Nationally obesity among adults continues to increase and is estimated to reach 32 percent by 2010. In 2002 data show that 24 percent of Virginians were obese. In response, Extension health education programs reached 313 individuals with nutrition information based on the food guide pyramid, expectations of normal aging, stretching the food dollar and basic diabetes information. Pre-post survey results indicated improved understanding of the My Pyramid nutrition and physical activity recommendations by almost 20 percent. Seventy-five percent of those who completed evaluations indicated raised awareness of the importance of drinking milk and their intent to include three dairy products in their diet each day. Additionally, VCE worked with an area agency on aging and a senior center to promote healthy lifestyles through nutrition education and physical activity. Volunteer leaders also helped reinforce program goals. All senior learners participated in physical activity sessions with 60 percent reporting feeling better after exercise, 48 percent reporting resting better after exercise, and 20 percent reporting lower blood pressure when checked by their family physician.

Increasing Healthy Habits. Obesity and overweight are a result of an imbalance between food consumption and physical activity. As stated by the CDC, the best treatment for overweight is prevention. Steps to Family Fitness: Trail-A-Week was offered to increase family physical fitness. Families walked trails as a group or on their own. Fifty families including 87 adults and 83 youth participated. Over the 10-week period, trail walks increased in length from 0.8 miles to 3.4 miles. Evaluation results revealed 75 percent of the participants increased water consumption and exercise, made positive changes in their diet, read the weekly newsletter, shared newsletter information with others, and increased their knowledge of the benefits of exercise and physical fitness. All of the participants increased their knowledge about the importance of drinking water, nutrition and family meal time, and a healthy diet.

Building Blocks for Healthy Active Kids. Healthy eating patterns during childhood and adolescence promote optimal childhood health, growth, and intellectual development. Healthy eating also prevents health problems such as iron deficiency anemia, obesity, eating disorders, cavities, coronary heart disease, cancer, and stroke. Since youth are spending considerable time each week in day care facilities and less time at home with their family, day care personnel need to understand and use good nutrition practices. To address this issue, the Department of Social Services (DSS) and VCE trained 54 day care center and home providers. As a result, over 85 percent of day care providers planned to provide healthy snacks (fruits, vegetables, whole grain bread and juices) for children and 35 percent said they would include physical activity in their programs.

Teen Health and Wellness. School health advisory boards identified obesity, eating disorders, and sedentary lifestyles as concerns following Youth Risk Behavior Surveys. Body Mass Index calculations compiled for 580 third, seventh, and tenth graders in the Allegheny County school system revealed 26 percent of students were overweight, and 17 percent were at risk for being overweight. To address this problem, VCE collaborated with the Virginia Department of Health (VDH) and the Allegheny School Health Advisory Board to design and implement a twice-monthly pilot health program, “It’s NOT All About the Image!” Due to its success, the program was renamed “Generation Fit” and expanded to Covington High School. A survey of female participants sought to determine the effect of the program on their health related behavior and choices. The group indicated they all made positive changes in diet and nutrition, exercise patterns, sleep habits, and stress reduction as a result of the program. They reported specific changes in food consumption, such as eating more vegetables and fruits, paying attention to portion sizes, and reducing or eliminating soda in their diet. One participant reported she had become more realistic about body image and no longer compared herself to models and movie stars. Other polls of participants revealed an increase in exercise and water intake, improvement in self-image, and more attention to portion sizes. A recent Youth Risk Behavior Survey confirms these increases in exercise and decrease in risky weight loss behaviors in these youth.

Good Nutrition and Physical Activity Help Youth Learn. According to the USDA MyPyramid Guidelines for Americans, children should engage in at least 60 minutes of physical activity daily. The Virginia Department of Education mandates that school wellness policies be in place in all schools that participate in federally funded school nutrition programs. An in-service entitled “Healthy Bodies/Healthy Minds: Good Nutrition and Physical Activity Help Kids Learn Better” was offered to physical education instructors. Sixteen Physical Education

teachers, representing 15 schools who instruct 5,053 students participated in this training. Program evaluations revealed 87 percent of participants gained greater understanding and knowledge in using the new MyPyramid.gov on-line program, “Learning in Motion” and “HWHK” curriculums. Participants indicated they acquired a greater awareness of opportunities available through the Community Healthy Foundation and the correlation between physical activity and academic scores.

Decreasing Risk of Obesity in Youth. (see Children, Youth, and Families at Risk description on page 74)

Educating Parents with English-as-a-Second Language. (see Parenting description on page 73)

Improving Life for At Risk Youth. (see Children, Youth and Families at Risk description on page 74)

Improving Preschool Children’s Health. (see Multistate Extension description on page 97)

Nutrition and Physical Activity Training for Child Care Providers. (see Child Care/Dependent Care description on page 72)

Source of Funding: Hatch, Smith-Lever, state funds, local funds, grant funds

Scope of Impact: State and national, and international

Underserved Audiences: Senior adults, incarcerated adults, at-risk preschoolers, overweight children

Human Nutrition

Extension Programs

Creating Healthy Families. Limited-resource families are at higher risk for chronic diseases from lack of regular medical care, limited funds, and limited knowledge of how to maintain a healthy lifestyle. The Healthy Families program involved 89 participants in two schools where 50 percent to 70 percent of the children receive free or reduced lunches. During the program, parents and children participated in hands-on activities focused on healthy food and physical activity including preparing healthy meals and enjoyed family time while eating together. Each family received groceries to take home to prepare healthy meals. As a result, parents reported reading food labels more often, making healthy food choices, more likely to include fruits and vegetables in their daily diets, and more likely to eat meals as a family. Youth participants reported a 50 percent increase in the ability to choose a healthy variety of foods, a 40 percent increase in physical activity awareness, a 40 percent increase in their ability to choose healthy drinks, and a 20 percent increase in using My Pyramid to make healthy food choices. One child said, “My mom is only cooking healthy foods now.” When asked if she liked foods her mom was cooking, she replied, “Yes, but I am just glad that she is cooking for me now.”

Healthy You - Bridging the Generation Gap while Encouraging Fruits and Vegetable Consumption. Research suggests eating fruits and vegetables helps prevent some cancers, fight heart disease and diabetes, and prevent obesity. Yet 96 percent of children ages two to 12 do not eat enough fruits and vegetables. Healthy You, an intergenerational program, targets at-risk preschoolers and senior citizens to emphasize health benefits of eating fruits and vegetables. The program reached 251 preschooler children and seniors with basic nutrition information. Through

this program, 111 senior citizens mentored and taught simple nutrition concepts in eight lessons to 140 preschoolers. Seniors volunteered 5,504 hours and \$1,232 of food was donated by agencies. Behavior changes from this program include 99 percent of the children could recognize fruits and vegetables from other foods, 90 percent of the families were trying new fruits, 82 percent of the families tried new vegetables in their diet, and 90 percent of the families included fruits and vegetables in their diet each day. One parent said, “Our son is now asking to eat vegetables and fruits.”

Encouraging Eating a Variety of Foods Throughout Life. Unhealthy dietary practices and a sedentary lifestyle are factors contributing to chronic diseases that lead to over 70 percent of the annual deaths in Virginia. Therefore, children need to learn healthful eating habits at a young age to prevent chronic diseases later in life. A basic practice for healthful eating is to consume a variety of foods. Extension and Headstart provided nutrition and physical activity education for pre-K youth. Headsart teachers implemented the program with 179 youth. At the end of the series teachers conducted an observational evaluation and noted 100 percent of the youth were eating a greater variety of foods.

School Nutrition Education Series. Healthy behaviors in youth promote lifelong health and prevent disease. Virginia statistics show that 30 percent of 10 to 17 year olds are overweight or obese. Studies show that 50 percent of overweight children and teens will remain overweight as adults. In response, a school nutrition series was implemented with 1,351 students, 72 classes, and 13 schools. Teacher program evaluations documented student improvements in nutrition knowledge as well as eating and health behaviors while cumulative student pre/post tests showed 89 percent now eat breakfast, 83 percent tried at least one new food, 80 percent read food labels, 83 percent increased the number of fruits and vegetables eaten, 86 percent consumed more milk, 90 percent increased daily physical activity, 88 percent limit sweet snacks, 90 percent brush teeth at least twice a day, and 91 percent wash hands before meals and snacks.

Fighting Childhood Overweight. Childhood obesity rates continue to rise across the country. Northern Virginia encounters unique challenges as 33 percent of the population speaks a language other than English. Key informant interviews with school nurses indicated recent immigrant children gain up to 20 pounds during their first years in the U.S. Extension developed a program to communicate with low literacy parents, provide venues for parents and children to participate together in nutrition programs, and provide grade appropriate Standards of Learning-based programs for implementation in schools. Partners included public schools, REEP-English as a second language (ESL) education provider, childcare providers, and after school child care programs. A total of 1,076 parents and children participated in the VCE Childhood Overweight Initiative. Evaluation tools varied depending on reading and writing abilities, activities, and participant’s ages. Results revealed 89 percent of middle school students felt they could explain a label to a friend (including how to convert the grams of sugar and fat into teaspoons of sugar and fat), 69 percent of teens and adults indicated they would visit the MyPyramid.gov website, and 85 percent of ESL adults indicated they would incorporate more fruits and vegetables into their diet. Oral low literacy evaluations revealed 92 percent of childcare providers intended to implement this program within 12 months. One hundred thirty age children also created a reusable “Healthy Plate” to take home to plan well balanced meals.

SCNEP and EFNEP Improves Nutrition for Low Income Audiences. The Food Stamp Nutrition Education (FSNE) grant, funded by Federal Nutrition Service (FNS), USDA through the Virginia DSS was secured in October, 2006 for \$4.3 million, matched with \$4.3 million of Extension resources. VCE program leadership developed a team approach to implementing these EFNEP and SCNEP programs establishing a statewide administrative team of six district coordinators, one educational designer, one fiscal staff, and the DSS benefits officer. To meet agency funding guidelines, standards for the 74.5 FTEs working with SCNEP/EFNEP were set including caseloads, match standards, and benchmarks for district coordinators. Marketing strategies for recruiting and hiring indigenous EFNEP/SCNEP employees were developed, the policy and procedures manual was updated, and DSS monthly logs for reporting impacts were developed. Collaborations with food banks and DSS across the state were developed and a social marketing campaign and faith-based initiative were implemented. A statewide EFNEP/SCNEP leadership council of fifteen agencies was also formed to guide the work. As a result, SCNEP reached 16,469 youth and adults with approximately 15,000 people received the Smart Choices for Young Families newsletter. Also, 1,875 volunteers were enrolled in the program, volunteering an equivalent of 6.4 FTEs. The adult program enrolled 7,099 clients. Seventy-four percent showed improvement in one or more food resource management practices, 82 percent showed improvement in one or more nutrition practices, and 53 percent showed improvement in one or more food safety practices. The youth program enrolled 9,370 children. Survey results show 71 percent now eat a variety of foods, 69 percent increased knowledge of the essentials of human nutrition, and 62 percent increased their ability to select low-cost, nutritious foods. The adult EFNEP program enrolled 2,349 clients. Program surveys reveal 78 percent improved in one or more food resource management practices, 86 percent improved in one or more nutrition practices, and 65 percent improved in one or more food safety practices. The youth EFNEP program enrolled 9,444 youth. Evaluations showed 68 percent now eat a variety of foods, 72 percent increased knowledge of the essentials of human nutrition and 59 percent increased their ability to select low cost, nutritious foods. In addition, 1,250 EFNEP volunteers donated the equivalent of 5.7 FTEs to both the adult and youth programs.

Source of Funding: Smith-Lever, state funds, local funds, grant funds

Scope of Impact: State specific

Underserved Audiences: Non-English speaking immigrants, low literacy adults, Hispanic and low income families, overweight children, and seniors

Funding and FTE's

Federal Smith Lever Funds:	\$1,079,094
Federal Hatch Funds:	\$480,095
State Matching Funds:	\$3,123,926
Local Government Funds:	\$1,971,302
Grant and External Funds:	\$5,305,138

FTE: **84.56**

Goal 4: To achieve greater harmony between agriculture and the environment.

Agriculture's long-term vitality and prosperity depend on its ability to co-exist with the natural environment. This involves a blending of environmental, social, and economic opportunities that strive to meet present-day needs without compromising the ability of future generations to meet their needs.

The quality and quantity of Virginia's water resources and the sustainability of agriculture and natural resources are heavily influenced by the nature of land use by local, state, and federal policies and by the actions of people who engage with agricultural and natural resources. One of the most crucial components determining the success of water quality management and protecting natural resources is education.

Virginia Cooperative Extension (VCE) educational programs on the conservation, protection, and stewardship of Virginia's land and water resources were conducted by Extension specialists at Virginia Tech (VT) and Virginia State University (VSU), and by Extension agents in 107 county and city offices. Extension efforts depend on basic and applied research providing answers to agricultural and environmental questions.

Many different strategies and applications of new technologies are necessary to accomplish the overall goal of achieving greater harmony between agricultural and forestry operations and the environment. Efforts included research and education related to farm and forest land protection strategies, reduction of nutrient loading, integrated pest management, reduced tillage, minimized pesticide use, and pesticide recycling and disposal.

Integrated Pest Management systems assured the most efficient pest management solutions and engaged one or more complimentary methods to eliminate or reduce pest pressure. Research and Extension efforts provided cost-effective recommendations for the safe and effective control of important plant diseases, weeds, and insects.

Extension and research efforts also developed strategic educational programs that lead to effective management of natural resources, sustaining agriculture, and improving and protecting water quality. For example, the Virginia Master Naturalist Program was implemented this year and 21 chapters of volunteer naturalists are being trained and have begun stewardship, citizen science, and education projects that protect and conserve the natural world. Over 1,000 individuals attended at least one program to earn Sustainable harvesting and Resource Professional (SHARP) Logger credits, a program that has resulted in enhanced logging safety procedures, operational efficiency, and enhanced environmental impacts. Water resources training for a wide variety of youth and adult learners also continues to help improve the quality of the Chesapeake Bay watershed (CBW). Research and Extension outputs generated as part of this goal included: 93 refereed journal articles, 4 books, 12 book chapters, 109 numbered Extension publications, 23 Extension manuals and guides, 28 trade journal articles, and 21 other reports.

This section highlights 2006 accomplishments of VSU and VT in achieving a greater harmony between agriculture and the environment. Five theme areas supporting Goal 4 efforts are:

- Integrated Pest Management (IPM)
- Natural Resources Management
- Nutrient Management
- Sustainable Agriculture
- Water Quality

All the nutrient management key theme reports also apply to the water quality and sustainable agriculture key themes.

Key Themes

Integrated Pest Management (IPM)

Basic Research

Differential Parasitism by a Specialist Parasitoid in the Virginia Alfalfa. Little is known about the underlying causes for the low success of biocontrol programs. Large variations in the levels of control have been observed throughout the geographic range of the natural enemy and its host. The biological control program involving the alfalfa weevil *Hypera postica* (Gyllenhal) and the parasitoid *Bathyplectes anurus* (Thomson) is a good example of such variability. Although this program has been reported to be successful in the Northeastern U.S., the same cannot be said for other regions such as in North Carolina, Tennessee, and Virginia. The primary goal of the project is to study the geographic pattern or structure of parasitism in the three distinct alfalfa-growing regions of Virginia where the levels of parasitism by *B. anurus* on the alfalfa weevil are known to vary among the regions. The project attempts to answer are the geographic patterns of parasitism of a specialist parasitoid related to the extent to which populations are adapted locally to the host? How important are landscape structure and spatial scale in shaping the geographic patterns of parasitism by a specialist parasitoid on host? Answers to the first question involve a series of functional response experiments framed within a reciprocal transplant design and studies of the spatial pattern of parasitism of the parasitoid directly in the field. To answer the second question, multi-scale analyses will be used to determine the effects of landscape structure on the geographic patterns of parasitism.

Heringia calcarata, a Predator of Woolly Apple Aphid. The woolly apple aphid (WAA) is a pest in the world's apple producing regions, including eastern and western North America. Although serious outbreaks of WAA are sporadic and unpredictable, damage to bearing trees can be significant. Factors that disrupt the natural control of WAA populations by predatory and parasitic insects may be associated with these outbreaks. Laboratory and field studies have examined the role of predatory hover flies in suppressing WAA populations early each growing season. Increasing evidence suggests larvae of one hover fly species, a specialized predator of WAA and larvae of another hover fly species that prey on WAA and other apple aphid pests are very common and important biological control agents of WAA. This study shows the hover fly predators are most abundant in apple orchards when WAA populations are increasing and that WAA colonies on the branches of potted apple trees placed in an orchard are eliminated by the

actions of these predators. Such demonstrations of the effectiveness of biological control agents at suppressing pest populations should lead to increased grower awareness and recognition of the importance of conserving natural enemies and the selective use of pesticides. Although more research is needed to determine factors that prevent biological control agents from maintaining WAA populations below economically damaging levels, these results provide a foundation to address those questions.

Aphidophagous Syrphids as Biocontrol Agents of Aphid Pests. Field trials in 2005 and 2006 demonstrated that runner-type cultivars are competitive with Virginia-types in yield and value. As a result, growers can choose superior cultivars of either market-type for planting in Virginia according to the value of production contracts. Soil fumigation with metam and selection of cultivars resistant to *Cylindrocladium* black rot (CBR) offered the most effective strategy to achieve maximum yields and profit in fields with CBR and nematode problems. Application of metam sodium to Virginia- and runner-type cultivars under these conditions increased yield by 1,389 and 1,614 kg/ha, and value by 578 and 610 \$/ha. Conventional tillage resulted in lower incidence of CBR, but *Sclerotinia* blight was lower in strip tillage. Since yield and crop value were similar in strip and conventional tillage, strip tillage may offer some advantage through a savings of labor and fuel costs. Virginia-type cultivars transformed with an oxalate oxidase gene from barley showed good to excellent resistance to *Sclerotinia* blight of peanut. The transgenic cultivars had up to 99 percent lower disease incidence and up to 69 percent higher yield than non-transformed cultivars when grown in a naturally infested field. Advancement of these cultivars into commercial production for control of *Sclerotinia* blight has the potential increase yield and crop value, and save up to 282 \$/ha in fungicide costs.

Applied Research

Natural Enemies and Energy Efficiency for Tomato Greenhouses and High Tunnels. Production of tomato in greenhouses and high tunnels could provide an alternative source of income to small and limited-resource farmers during the colder months. High costs of pest control and energy are two major limiting factors in growing tomatoes in greenhouses and high tunnels. This project addresses both issues of pest control and energy efficiency. Among the natural enemies tested, the parasitoid *Aphelinus addominalis* was more effective against potato aphids than the commonly recommended *Aphelinus ervi*. Both species had over 90 percent emergence. The rove beetle was effective against thrips and fungus, gnat pupae. Light conditions were monitored and related to yield and fruit load. Heating costs can be reduced by correlating the available light to the growth of the plants and number of tomato heads. Results of this research were presented at three different occasions including at the annual meeting of the Entomological Society of America by VSU scientists.

Refining Mating Disruption Techniques in Gypsy Moth IPM. Gypsy moth insecticides evolved from broad-spectrum, persistent, environmentally hazardous compounds to highly specific and relatively environmentally benign products. Chief among these new tools is the use of Disparlure, the synthetic gypsy moth mating attractant. This compound applied aurally disrupts mating with profound positive effects in halting gypsy moth mating and subsequent population growth. Researchers funded through the U.S. Forest Service, Slow The Spread (STS) Project fine tuned both the concentration and application of Disparlure which led to an overwhelming increase in product use within the STS Project area. Since 1995, when mating

disruption was first used in STS, it has grown from 7 percent of the 35,238 treated acres to 74 percent of the over 575,000 acres treated in 2006. Eighty percent of the mating disruption is at the six gm/acre rate as opposed to earlier concentrations of 15 or 32 gm/acre. Disparlure now accounts for approximately one third the cost per acre as Btk and has fewer environmental effects. This is especially valuable in areas with threatened and endangered lepidopteran species. In Virginia, 80 percent of the 2006 STS treatment acreage was treated with mating disruption.

Diagnosis and Management of Insect-Transmitted Viruses in IPM Systems. Pathogens and nematodes affecting viruses are major constraints in many developing countries in producing vegetable crops. The viruses are likely to be vectored by aphids, whiteflies, or thrips. Farmers apply massive doses of insecticides in a futile attempt to prevent virus infection. Proper diagnosis of both the virus and the vector are needed before research can be designed to reduce incidence of disease and increase yields. The IPM Collaborative Research Support Project (CRSP) managed by VT provided an avenue for studying viral diseases through collaborative, multidisciplinary, and multi-national research. Collaborations for research and training have been established in the Caribbean (Jamaica, Dominican Republic), Central America (Guatemala, Honduras), and West Africa (Burkina Faso, Cameroon, Mali). Emphasis is on setting up an international plant disease network between countries to share diagnostic methods and results. One workshop in Guatemala examined and found in-country capabilities lacking in virus diagnosis. However, a network of scientists is in place among U.S. and in-country collaborators. Training activities have begun in diagnostics and building capacity to recognize that plants are non-productive because of viruses. Over the next two years, management approaches will be designed to strategically use pesticides and institute programs to decrease viruses.

Evaluating Insecticidal Products for Bed Bug Control (see Integrated Research and Extension description on page 114)

Novel Research Stimulates Practice Changes in the Nursery and Floral Industry (see Integrated Research and Extension description on page 114)

Extension Programs

Disposal of Unwanted Pesticides. Disposal of pesticides can threaten human health and the environmental quality. To address this concern, the Virginia Department of Agriculture and Consumer Services (VDACS), with the Virginia Pesticide Control Board and VCE, sponsored a disposal program offering free removal of unwanted pesticides or containers for producers. Over 150 producers and area agribusinesses brought these items to local pick-up points for disposal. A private contractor properly packaged these materials for disposal according to federal Environmental Protection Agency (EPA) regulations. This program was conducted at eight locations and involved a team of VCE agents and state government employees. A total of 85,315 pounds of canceled, banned, or unwanted agricultural and commercial pesticides were collected and destroyed. At an average cost of \$100 per pound of disposal, this represents a cost savings of approximately \$500,000 for producers.

Virginia Extension Pesticide Safety Education Program. The EPA mandates the safe use of pesticides by private, public, and commercial applicators. Extension agriculture and natural resources agents are mandated by VDACS to provide educational programs to recertify producers as pesticide applicators. Extension's Pesticide Safety Education Program provides

workshops, certification courses, and Web-based education for pesticide applicators. As a result of this year's efforts, pesticide applicators were trained and certified according to state and federal requirements. The program enabled 21,439 agricultural producers and pest managers to maintain 29,194 certifications in 27 different categories of private and commercial pesticide application. This enabled these employers and pesticide managers to use restricted and general use pesticides on their farms and in their pest management businesses as a result of the pest management programs throughout the Commonwealth. Consequently, the risks to public health and the environment were minimized while maintaining crop protection and effective pest control efforts. The local VDACS pesticide investigator also randomly inspected growers and dealers during the growing season and found that 95 percent of the applicators during the spot checks were in compliance with pest control efforts in following labels.

Asian Soybean Rust Monitoring Program. Infestation of Asian Soybean Rust is a major concern for soybean producers in Virginia. This disease can reduce yield by 80 percent to 85 percent. Local monitoring and effective multi-state communication system for tracking this disease is imperative for the success of this program. Additionally, accurate and timely communication of information must be provided to producers for the most economically feasible control of this disease. Through the combined efforts of county Extension and agricultural research center faculty, a Soybean Rust Tracking System was implemented in each soybean producing county by the installation of a Sentinel Plot on a grower's farm using an early maturing soybean variety. These plots were visited weekly by soybean scouts to collect tissue to determine if rust is present. Updated scouting information was provided through e-mail, newsletters, and direct mail updates. In late October a positive identification of this disease was discovered in a production field in Northampton County. Through communication by county Extension faculty, clientele were advised in 2006 that pest pressures didn't warrant insecticide or fungicide sprays on wheat. This saved growers \$22/acre or \$1,100,000 total for over 50,000 acres of soybeans. Presentations on this project were made at weekly grower meetings and the Eastern Shore Ag Conference and Trade Show.

Virginia Ag Pest Advisory. Agricultural crops are grown on more than 40,000 farms and 400 million acres of land in Virginia and make a multi-billion dollar contribution to Virginia's economic vitality. Timely and effective pest management of insects, diseases, and weeds is critical to the successful production of corn, soybeans, cotton, small grains, peanuts, potatoes, and vegetables. To ensure this practice, in July 2004, Extension faculty launched the Virginia Ag Pest Advisory (<http://www.sripmc.org/virginia/>) in cooperation with the Southern Region IPM Center. The advisory is a database-driven website that compiles frequent pest updates from pest management specialists in Virginia. An e-mail is automatically generated weekly and sent to growers, Extension agents, farm managers, and crop consultants on the newly posted information. In 2006, over 400 participants from all over Virginia and surrounding states received information from the advisory. During the year, a total of 119 pest alerts, forecasts, and updates were disseminated that alerted and educated growers and crop advisors about potential pest outbreaks, action thresholds for IPM decision-making, and up-to-date efficacy information on pest management tools and products. The advisory site received 8,562 hits. A recent survey of the e-mail recipients indicated 87 percent of respondents accessed the Virginia Ag Pest Advisory site, virtually all of them found it useful and educational, and most stated that it favorably impacted their agricultural production.

Biological Control of European Corn Borer in Peppers. (see Multistate Extension description on page 100)

Detecting Fungicide Resistance in Grape Pathogens. (see Integrated Research and Extension description on page 115)

Discovering Management Solutions for Weeds in Turfgrass. (see Integrated Research and Extension description on page 114)

Evaluating Insecticidal Products for Bed Bug Control. (see Integrated Research and Extension description on page 114)

Fruit Website and Publication. (see Multistate Extension description on page 98)

Glyphosate-Resistant Weeds. (see Integrated Research and Extension description on page 110)

Grounds Maintenance Conference. (see Multistate Extension description on page 99)

Horsenettle Control in Virginia Pastures. (see Integrated Research and Extension description on page 116)

Improving Management of a Destructive Disease of Small Grains. (see Multistate Extension description on page 98)

Integrated Weed Management in Landscape Maintenance. (see Integrated Research and Extension description on page 116)

Italian Ryegrass Control in Wheat. (see Integrated Research and Extension description on page 113)

Managing Tobacco Diseases and Nematodes. (see Integrated Research and Extension description on page 106)

Multi-Use Regional On-Line Courses in Pesticide Safety Education. (see Multistate Extension description on page 98)

Pesticide Inspector Residential Training in Structural Pest Control. (see Multistate Extension description on page 97)

Plant Growth Regulator Product Selection. (see Integrated Research and Extension description on page 106)

Preventing Weeds in Snap Beans. (see Integrated Research and Extension description on page 110)

Southwest Commercial Pesticide Recertification. (see Multistate Extension description on page 99)

Transitioning Overseeded Turfgrasses. (see Integrated Research and Extension description on page 113)

USDA Pesticide Recordkeeping Inspector Online Course. (see Multistate Extension description on page 99)

Virginia Potato Disease Advisory. (see Integrated Research and Extension description on page 116)

Source of Funding: Hatch, Smith-Lever, state funds, local funds, grant funds

Scope of Impact: State, national, and international

Underserved Audiences: Small scale and limited income producers

Natural Resources Management

Extension Programs

Virginia Forest Landowner Education Program. Virginia now has over 400,000 non-industrial private landowners but the state is losing over 26,000 acres of forestland each year. This has resulted in smaller land parcels and increased land use fragmentation which present challenges for forest managers. Many forest landowners have little or no forest management experience. The Virginia Forest Landowner Education Program was formed in 1997 to provide courses that taught landowners to promote sustainable forestry practices. Courses are taught statewide by natural resource professionals from state, federal, and private organizations, as well as consulting foresters and experienced landowners. Over 2,000 landowners to date have participated in over 100 courses with 131 participants in 2006. Ninety percent of participants stated they would seek professional assistance when conducting forest management in the future. They predicted that taking the short course would help them earn on average, \$44 more per acre.

Virginia Master Naturalist Program. Changes in environmental quality have raised concerns about enhancing the protection, conservation, and management of the natural world. In response, the Virginia Master Naturalist Program (VMNP) was launched by VCE in 2006. The program plans to develop a corps of well-informed volunteers who provide education, outreach, and service towards beneficial management of natural resources and natural areas within their communities. The VMNP is sponsored by VCE, the Virginia Departments of Game and Inland Fisheries, Conservation and Recreation, and Forestry, and the Virginia Museum of Natural History. Each local VMNP chapter is responsible for recruiting and training volunteers and for working with partners to create and coordinate volunteer service. The 40 hours of classroom and field time cover ecology, natural resource management, basic natural history of the animals and plants of Virginia, and skills for teaching and field research. Certified VMNs also complete 40 hours of service in education, citizen science, or stewardship. In 2006 the first ten chapters were formed with eleven other chapters close to implementation. These chapters are well distributed across the state in communities with a need for more natural resource volunteers. More than 75 volunteers served as local chapter coordinators and ten field staff from sponsoring agencies serve as chapter advisors. Four of the 10 chapters completed their basic training courses in 2006, graduating more than 100 volunteers. Many of the volunteers have started work on the service component of their certifications, and five individuals have completed certification requirements. Program evaluation questions, an evaluation plan, and evaluation tools have been developed for implementation in 2007.

Virginia's SHARP Logger Education. This program was implemented as part of the American Forest and Paper Association's Sustainable Forestry Initiative, designed to publicly demonstrate the forest industry's commitment to practicing sustainable forestry. The core training includes logging safety, sustainable forestry and harvest planning including best management practices. In addition, loggers must earn 12 credits of continuing education every three years to maintain their SHARP logger standing. A formal three year post-training evaluation of the program was conducted in 1999 and showed the program objectives were being met. In 2006, 1,078 individuals attended at least one program to earn SHARP logger credits through 44 programs. In one of these programs, 25 loggers earned SHARP logger status. They cited direct benefits of being able to sell logs to larger mills and increasing merchandising options due to their SHARP

logger status. Ninety-two percent of these participants indicated at the conclusion of the training, by written evaluation, that the training would help them financially and 95 percent identified at least one specific benefit including proper implementation of forestry best management practices, new pre-harvest planning skills, increased timber marketing options, and improved professionalism. Additionally, these loggers, who on average impact 23,104 acres of forestland yearly, believe this training will help them improve forest sustainability in Virginia. In one program, 56 loggers participated in the chainsaw safety demonstration class. As a result of participation several loggers indicated they would try new techniques. Eighty dollars worth of safety equipment was also purchased for use in the field. An additional 24 loggers who participated in the log grading and merchandising workshop for continuing education cited a substantial knowledge gain of log grading and merchandising. Seventy-five percent cited at least one action they planned to implement on the job, such as cutting logs to length to maximize quality rather than volume or studying the markets more closely.

Enhancing Best Management Practices in the Logging Industry. Water quality laws require loggers to observe best management practices (BMPs) to protect the environment. Extension offered BMP and water quality workshops to better educate loggers on the proper use of BMPs to protect water quality. The Virginia Department of Forestry and VCE through an indoor presentation taught basic concepts and added an outdoor site visit to demonstrate the proper use of BMPs on timber harvest sites. Seventy-one loggers attended the BMP and water quality law workshops in Southwest Virginia. Data from post workshop surveys show 98 percent of the loggers reported they increased their ability to correctly use BMPs to a great extent. Ninety-five percent reported they will “almost always” incorporate information gained on the water quality law into their future logging operations. Sixty-six percent of the loggers increased their ability to comply with water quality laws to a great extent.

Small Landowner Forestry and Conservation Education. Limited-resource and minority farmers and landowners rarely participate in forestry management and conservation programs offered by the government. In recent years, many small land owners are farming less land, from changes in government price support policies for major cash crops such as tobacco and peanuts. As a result, this farmland sits idle and farmers struggle to pay land-related taxes. Placing farmland in conservation programs and/or using forest management practices may qualify them to receive cost-share assistance to enhance the value of their land and pay dividends to help cover lost income. VSU worked with the Virginia Department of Forestry and the Natural Resources Conversation Service to implement educational tours to create awareness and increase participation among limited-resource and small-farm landowners in cost-share/conservation programs offered by state and government agencies. A total of 107 limited-resource and minority landowners participated in these tours. Participant evaluations indicate 25 percent plan to develop a forest management plan. Participating landowners planning to sell timber in the next year indicated they will seek professional advice and have a better understanding of the timber sale process which could increase timber sales up to \$1,000 per acre. One female landowner from requested a follow-up visit to discuss the effects and benefits of spray release on timber land. In turn, she shared this information with her son, and they met with a local forester to develop a forest management plan. These two landowners also qualified for cost-share assistance which saved up to \$2,500 dollars in out-of-pocket expenses. Additionally, by adopting the

prescribed conservation and management practices, it is projected the value of their timber stand may increase by as much as 50 percent.

Adding Value to Woodlands with American Ginseng. (see Integrated Research and Extension description on page 107)

Enhancing Prime Farmland Restoration. (see Integrated Research and Extension description on page 112)

Source of Funding: RREA, McIntire-Stennis, Smith-Lever, state funds, local funds, grant funds

Scope of Impact: State specific

Underserved Audiences: Small scale land owners

Nutrient Management

Basic Research

Improving Soybean Seed Composition for Increased Phosphorus Utilization. Soybeans are a major component of animal diets as a source of high quality protein. Soybeans also contain abundant phosphorus stored as phytate (myo-inositol hexakis phosphate) but is poorly digested by animals such as swine and poultry. Phytate also binds mineral nutrients such as calcium, magnesium, and zinc, decreasing their dietary availability. Undigested phytate is excreted in manure, applied to croplands in fertilizer, and becomes a pollutant in watersheds from agricultural run-off. Reducing phytate content in soybean seeds will provide a high value product for soybean farmers and offer an additional tool for nutrient management for livestock producers. The pathway for production of phytate is being studied to determine the best targets for reducing phytate accumulation in seeds by blocking specific steps in the pathway. Using a biotechnology approach, this project applies these basic biochemistry results to reduce phytate content in soybean seeds, improve phosphorus availability in soybean meal, decrease the need for nutritional supplements of animal diets, and reduce potential negative impact of animal agriculture on sensitive watersheds such as the Chesapeake Bay.

The Effects of Quantum Phytase on Bone Ash of Nursery Pigs Fed Reduced Phosphorus Diets. Amendments to the Clean Water Act of 1972 changed the application of manure to crops from a nitrogen (N) to phosphorus (P) basis. Crops use more N than P for growth, and hence, the amount of manure applied to the land is less when applied on a P basis. Cereal grains commonly used to feed animals store P mainly in the form of phytic acid. This form of P cannot be utilized by monogastrics such as pigs because they lack the enzyme, phytase, necessary to free the phosphorus. Phytic acid passes through the gastrointestinal tract of pigs without being digested and is excreted. Excess P excretion from farm animals contributes to environmental pollution. This study was conducted to evaluate the effects of a new phytase enzyme (Quantum, Syngenta Animal Nutrition, Inc., Research Triangle Park, NC) on body growth, food intake, food efficiency (food consumption-to-growth ratio), and percentage bone ash of young pigs fed diets low in phosphorus. Reduced growth, food efficiency, and bone ash content resulted from consumption of a low phosphorus diet. Addition of Quantum phytase to the same low phosphorus diet improved the growth, food efficiency, and bone ash content of pigs. Therefore, a reduction in phosphorus excretion without compromising the growth of monogastric animals such as pigs can be achieved by the addition of phytase enzymes to diets low in phosphorus.

Environmental Impact of Biosolids-Derived Trace Metals in a Piedmont Soil. Biosolids application to soils increased since ocean dumping was banned in 1988, tipping fees for disposal in landfills escalate, and farmers accepted biosolids as a cheap and safe plant nutrient source and liming material. However, long-term mobility and plant availability of biosolids-applied trace metals to soils has been raised as a serious environmental and health issue, particularly as organic material is lost and pH decreases. This study examined a site at the Northern Piedmont AREC that received several rates of a single heavy metal enriched biosolids application over the past 17 years. In this Davidson soil, essentially all (95 percent) of the applied trace metals were accounted for by mass balance calculations, more than 85 percent were in the topsoil, and a small amount of downward movement occurred to 0.35 meters. There was little risk of groundwater contamination of biosolids-applied trace metals at this site. Plant analysis revealed no significant effect of biosolids applications on yield of corn, lettuce, or radish when pH was maintained above 5. While plant tissue metal concentrations increased with biosolids rates, they remained within normal ranges for these crops, and within federal compliance levels. At this Piedmont site (Davidson soil), 17 years of exposure had little negative effect on the soil's ability to sequester and reduce heavy metal bioavailability, as long as soil pH is adequate to grow good crops.

Evaluation of P-cycling Processes in Soil: Development of Novel Methods. Phytase plays a key role in the biogeochemical P-cycling process because of its effectiveness in catalyzing hydrolysis of one of the most prominent organic P compounds in soil, phytic acid. Presently, there are no reliable methods available for measuring phytase activity in complex natural environments. Needed to solve this dilemma is a direct, highly specific, sensitive, convenient assay, capable of accurately measuring the fate of phytic acid during phytase-catalyzed dephosphorylation. A new approach for measuring phytase activity was developed employing a novel chromophoric substrate analog of phytic acid, 5-O-[6-(benzoylamino)hexyl]-D-myo-inositol-1,2,3,4,6-pentakisphosphate (i.e., tethered (T)-IP5) that permits direct measurement of the phosphate ester bond-hydrolysis reaction. Further, T-inositol phosphate intermediates and the final product, T-myo-inositol, are readily quantifiable using UV detection (wave length maximum 226 nm). Phytase catalyzes dephosphorylation of the T-IP5 probe producing in rapid succession T-IP4 then T-IP3 (identity confirmed using nuclear magnetic resonance spectroscopy), which accumulates as the reaction proceeds. Since the detection of T-IP5 and T-inositol phosphate intermediates all rely on the same UV-sensitive benzamido chromophore, which is not affected by number of P groups present on the inositol moiety, the parent compound, T-IP5, can be used as an external standard for the quantification on a molar basis, of all T-inositol phosphate species. T-IP5 will be useful as a molecular probe for measuring microbial phytase activity in complex environmental samples. With this new method for measurement of phytase activity it may be possible to elucidate: P source coefficients controlling conversion of recalcitrant P pools into bioavailable/labile P in P-based soil regulations, the impact of cultivation/cropping practices on rates of phytase-catalyzed P release in high P manured soils, the role of phytase activity as a potential indicator of ecosystem function and status, and the endogenous capacity for phytic acid digestion by cattle.

Polyphosphate Metabolism in *Pseudomonas fluorescens*. Microbial accumulation of P, as polyphosphate, is an unrecognized element of the P-cycling process in soils, including P-burdened manure amended soil. As soil microbes transform recalcitrant forms of P, to polyphosphate, a more labile form of P, they increase the amount of crop available P.

Polymerase Chain Reaction (PCR). Cloning techniques were used to isolate and sequence the *ppk1* (encoding polyphosphate kinase, PPK1) and *ppx* (encoding exopolyphosphatase, PPX) genes, with their respective regulatory regions, of the soil isolate, *Pseudomonas fluorescens* RBg10. RBg10, isolated from a P-burdened manured soil. This is a putative phytic acid degrading organism, accumulates polyphosphate while growing on a mineral salts media with phytic acid as the source of P. This research will help establish a new soil P-quality indicator.

Improving the Nitrogen Use Efficiency of Grain Production. In 2002, the total N load entering the Chesapeake Bay from Virginia was estimated at 77.8 million lb/yr, and agricultural crop production was estimated to contribute 18 percent of this load. The total N load from Virginia has decreased 16 percent from benchmark levels in 1985; however, additional reductions of 37 percent are needed to meet the nutrient reduction goal set for 2010. The environmental concerns associated with excess N fertilizer application put a premium on efficient production and more resourceful N fertilizer usage. This research focused on developing strategies for implementing optical sensor-based, variable-rate N fertilizer application technology into Virginia wheat and corn production systems. These strategies include correlating plant spectral measurements with plant biomass and N content, using in-field reference plots to assess crop responsiveness to in-season N fertilizer, and using this information to identify optimum in-season N fertilizer requirements. Sensor-based, variable-rate fertilizer technology can reduce N inputs for wheat and corn without affecting grain yield; thus, increasing N fertilizer efficiency compared to standard practices. Approximately 540,000 acres of wheat and corn are produced in Virginia each year. Assuming that N inputs to most of this area average 125 lb/acre/yr, approximately 68 million lb of N fertilizers are applied each year. This research has demonstrated that sensor-based fertilizer technology can reduce N use in Virginia by nearly six million lb/yr, making variable-rate fertilization an environmentally and agriculturally beneficial addition to the state.

Impacts of Compost, Manure, and Commercial Fertilizer on Soil and Water Quality and Crop Production. Applying compost to soil provides an environmentally sound method of treating, handling, and disposing of waste products. Composting destroys pathogens and weed seeds, stabilizes organic matter, and reduces the solubility and leaching potential of nitrogen; however, applying compost to soil to provide crop nitrogen needs may increase soil phosphorus concentrations to levels that reduce surface water quality. The amending of soils with compost can also provide non-nutrient benefits for plant growth. This research determined the existing range of organic N mineralization factors for cured, stable compost of 10 to 15 per cent are sound and result in little risk of nitrate contamination of groundwater. Despite increasing soil P to concentrations higher than required for maximum crop yield when applied annually at agronomic N rates, compost use actually reduced the potential for P impairment of surface water by reducing runoff and erosion, factors that contribute to P transport to surface water. No evidence for the beneficial non-nutritive effects of humic substances was observed despite the increases in soil humic substances with compost application. Compost can serve as a valuable soil amendment with little potential for water quality impairment when applied at agronomic N rates. Regular soil P monitoring should be practiced to prevent surface water quality impairment from long-term compost application.

Modeling Nonpoint Runoff Phosphorus Concentrations by a Water Soluble Phosphorus Soil Test. P loss in soil-bound and soluble forms from agricultural land is a major concern for water quality degradation. Runoff P concentrations can be dramatically different depending on soil properties, P sources and amounts, as well as transport and management factors. Runoff studies provide the best prediction of runoff concentrations, but are time consuming, difficult to perform, and require unique equipment. Soil test P (STP) provides an estimate of potentially labile P in the soil, but attempts to relate STP with runoff concentrations have had variable success. In this effort, runoff studies and as all specific soil P extraction tests used in established P-Indices were conducted on soil types representative of the major agricultural areas in Virginia. Of all existing P extraction tests, only water extractable P provided similar slopes when correlated to P in runoff waters for a given soil type. Furthermore intercepts from these relationships were highly related to soil clay content when grouped by a specific region. Coastal Plain soils exhibited a greater intercept than more fine-textured Piedmont and Ridge and Valley soils, and will yield a higher concentration of P in runoff than Piedmont, Ridge, and Valley soils for a given soil water soluble P level. Relationships between STP, clay content, and soil region/mineralogy will be used to improve interpretations in the existing Virginia P-Index regarding potential for soluble P loss in runoff.

Deploy Microbial Source Tracking to Solve Localized Water Pollution Problems. Microbial source tracking (MST) emerged as a new technology 12 years ago and has been used nationwide to identify sources of fecal pollution in water. Many researchers reported problems with approaches that required host-origin libraries, and Multi-State Project S-297 was designed to evaluate one of the best MST library-based methods, ribotyping. Results demonstrated that DNA ribotypes of the most widely used fecal indicator bacteria varied with geographical area, time of sampling, stream flow conditions, and animal diet. These results indicated library-dependent MST methods will require tens of thousands of isolates, will be time-consuming, and expensive to construct and maintain. The project then focused on three library-independent approaches. The first targeted sampling and was developed to reduce the effects of bacterial changes with geography and time. By reducing environmental complexity, existing MST methods could be performed faster and cheaper. The second approach was based on fluorometry, a chemical method that works by detecting optical brighteners from laundry detergents in water from malfunctioning septic drain fields and leaking sewer pipes. Results to date indicate that fluorometry is an acceptable, inexpensive method to detect human sewage in fresh and marine waters. The third approach was the development of a species-specific DNA primer that works in a biosensor to detect DNA sequences in the fecal indicator bacterium, *Enterococcus faecalis*. This is a positive first step in the development of an inexpensive new technique to rapidly detect pathogens directly in water. This three-technique approach was deployed in 2006 at a variety of watershed locations in Virginia and Georgia to perform field evaluation of the techniques and to attempt to solve local water pollution problems.

Environmental Fate and Transport of Fecal Bacteria from Livestock. Bacterial impairments are the leading cause of stream and river water quality problems in the U.S. While research exists on human and livestock bacterial sources, little research has been conducted on wildlife contributions. Numerous bacterial Total Maximum Daily Loads (TMDLs) studies in Virginia found elimination of all bacterial loadings from human and livestock sources is often insufficient to meet water quality standards because wildlife loadings alone may be sufficient to violate water

quality standards. The parameters used for wildlife bacteria concentrations being used in current Virginia TMDLs are suspect from lack of replication in source sample data or from making assumptions with no scientific rationale. Research was initiated to improve characterization of the bacterial loadings of wildlife to more accurately partition bacterial water quality problems between livestock and wildlife. The wildlife research is producing very different numbers for bacterial concentrations of semi-aquatic wildlife feces than are typically used in many TMDL's. In raccoon feces, levels of fecal coliform (FC), *Escherichia coli* (EC), and *Enterococcus* spp. bacteria are over half a billion bacteria per gram of feces. In addition, bacteria levels from other species being studied are higher than those currently being assumed. The levels of bacteria in muskrat, snapping turtles, and beaver, are in the 1,000,000, 100,000, and 50,000 bacteria per gram of fecal material range, respectively. One key finding is that snapping turtles are a source of enteric bacteria, a species that TMDL developers have completely ignored. Die-off curves of FC and EC bacteria appear to follow typically assumed first order kinetics, or first order kinetics following an initial period of growth. However, preliminary examination of the die-off curves of enterococci bacteria have shown unexpected growth many weeks after simulated terrestrial deposition. Increases in enterococci concentrations of two to three orders of magnitude have been seen two months after simulated deposition for raccoon feces. Die-off kinetics for bacteria in an aquatic matrix has been much more rapid, with bacteria levels dropping to below the detection limit within one to two months.

New Screening Procedures for Phytotoxicity and Leaching Potential of Land Applied Coal Combustion byproducts. Virginia and surrounding states allow coal combustion byproducts such as fly ash and scrubber gypsum to be land-applied as a soil amendment or a liming agent. However, routine procedures were not available for screening these materials to assure efficacy and a lack of combined phytotoxicity or leaching impacts. Working with industry cooperators, the Virginia Division of Mined Land Reclamation (DMLR) and the U.S. Office of Surface Mining, researchers devised and tested a new set of simple laboratory extract and greenhouse bioassay procedures that are relatively inexpensive and can be performed in less than 90 days. The VDACS and VDMLR are using researcher advice and input as they consider materials for mine placement or for labeling as them soil amendments. Proper application of these procedures will ensure beneficial recycling of these products and save landfill space while protecting soil and water quality.

Hydraulic Habitat Metrics for Stream Restoration Design and Evaluation. Interest in river and stream restoration increased dramatically over the last two decades. Conservative estimates place river restoration costs for the continental U.S. in excess of \$14 billion since 1990 with more than \$400 million spent on restoration projects in the CBW. Restoration goals include water quality, riparian management, in-stream habitat, fish passage, and bank stabilization. This research focuses on the interdisciplinary linkage between aquatic ecology and engineering. This project addresses the lack of quantifiable measures to evaluate stream habitat restoration projects and evaluates the hydraulic characteristics of in-stream habitat for successful stream habitat restoration. Specific objectives include evaluating flow complexity metrics to determine which ones directly relate to fish habitat preference, investigating the transferability of flow complexity metrics to predict the distribution of fish within the same geographic region, and using metrics determined to be biologically relevant to evaluate in-stream habitat structures for their ability to create preferred hydraulic conditions for fish.

Applied Research

Improving Water Quality and Grain Profitability with Cover Crops and Continuous No-Till Cropping. By 2010, Virginia is committed to making significant reductions of sediment, nitrogen, and phosphorus to Chesapeake Bay waters. The tributary strategies developed for each major watershed count on agriculture to provide the largest share of these reductions. Extension and Colonial Soil and Water Conservation District helped develop a grain cropping system to trap unused plant nutrients, prevent soil erosion, reduce fertilizer inputs, and increase soil organic matter. These proven benefits are derived from a systems approach that includes winter annual cover crops, continuous no-till cropping, and nutrient management. This system has shown that through species selection, planting dates, and winter nitrogen applications that cover crops are an important part of saving the Chesapeake Bay and provide an economic benefit to grain producers. This cover crop work has shown that early-planted rye can take up greater than 100 pounds of nitrogen and make six tons of dry biomass per acre. Cover crop acreage increased from 200 to 2,400 acres in New Kent and Charles City Counties between 2004 and 2005. The results of this research showed significant reductions in the amount of nitrogen uptake and biomass production. Based on this data the State BMP Cost-Share Program now puts a high priority on cover crop, continuous no-till cropping, and nutrient management practices.

Phosphorus Dynamics in Nutrient-rich Sediment. Sediments are repositories of nutrients and other chemicals in surface water. Inputs from agricultural and confined animal operations increase sediment phosphorus loading. Soluble forms of phosphorus could potentially be released from sediments into the aqueous environment when conditions in tidal current, pH, and river volume change. This project has been implemented at VSU-Agriculture Research Station (ARS) to determine the effects of temperature, dissolved oxygen, anaerobic conditions, and pH on the release of phosphorus from sediment. High phosphorus concentration correlated with high iron content and had non-uniform correlations with clay and calcium. At pH 5, phosphorus concentration was higher in anaerobic than aerobic sediments.

Improving Soil Quality and Agriculture and Environment Sustainability through Continuous No-Till Cropping Systems. Virginia, based on tributary strategy reports, is counting on agriculture to provide the majority of sediment and nutrient reductions needed to meet 2010 Chesapeake Bay water quality goals. Through a cooperative educational program conducted by VCE and the Colonial Soil and Water Conservation District for New Kent and Charles City Counties, 11,800 of 12,000 acres of small grain planted in 2006 were planted No-Till. In 1996 only 5 percent of this acreage was No-Till and by the year 2000, 70 percent of all small grain acreage was planted No-Till. A rainfall simulator study conducted on a Charles City farm in the year 2000 under a long term continuous No-Till cropping system showed a 74 percent reduction in water runoff; 99 percent less sediment loss; 94 percent less nitrogen loss; and 92 percent less phosphorus loss compared to conventional tilled wheat planting. Continuous No-Till cropping is working toward agricultural and environmental sustainability by increasing soil organic matter, trapping unused plant nutrients, preventing erosion, and helping with ground water recharge. Preliminary results showed increases in soil carbon that helps reverse 'Greenhouse Effect' from carbon emissions.

Economic Analysis of Alternative Cropping Systems. Energy costs have increased greatly and environmental impacts of grain crop production need to be minimized in the Mid-Atlantic

region. Over 135,000 acres of corn, wheat, barley, and soybean are affected by this cropping system in Virginia. An economic analysis was conducted on data from a five year field scale cropping systems project that compared three cropping systems on four soil types. The economic analysis indicates site-specific soil management should be considered as yields and profitability differ with soil series. Continuous no-till and cropping systems that reduce equipment requirements showed the greatest profitability. These data also illustrate to grain buyers that price levels associated with barley and wheat production during this period are not conducive to maintaining production in the mid-Atlantic Coastal Plain region, except on very productive soils. Prices have moved upward in response to declining acres due to low profitability.

Innovative and Cooperative Approaches to Support the Agricultural Community and Protect Water Quality. The Chesapeake Bay and many of its tributaries in Virginia and the Northwest part of the state do not meet EPA's standards for water quality from excess nitrogen, phosphorus, and sediment loads. One Chesapeake Bay Commission report identifies excess animal manure and poultry litter as an overarching problem for the Bay. The Virginia Department of Environmental Quality reported over 255,000 tons of poultry litter was transferred off of Shenandoah Valley farms in 2005. Of this amount, only 3 percent was transferred out of the CBW. Therefore, there is a significant community need and political pressure for wider application and implementation of nutrient reduction and renewable energy technologies. Innovative cost-effective nutrient reduction and renewable energy technologies that convert animal manure and poultry litter from being a liability for the agricultural community to a value-added resource that protect water quality and return revenue to the farmer are critically needed. A \$1 million grant from the National Fish and Wildlife Foundation was obtained by VT to pilot nutrient reduction and renewable energy technologies in Northwest Virginia's agricultural community. The objectives are to pilot a transportable pyrolysis unit to convert poultry litter into a bio-oil, synthetic gas, and fertilizer; decrease the cost of dairy manure transport through struvite precipitation of phosphorus; increase markets for manure, composts, and other value-added products; and provide other educational and cooperative approaches to reduce and better utilize nutrients.

Integrated Plant Nutrient Management (see Integrated Research and Extension description on page 112)

The Virginia Phosphorus Feeding Incentive Program (see Integrated Research and Extension description on page 112)

Extension Programs

Grass Guru Lawn Care Program. Urban water quality has been identified as a critical issue in Virginia. According to studies from the Elizabeth River Project and the Chesapeake Bay Foundation, individual homeowner lawn and landscape practices account for a significant percentage of the total amount of nutrients and pesticides in waterways. Reducing the pollution from these sources is critical to protecting and preserving water quality. In response, a VCE horticulture agent with Master Gardener volunteers initiated the Grass Guru, Homeowner Lawn Care Program. This program teaches property owners environmentally friendly methods for lawn care through educational sessions and individual on-site lawn care consultations. Individual property owners contract to stay with the recommended maintenance program for a year. During that time a Master Gardener Grass Guru assigned to them assists with evaluation and

consultation. The approximately 600 participants are surveyed through pre and post program interviews. Current data shows of the homeowners completing the program, 72 percent reduced the amount of fertilizer they use and 100 percent of the participants agree their lawns look nicer and are easier to maintain than before they began the program. Over 7 million square feet of turf was placed under a lawn care nutrient management plan for a two-year total of nearly 11 million square feet. Additionally, 92 percent of the participants are now mowing at the correct height, 67 percent are now mulching-in-place their grass clippings, 52 percent who never aerated now do so, and 88 percent understand their lawn care choices impact water quality.

Reducing Phosphorus in Feed and the Environment. Manure production from dairy herds can contaminate surface water with excessive P. Extension provided educational programs to demonstrate how farmers can reduce P in their operations. In 2006 this project included 183 Virginia dairy herds with over 30,000 cows representing over 30 percent of the Virginia dairy industry. One thousand five hundred forty-two feed samples were analyzed for multiple nutrients and educational programming was conducted for producers and nutritionists. As a result, producers reduced P in rations and manure to 2.92 grams per day per cow. For a 100 cow herd this reduction of 292 grams per day translates to 235 pounds of P yearly not present in the manure produced on that farm, thus reducing the potential for water pollution. With over 30,000 cows in the program this is a potential reduction of 35 tons of P per year.

Prescription Nitrogen Program Reduces Costs. Raising corn is expensive especially in 2006 when the cost of nitrogen and fuel were at an all time high. Farmers were seeking strategies for becoming as efficient as possible with their enterprises. Educational programs were held for farmers and custom nitrogen recommendations provided. During the 2006 crop year VCE tested 144 samples for nitrate representing 2,400 acres of corn. The results showed over 70 percent of the acres needed no nitrogen or a reduced rate of nitrogen. Accurate nitrogen recommendations were provided and as a result of this nutrient management program, farmers saved \$20,000 by reducing nitrogen fertilization rates. On fields where the sample analysis showed a full rate of nitrogen was needed, farmers benefited from knowing their fields needed additional nitrogen to obtain optimum yields.

Chemistry, Bioavailability, and Toxicity of Constituents in Residuals and Residual Treated Soils. (see Integrated Research and Extension description on page 111)

Efficient Tobacco Fertilization. (see Integrated Research and Extension description on page 116)

Evaluation of Nitrogen for Maximum Yields and Profits of Burley Tobacco. (see Integrated Research and Extension description on page 117)

Integrated Plant Nutrient Management. (see Integrated Research and Extension description on page 112)

Source of funding: Hatch, Smith-Lever, state funds, local funds, grant funds

Scope of impact: State and regional

Underserved audiences: Urban home owners, financially at-risk producers

Sustainable Agriculture

Applied Research

Medicinal Plants as Antibiotic Alternatives in Poultry. The Virginia Poultry Federation reports the poultry industry contributed approximately \$843 billion to the economy. Per capita U.S. poultry meat consumption rose from 34 pounds in 1960 to 100 pounds today. Virginia exports 16 percent of their chickens and 8 percent of turkeys to other countries. Use of antibiotics in food animals such as poultry has been linked to the generally high frequency of resistant bacteria in their intestines, which may be passed through the food supply. The indiscriminate use of antibiotics could ultimately compromise the treatment of bacterial infections in humans as many of these drugs are used in human medicine. Several major poultry producers in the U.S. voluntarily stopped using certain antibiotics in chickens for growth promotion and disease prevention. This resulted in the need for natural, non-antibiotic alternatives for growth promotion and disease prevention. In response to the poultry industry's need for alternative sources of growth promoters and reduction of bacteria in poultry, research is underway at VT to identify plant natural products with antibiotic qualities. The research may provide agriculture with new sources of plant-derived antibiotics as growth promoters thus decreasing reliance on standard antibiotics and increases in bacterial resistance spreading from animals to the environment and more importantly into food production. Initial screening of plants known for medicinal qualities identified several sources of compounds that inhibited growth of *Salmonella* sp., *E. coli* sp., and other bacteria in tissue culture. Further experiments will include the addition of effective medicinal plants to poultry feed. Growth will be monitored, as will the numbers and types of bacteria being released into the poultry feces.

Extension Programs

Plasticulture Best Management Practices for Tomato Producers. (see Integrated Research and Extension description on page 112)

Source of Funding: Hatch, Smith-Lever, state funds, local funds, grant funds

Scope of Impact: Region-specific

Underserved Audiences: None

Water Quality

Extension Programs

Water Resources Training. Many studies show water quality declining in many parts of Virginia. In response, Extension provided 13 water quality training workshops for 415 adult educators (Extension Master Gardeners, Envirothon coaches, classroom teachers, university faculty, state agency, and non-government/non-profit personnel) for a total of 58 hours. Training content included watershed and water quality, biological/chemical monitoring, and water-related curricula. Pre-post tests and surveys indicated an average increase in participant's knowledge, and understanding of presentation content ranged from 63-87 percent. Nineteen Envirothon coaches reported a 78 percent increase in content knowledge, 70 percent increase in training resource awareness, and 60 percent increase in content presentation ability. Twenty-three Master Gardeners reported an average 67 percent increase in awareness of the relationships between Master Gardener certification training and its role in water resource protection. Chesapeake Bay

Academy teacher participants reported an average 69 percent increase in understanding of Bay resource issues and processes, educational curricula, and classroom/field-study applications.

4-H Water Resources Training. Extension 4-H agents and adult volunteers need current and applicable instructional resources and training to provide effective educational programs for positive youth development. To meet this need, VSU conducted educator training through the 4-H Marine/Aquatic Education Program. Five workshops reached 201 Virginia and out-of-state 4-H professionals and volunteer leaders for 22 hours of instruction. Presentations included watershed and water resource education, water quality monitoring, educational curricula and 4-H camp programming. Extended trainings were conducted for 4-H educational center staff and volunteers (10 hours, 20 participants) and Northampton County 4-H volunteers (nine hours, 11 participants) on natural resource and environmental education (NREE) content. Trainings resulted in increased effectiveness of NREE programs at the 4-H centers. The centers reported knowledge increases from pre/post testing ranging from 48 percent to 75 percent depending on session content and duration. 4-H center staff reported increased familiarity with outdoor classroom NREE activities and content and enhanced teaching skills. Approximately 3,200 youth benefited from the 4-H center staff training. Project Water Education for Teachers (WET) and Discover a Watershed training in Northampton County (9 hours, 11 participants) resulted in a 79 percent increase in content awareness and knowledge, greater familiarity and comfort with water resource education curricula, and increased awareness of and commitment to stewardship behaviors (6.8 to 8.3 of a 10-point scale).

Water Wizard Van Program. Water is a limited-resource and important for all aspects of life. Teaching people how to protect and conserve water resources is a major goal of many local, state and national organizations and agencies. Therefore, the Virginia office of the Natural Resources and Conservation Service (NRCS) dedicated a cargo van to the Virginia 4-H Program that serves as a traveling, water resource, education vehicle. The van in operation since 1999, is managed by the Virginia 4-H educational centers and coordinated by VCE. More than 50 programs were conducted during 2006 involving 5,302 youth and 26 adult instructors. The van has become an integral part of 4-H summer camp environmental education programs and a focal point for visiting school groups during the off-camping season. One program evaluation with 97 students, grades three through six was conducted. The results indicated youth preferred interactive modules and games over watershed and aquatic insect identification. Youth were quick to relate important facts and concepts they learned about water processes and issues. One teacher stated the Water Wizard Van was "A great resource that was both educational and engaging."

Improving Productivity of Farm Ponds. Many Virginians have farm ponds that management to improve the ponds for recreational fishery and other alternative uses, such as small scale aquaculture. Working with Extension agents, VSU faculty offered educational programs in water quality for farm pond owners in Virginia. Workshops in Southside Virginia focused on pond management for recreation, fun, and profit. The workshops promoted the use of ponds for aquaculture. In 2006, four workshops were conducted for over 100 farm pond owners. Water from their ponds was tested or an on-site visit was arranged for examining water quality and providing recommendations for improving water quality. Information on cage culture production of catfish or trout was also given. The workshops resulted in 50 percent of the attendees taking action to improve the water quality of their pond including increasing the alkalinity and hardness

of the pond, allowing it to be more productive for growing fish. The workshops resulted in eight site visits to analyze farm ponds for recreational and aquaculture uses. More significantly, the workshops provided opportunities to start cage culture fish operations. Several of the attendees indicated they would try cage culture in their ponds. The workshops increased participants' farm pond management knowledge and skills by 30 to 40 percent.

Agronomic Uses for Reclaimed Water. (see Integrated Research and Extension description on page 113)

Composting and Compost Use. (see Multistate Extension description on page 97)

Disposal of Unwanted Pesticides. (see Integrated Pest Management description on page 53)

Improving Chesapeake Bay Water Quality. (see Multistate Extension description on page 114)

Novel Research Stimulates Practice Changes in the Nursery and Floral Industry. (see Integrated Research and Extension description on page 114)

Source of Funding: RREA, MacIntire-Stennis, Federal Smith-Lever, state funds, local funds, grant funds

Scope of Impact: State and regional

Underserved Audiences: Small scale landowners

Funding and FTE's

Federal Smith Lever Funds: \$1,614,558

Federal Hatch Funds: \$2,031,131

State Matching Funds: \$4,674,066

Local Government Funds: \$2,949,494

Grant and External Funds: \$7,937,630

FTE: 126.52

Goal 5: To enhance economic opportunities and the quality of life among families and communities.

Virginia Cooperative Extension (VCE) and the Virginia Agricultural Experiment Stations (VAES) focus on enhancing economic opportunities and the quality of life among families and communities throughout the Commonwealth of Virginia. Extension agents and specialists at the Land-Grant universities of Virginia Tech (VT) and Virginia State University (VSU) worked with adults, children and youth, volunteers, other organizations and groups, and communities to achieve this goal during the reporting year. The accomplishments of VT and VSU research, and VCE programs during 2006 enhanced the economic opportunities and the quality of life among families and communities in several key theme areas. The highlights of these theme areas are presented in this summary.

During the reporting year, farm families, rural and suburban families, and the families of urban populations throughout the state benefited from VCE and VAES research and educational programming. Reported impacts validate improved quality of life for these families, as well as

the capacity of communities and local government to improve the quality of life for children, youth, and adults.

Agriculture Natural Resources (ANR) agents and specialists conducted programs and provided educational information which contributed to the increase of knowledge, attitudes, skills, and aspirations of the citizens of the Commonwealth. These agents and volunteers worked to address the needs and priorities of citizens by involving 82,967 extended learners and 7,653 volunteers. These volunteers contributed 270,038 hours time valued at \$4,871,486. Additionally, a total of \$1,818,296 of revenue generation was contributed by agents to ANR programming.

VCE's Family and Consumer Sciences (FCS) programs provided informal education that increased knowledge, influenced attitudes, taught skills, and inspired aspirations. Through the adoption and application of these practices, the quality of individuals, family, and community life in Virginia was improved. During the reporting period, FCS faculty brought specialist, agent, and volunteer expertise together to address the needs and priorities facing Virginia's families. Family and Consumer Sciences programs involved 115,163 extended learners and 7,557 volunteers, contributing 95,302 hours of volunteer time, valued at \$1,719,248. A total of \$1,032,749 of revenue generation was contributed by agents to FCS programming.

Virginia 4-H Extension agents and specialists provided educational programs that reached 238,371 extended learners. The 4-H program efforts were supported and sustained with 20,320 volunteers contributing over 745,563 hours of time, valued at \$13,449,957. There were 237,713 extended learners with a minimum of six hours of programming exposure in 4-H programs. Educational 4-H programs were delivered in 10 subject matter areas, including animal sciences, citizenship, communication and expressive arts, natural resources and environmental education, leadership and personal development, plants soils and entomology, and science and technology. Revenue generation contributed by 4-H agents to 4-H programming totaled \$3,097,273 with an additional \$865,099 contributed to the six 4-H educational centers for a combined total of \$3,962,372. Statewide, the 4-H program experienced 13 percent growth in enrollment over the previous year. The number of members increased from 157,068 to 177,282. Of this number, 31 percent represent minority populations, the highest percentage of any department at VT (28 percent last year). Additionally, growth in teen programming increased to 15.4 percent of total enrollment (14.5 percent last year). A total of 25,874 youth and adults participated in 4-H camping last year.

Community Viability programming involved 395 volunteers and 11,421 extended learners. A total of 11,504 hours of volunteer time were contributed, valued at \$207,532.16. Revenue generation by Community Viability specialists reached \$116,004 for this reporting cycle. This programming was effective in helping families improve their lives through community improvement, creative employment to alleviate job loss, and alternative entrepreneurship.

In total, the four major program areas above involved 447,264 extended learners and 38,660 volunteers contributing 1,136,084 hours of volunteer time worth \$20,455,753. Also, a total of \$21,936,809 of external funding was contributed to VCE in 2006.

Research and Extension outputs generated as part of this goal included: 8 refereed journal articles, 4 books and book chapters, 21 numbered Extension publications, 9 papers presented at professional meetings, 26 manual and guides, and 30 other reports.

This section highlights the 2006 accomplishments of VT and VSU Extension and research in enhancing economic opportunities and the quality of life among families and communities. Thirteen theme areas are presented for Goal 5:

- Aging
- Character/Ethics Education
- Child Care/Dependent Care
- Children, Youth, and Families at Risk
- Communication Skills
- Family Resource Management
- Agricultural Financial Management
- Home Safety
- Job/Employment
- Parenting
- Promoting Business Programs
- Supplemental Income Strategies
- Youth Development/4-H

All the reports in Character/Ethics Education and Communication also apply to the Youth Development key theme area.

Key Themes

Aging

Extension Programs

Farm Succession Planning. The aging of the U.S. farm population is resulting in a significant turnover in asset ownership and management control. This trend presents opportunities for the next generation and potential problems for those interested in entering production agriculture. Farm families from across the state received introductory and in-depth Extension programming in the farm succession planning process. Participating families learned about goal setting, family communication, business evaluation, income tax planning, estate planning, and insurance/retirement planning to help pass their farm business on to the next generation yet meet the goals of all the generations involved in the business. Approximately 60 farming operations were involved in the series. With 14 percent of Virginia's gross product coming from agriculture, this VCE program helped stabilize the state's economy by helping farm families transfer ownership and management of their farms rather than go out of business.

Improved Quality of Life for Older Adults. The aging population in Virginia continues to rise. This trend results in the presence of many chronic diseases that result in increased healthcare expenses, caregiver burden, and consequently reduced quality of life for individuals, families,

and communities. If better managed, the impact of these diseases could be lessened and could lead to improved quality of life for older adults, decreased medical expenses, and increased individual independence. Extension collaborated with senior center directors to develop Active Aging, a four-part series on managing common chronic conditions through diet, exercise, and cognitive activities. The pilot of this program involved 139 senior adults. Locations were accessible to public transportation and included community centers, senior centers, and a senior apartment complex. Of the 45 participants who completed the weekly evaluations, 89 percent rated the program as valuable or very valuable, 96 percent set specific health-related goals, and 89 percent instituted at least one behavior change by the end of the four-week series.

Source of Funding: Smith-Lever, state funds, local funds, grant funds

Scope of Impact: State specific

Underserved audiences: African American grandparents, senior adults

Character/Ethics Education

Extension Programs

CHARACTER COUNTS!SM Impacts Brazilian Schools and Virginia. Seventy percent of the Brazilian population is indigent and experiences high rates of crime and violence. According to one report, the violence index at schools is very high and growing at a frightening, uncontrollable rate. Non-governmental organizations conducted surveys on the issue. Increased violence comes from a lack of values among youth in Brazilian families; a lack of future opportunities for Brazilian youth; enticement of the young by drug dealers; impunity of crimes committed by youth; and the lack of programs focused on the rehabilitation of young people with inappropriate behavior. In response, a team of VCE 4-H youth development faculty conducted CHARACTER COUNTS! (CC!) training in Brazil. This program provides instruction on six pillars of character for positive behavior change. Extension trained 250 principals and teachers from 72 schools with 72,000 students who comprise 18 percent of the total population. To sustain CC! in Brazil, the team met with representatives of the Rio de Janeiro Judges School and the local Rotary Clubs. The team is also orchestrating a judges' exchange between Brazil and Virginia. The results of these efforts show 86 percent of participants rated the training as excellent or very good. Since the training, participants met to develop school-wide CC! implementation plans and behavior strategies for 65 schools. Eighty percent of these schools reported positive results from teachers and parents in the first year of implementation enhancing the integration CC! into other programs such as drug prevention and environmental preservation. Additionally, 57 percent of Joinville Rotary Clubs in Brazil committed to raise funds for CC!

Virginia 4-H has actively been involved with the CC! program for over a decade. This year, trained 4-H agents, volunteers, and 4-H educational center program directors implemented 4-H/CC! programs with all six 4-H educational centers and in 46 counties and cities throughout the state. This educational programming involved 31,840 youth during the year. Significant positive behavior changes by children enrolled were made in all six "pillars of character." Program impacts with youth involved in the 4-H camping program also demonstrated significant positive behavior changes in the areas of respect for others, caring for others, and being responsible for one's own belongings.

Source of Funding: Smith-Lever, state funds, local funds, grant funds

Scope of Impact: State and International

Underserved audiences: African American youth, Hispanic youth, Brazilian youth and adults

Child Care/Dependent Care

Extension Programs

Training for Child Care Providers. The Virginia Early Childhood State Plan proposes strategies for family-centered, coordinated, prevention-oriented and funded services to support the health and development of young children. The plan has one objective to build a supply of trained, quality child care providers to adequately meet community needs. Partnerships between the Virginia Department of Social Services (DSS) and VCE helped local child care providers obtain state-required training. Through a Quality Initiative Grant, workshops based on the Penn State Better Kid Care Training Program are offered on a monthly basis. In one county, seven sessions reached 78 participants, and in another county 232 providers attended 11 workshops. Of this number, 17 providers attended six or more workshops obtaining 200-300 percent of the required training hours. In post-program surveys, 90 percent of the child care providers planned to use one or more new ideas from the classes in their programs.

Nutrition and Physical Activity Training for Child Care Providers. Increasing obesity rates in children are a nation-wide dilemma. Child care providers can help curb this trend. Extension worked with DSS and the Success by Six Early Childhood Coalition to teach child care providers about stretching their food dollar when planning nutritious meals for children, appropriate serving sizes for children; understanding food labels; incorporating at least 60 minutes of physical activity into every day; and preparing healthy snacks for children. One hundred sixty-seven child care providers participated in these trainings. Program evaluations showed 97 percent of the participants understand ways to incorporate more physical activity into child care programs. Ninety-four percent of the participants increased their knowledge of strategies to promote positive attitudes and habits toward food among youth, including family-style meals, healthy portion sizes, and creative ways to deal with picky eaters.

Improving Child Care Accessibility. Over 75 percent of the women in some Virginia counties are working outside of the home, resulting in dual income families arranging for non-parental child care. Waiting lists for child care have been created by the escalation of this population. The Family Child Care Program addresses the need to create regulated child care slots for family child care. This program provides education for potential caregivers on state and business licensing requirements; voluntarily registration; zoning regulations; the USDA food reimbursement program; and liability insurance state and business licensing requirements; voluntarily registration; zoning regulations; the USDA food reimbursement program; and liability insurance to help them to make informed decisions about developing the business aspects of family-based child care. As a result, 155 participants were trained to start family child care businesses. Post program surveys reveal 95 percent of participants will start a business and become either state licensed or voluntarily registered. Since each provider who becomes eligible for state licensing creates up to 12 regulated child care slots and voluntarily registered up to five regulated child care slots, the 155 participants could add 1,860 child care slots. A review of state

licensing and voluntarily registration records published by DSS indicates 10 percent of the 155 individuals trained have become regulated providers.

Enhancing Child Care in Virginia. For many child care providers few professional contacts or sources of support exist. The Inter-County Childcare Connection collects and maintains standardized statewide child care data. This ChildNet database network served 310 childcare programs throughout the region with 82 percent of them having direct contact with VCE. More than 1,037 child care program contacts occurred through the network, and more than 298 resource and referral contacts were made with at least 149 families and over 187 children. Extension responded to 166 community contacts for resource and referral services. Twenty-three educational workshops were held on the business of family child care, cardio pulmonary resuscitation certification, partnering with parents, family child care taxes, and supporting family style meals involving 219 participants from 66 child care programs. The program brochure was translated into Spanish to reach more parents and translated flyers and translation services for program events were offered and used. Evaluations of the workshops showed participants increased knowledge, skills and abilities in child care and accessibility of resources in the community. Providers also reported increased confidence in their ability to work with children and families with special needs. A parent follow-up evaluation of the referral process revealed VCE consistently meets or exceeds state standards for follow-up.

Supporting Grandparents as Kinship Care Providers. (see Parenting description on page 80)

Source of Funding: Smith-Lever, state funds, local funds

Scope of Impact: State specific

Underserved audiences: African American adults, low-income families, Spanish speakers

Children, Youth and Families at Risk

Extension Programs

Helping Immigrants Succeed. Many Virginia communities have large or increasing immigrant populations that face a variety of challenges. This mentoring project for immigrant youth endeavors to increase academic performance, introduce positive role models, reduce unexcused absences, and sustain mentor/mentee matches over extended periods of time. Program evaluations of 23 mentor/mentee matches reveal 62 percent of the program's youth improved at least one letter grade in at least two core subject areas; 76 percent of the youth improved at least one letter grade in at least one core subject area; 75 percent of the youth enjoyed working with their mentor and have a very good relationship; 100 percent of the youth stated their mentor provides tutoring and homework help; and 88 percent believed their mentor is very involved in their school work and they see their mentors as a positive role model. Finally, 100 percent of youth surveyed believe their mentor cares about them and makes them feel important. Overall, report card evaluations show a significant improvement in academic achievement correlated with youth time spent with mentors.

Educating Parents with English-as-a Second Language. Many of Virginia's residents speak a language other than English as their first language and have little access to nutrition education information in their native language. Many of these residents consider obesity as a sign of wealth

and good parenting. Key informant interviews with school nurses revealed many recent immigrant children gain as many as 20 pounds during their first few years in the U.S. due to diet and activity changes. To combat these challenges, Extension focused on communicating with low English literacy parents about healthy nutrition and physical activity. The program also provided opportunities for parents and children to participate together in nutrition programs and offered grade-appropriate Standards of Learning instruction for schools. In total, 1,076 parents and children participated in these Extension childhood overweight programs. Program evaluation showed 89 percent of the middle school students who completed the reading-a-food-label evaluation could explain a label to a friend. Sixty-nine percent of teens and adults who completed the MyPyramid Choices post evaluation said they would visit the MyPyramid.gov website again, and 85 percent of English-as-a-Second-Language adults who participated in MyPyramid Choices said they would incorporate more fruits and vegetables into their diet. Due to low literacy, this evaluation was an oral post evaluation. Train-the-trainer evaluations showed 92 percent of childcare providers who attended the MyPyramid Choices Response intended to implement this program in their facilities within 12 months.

Decreasing Risk of Obesity in Youth. Lack of physical activity and poor nutrition contribute to weight problems of youth that put their health at risk. School health advisory committees (SHAC) and school health advisory board (SHAB) identified youth nutrition, especially school lunches and snacks, as a contributor to youth health risks. In response 4-H worked with SHAC volunteers to conduct the “Dairy and Me” program. The program promoted healthy nutrition and physical fitness through educational sessions, exhibits, and activities 600 youth in grades three to five. All students participated in lunchroom exhibits, displays, and dairy food sampling. 4-H with SHAB received grants to expand the wellness and fitness program. Six additional educational programs were conducted about the benefits of three daily servings of dairy for 120 students. One program evaluation shows 97 percent of participants rated the event as excellent; 56 percent increased dairy products in their diet; 50 percent tried new foods; 53 percent increased their level of exercise; and 69 percent increased their awareness of healthier food choices. Other program outcomes include 50 percent of students completed a food log during the four-week program; parents sent healthy dairy food snacks for school holiday parties; one school cafeteria now serves only two percent or less fat milk; one cafeteria manager incorporates demonstration foods into regular menus; and 120 youth participated in extra “Let’s Get Physical” activities. One school food service reported a 13 percent increase in the number of lunches purchased and milk consumed during the program. One lunchroom monitor said, “This program has really helped the students to be more mindful of the items they pack in their lunches and the choices they make at the snack room.” As a result of the program, one SHAB received a \$10,000 grant to more fully address increased physical activity and improved nutrition in youth.

Improving Life for At-Risk Youth. National and state studies find childhood obesity is growing. In particular, 42 percent of youth, ages five to 13, are now overweight or at risk of becoming obese. 4-H partnered with Project Right Start, a national program providing formation on good nutrition choices and tobacco awareness funded by a county community foundation. During the reporting year, 1,800 kindergarten through fifth-grade students participated in this program through this partnership with 4-H, school cafeteria managers, school teachers, physical education teachers, and school principals. Educational programming included MyPyramid.gov, food tasting, coupons for free fruit, and a monthly newsletter for parents and stakeholders. As a

result of this program, three weight management programs have begun with students. A total of 54 members lost 213 pounds in two months. Two schools are vying for the Governor's Score Card for this program; 73 teachers lost 786 pounds; and three schools started a walking club for teachers and students. One school now provides dance exercise each morning and an exercise program started at a wellness center for youth and parents with 139 students participating.

Addressing After-school Safety for Youth. In many counties across Virginia, the workforce commutes out of the county for employment. As a result, many children are home alone after school, and with parents working a significant distance away, they are not accessible in an emergency. Research indicates children who stay home alone are at risk for loneliness, boredom, and early sexual activity. The Strong Families-Competent Kids curriculum teaches children in fourth grade safe practices when they are home alone. One hundred forty-two volunteers and school staff delivered the Strong Families-Competent Kids program to 4,131 fourth-grade students in 44 elementary schools. A survey conducted with 416 students demonstrated a 28 percent increase in knowledge of issues of safety and well-being when home alone.

Source of Funding: Smith-Lever, state funds, local funds, grant funds

Scope of Impact: State specific

Underserved audiences: Immigrant populations, at-risk youth

Communication Skills

Extension Programs

4-H Helps Schools Meet State Standards of Learning. Virginia's public school Standards of Learning (SOL) include the development of effective oral communication skills, including presenting and listening to presentations and reports. Elementary students are also required to use subject-related information and vocabulary, organize information, and present clear directions to individuals and small groups. 4-H public speaking and presentations contests help develop these communication skills. Participants research a topic, organize information for clarity, and deliver information effectively to a group. Eighty-five youth ages nine to 18 participated in a 4-H district public speaking and presentations contest. Fifty-three completed written evaluations. The following communication improvements were noted on a scale where 1 represents no improvement and 5 represents significant improvement: gathering information - 3.58, organizing information - 4.00, and speaking in front of a group - 4.15. Sixty-seven parents completed evaluations indicating the degree to which their child improved in the same areas: gathering information - 3.66, organizing information - 4.18, and speaking in front of a group - 4.37. Nineteen parents mentioned gains in their child's self-confidence from participation. One parent commented, "The ability to communicate is essential in life, and this is a superb way to hone that skill." In some counties, teachers require students to complete a 4-H presentation for a grade because the event covers SOL's for oral communication skills. Fifth-grade educators also use the 4-H oral presentation format to prepare students for the SOL writing exam.

4-H Alleviates Fear of Public Speaking. Research shows 50 percent to 75 percent of adults fear public speaking, yet communications skills are second only to job content knowledge in ranking of skills desired by corporate employers for new hires. Research also shows youth involved in 4-H have decreased fear of public speaking and an increased aptitude toward this life skill. In 4-H

school and community clubs, youth have many opportunities to speak in public. Ninety-eight fifth-grade youth, including those with developmental disabilities, enrolled in a 4-H public speaking workshop all 98 gave presentations. The teachers made this work part of the core curriculum, and the presentations were graded. In an evaluation one month after presentations were given, 85 percent of youth said they thought they would be less nervous speaking in the future, 95 percent found the experience helpful, and more than one third of the students wanted to give their presentations at the county 4-H speaking contest.

Source of Funding: Smith-Lever, state funds, local funds

Scope of Impact: State specific

Underserved audiences: African American youth, Hispanic youth

Family Resource Management

Extension Programs

Reality Store Improves Youth Money Management. Teenagers need to manage money to be successful. Most youth learn about money management from their parents. To help teens better understand financial management Extension offered the Reality Store program for eighth grade students. The Reality Store provides career exploration, decision-making, and money management experiential learning through a simulation. Students choose a career and spend their monthly salary to cover basic needs for a randomly selected family. Eighty-seven percent of students participating in this program responded they became more aware of the need to budget money and make wise financial choices. Ninety percent increased awareness of the expense of having children and the importance of having a good education.

Improving Financial Management in Young Adults. Young adults as a group have rapidly growing rates of bankruptcy and identity theft. Most of them live paycheck to paycheck, with few reporting savings for the future or retirement. Young adults are graduating from college with records levels of debt for education and credit cards. Extension provided a basic financial management course for 400 university students. As a result of the course, participants improved their financial literacy and learned how to manage their financial future with basic financial planning principles and products. Students practice budgeting skills during the class and develop a comprehensive budget their first year after graduation. In the budget narrative, students reported knowledge gains and increased confidence in managing their financial future.

Kids' Marketplace Focuses on Money Management. Older children and teens are a growing segment of the consumer market. Studies show parents feel unable to teach children about personal financial management, so children and teens are often left to their own devices to learn how to manage money. The Kids' Marketplace program gave children practice making spending decisions while learning how to stay within a budget. Each child is given a job with a salary used to purchase normal monthly expenses. One hundred twenty-two second grade students participated and 17 volunteers contributed 80 hours to this program. Volunteer evaluations about the program stated, "It is never too early to begin teaching children the value of saving and understanding the consequences of choices;" "It helps children to watch what they spend, how to count out large amounts of money, figure out their change back, and what resources are used in everyday life;" and "It helps them to truly understand the concept of 'money doesn't grow on

trees.’ It helps them to learn that you can always have everything fun you want.” When asked about the most important concept learned, children responded, “Counting money;” “You should make wise choices;” “About income and savings accounts;” and “You have to make good choices when you grow up.”

Money Management Education for Prisoners. Incarceration prolongs the repayment of child support, credit card, and other debts, and many prisoners are also required to pay court fees and restitution related to their offenses. Without proper money management skills and knowledge, former male prisoners often revert to illegal behavior to make necessary payments, thus contributing to high recidivism. Studies show the recidivism rate decreases 29 percent for those completing life skills training while incarcerated. One hundred men from two detention facilities attended a series of money management classes on goal setting, budgeting, cutting costs, credit and debt management, starting a small business, saving and investing, taxes, and home buying. A survey conducted at the end of the classes revealed 100 percent of participants could list steps to get out of debt, and 100 percent could list at least two ways to save money. Participants also listed actions they planned to take as a result of the classes, including preventing re-incarceration, quickly paying child support, and keeping a job.

Improving Financial Management for Underserved Audiences. Financial education has emerged as an issue with bankruptcy at an all-time high. Families are experiencing financial stress due to job layoffs, increased transportation costs, the high cost of housing and child care, as well as incomes falling behind the rising costs of living. A lack of financial education and the inability to manage resources effectively contributes to bankruptcy, lower employee productivity, divorce, and other negative issues. Extension offers free financial education through one-on-one counseling and workshops. Counseling covers budgeting, credit and debt management, savings, record keeping, and values clarification. Volunteers are recruited and trained to work with individuals and families. One financial counseling coordinator worked with volunteers to conduct workshops in local shelters and counseled 13 families one on one. Overall, the program served 148 clients with financial counseling. Three families living in community residential shelter housing saved collectively \$3,000 and eradicated debt of over \$35,000. Five families living in transitional housing decreased debt collectively by \$4,803. Ten clients that participated in one-on-one counseling avoided bankruptcy, one avoided eviction, and five collectively paid back taxes of \$3,083. Clients report improved family communication about money, planning for expenditures, and decreasing household expenses. Fifty-eight individuals served through group workshops, and all other participants reported increased knowledge on financial management. Sixty-nine volunteers contributed approximately 4,100 hours of service assisting families with financial counseling.

Ethics for Tax Practitioners. (see Multistate Extension description on page 101)

Source of Funding: Smith-Lever, state funds, local funds

Scope of Impact: State specific

Underserved audiences: Incarcerated men, at-risk families, African American and Hispanic adults

Agricultural Financial Management

Extension Programs

Rural Families Enhance Financial Management through Livestock Sale. Many rural families struggle to make ends meet financially. Junior livestock shows and sales provide an opportunity for 4-H members to teach show and sale attendees about leadership, livestock, financial management, sportsmanship, recordkeeping, and healthy physical activity. In one sale, twenty-two 4-H members participated in the show and sale, which had one hundred exhibitors. The 4-H members exhibited sixteen hogs, fifteen lambs, five steers, and sold their animals for a gross profit of \$19,000. One hundred percent of the exhibitors completed a financial record sheet.

Small Farm Outreach and Technical Assistance. VSU Extension specialists, agriculture management agents, and technicians conducted the small farm technical assistance and outreach program in selected Southside and Southwest Virginia counties. Participants received information, training, and technical assistance in agricultural production, record keeping and analysis, loan application packaging, business management, marketing, financial management, agricultural risk management, and USDA farm programs for small, limited-resource, and socially disadvantaged producers. Direct contacts were made with more than 3,800 individuals during 2006 through farm visits, conferences, workshops, group meetings, farm demonstrations, field days, phone calls, direct mail, and other methods. A survey of participants indicated over 70 percent of participating producers now make more informed production, marketing, financial, and business decisions. Recent research to evaluate program impacts, found the program significantly increased net farm income (\$4000 - \$12,000+/year) for the average participant. Economic benefits from the program increased with the intensity of the producer's participation in the program.

Agricultural Risk Management Training. (see Multistate Extension description on page 101)

Farm Succession Planning. (see Aging description on page 70)

Source of Funding: Smith-Lever, state funds, local funds, grant funds

Scope of Impact: State specific

Underserved audiences: African American adults, at-risk farm families

Home Safety

Extension Programs

Increasing Home Ownership. Many people are unaware of where to begin to own their own home or what to expect from the process. After purchasing a home, many owners are unaware of cost-effective ways to maintain their homes. For the past 15 years, VSU has conducted an annual home ownership program for potential and existing homeowners. Topics include steps to home ownership, credit and budgeting, mortgage financing, predatory lending, wills and legal issues, insurance, landlord and tenant rights, fair housing, indoor air quality, energy conservation, loan closing, the role of the realtor and lenders, and maintaining and enhancing property values. In conjunction with the Virginia Housing Development Authority, Extension offered in-depth classes and a fair for potential homeowners. As a result of these efforts, 65 home education participants purchased homes. Certificates were also issued for completing home education

programs and helped participants secure loans from lenders. Ten workshops on home maintenance and repair included 180 participants and resulted in a net saving of nearly \$7,000.

Source of Funding: Smith-Lever, state funds, local funds

Scope of Impact: State specific

Underserved audiences: African American adults

Jobs/Employment

Extension Programs

Improving Revenue for Virginia's Watermen. Reduced catch from local fisheries, increased operational costs, and competition in the marketplace from foreign producers reduces revenues for many Virginia watermen. As a result, many watermen leave their fishing heritage, endure financial hardship, and search for alternative employment. Increasing income opportunities for Virginia watermen by diversifying aquaculture is a major thrust for VCE on the Eastern Shore. Aquaculture offers watermen employment in a fisheries-related enterprise and allows them to remain in their communities. At VSU, the first successful production in the U.S. of cobia in intensive re-circulating aquaculture production systems to market size was achieved. In addition, income of \$11,900 was generated through the holding and marketing of flounder in the lucrative live flounder market.

Improving Economic Opportunities in the Alleghany Highlands. Economic development is consistently identified as the top priority for the Alleghany Highlands area where plant and business closings and lay-offs resulted in high unemployment. In response, Extension worked with regional agencies and businesses to provide a job-seekers program to link un/under-employed individuals with job, training, and community resource opportunities. Extension faculty also partnered with downtown revitalization and tourism efforts on economic development, networking and collaboration, and recreation and tourism. Senior 4-H Club members also planned teen forums to identify strengths and weaknesses of the community, mobilize teens for change, and promote a more positive image of the community to visitors and potential residents. Agents also worked with a career council to conduct job fairs, mock interviews, and career exploration programs for students in grades K to 12. Twenty business and service providers and 62 residents participated in a job seekers resource expo. Tentative job offers were made to seven participants the day of the event and 50 people enrolled in job training programs. Thirty-seven volunteers were recruited and trained by Extension as ambassadors for the Alleghany Highlands. Finally, as a result of these efforts, one county administrator highlighted many positive e-mails, letters, and calls in response to this program.

Job Creation for Economic Development. In the VCE situation analysis, 60 counties identified job creation as a key and often top priority. Extension worked with the Virginia Department of Business Assistance and other organizations to pilot a program for start-up entrepreneurs. The program included a one-day fair and a series of half-day, smaller-scale entrepreneur express workshops for every county in western Virginia. Due to its success, the program was replicated other locations. A written resource guide and CD-ROM for entrepreneurs and small businesses were also developed. In 2006, 170 entrepreneurs participated in the pilot Entrepreneur Express workshop. End-of-event surveys indicate that participants gained greater awareness and

knowledge of funding sources, business planning, marketing strategies, and available resources for assistance. As a result of this pilot program, three participants were securing loans from non-traditional lending sources identified at the workshop.

Bio-Energy Research Impacts Economic Development. (see Integrated Research and Extension description on page 118)

Introducing Bio-Fuels Opportunities. (see Integrated Research and Extension description on page 109)

Source of Funding: Smith-Lever, state funds, local funds

Scope of Impact: State specific

Underserved audiences: At-risk watermen, at-risk youth and adults

Parenting

Extension Programs

Parenting Instruction for Divorcing Parents. Each year over one million children experience divorce, and the rate for divorce for the current generation may climb to 50 percent. The Supreme Court of Virginia requires parents in custody dispute to attend a four-hour class to decrease harmful parenting behaviors. Extension provides this required education using the Parents Forever curriculum. In one area of the state, classes were offered monthly. This class was also offered to incarcerated woman in transition. A total of 45 community adults and 19 female inmates attended this program in 2006. Post-tests indicated that 90 percent understood how unintentional harmful behaviors, such as putting children in the middle, impacts children. All participants expressed satisfaction with the program and planned to practice at least one of the parenting skills learned in this class.

Supporting Grandparents as Kinship Care Providers. Many grandparents raise their grandchildren, with 57 percent of them in the workforce and 17 percent living in poverty. Over \$12,000 were raised to begin programming for grandparents raising grandchildren in one part of the state. The STARS program was developed and met monthly to promote services and resources available for grandparents. Another \$3,000 was given to the program through in-kind donations and volunteer time. Extension collaborated with the local community service board to create a community resource guide given to all program participants and to new parents at the hospital. Program participant surveys showed 100 percent of participants feel more knowledgeable about services available to the family, community resources, their rights as a kinship care provider, and how others handle similar experiences.

Improving Teen Parenting Skills. Many teen parents have poor parenting skills or knowledge to properly care for infants and toddlers. Without proper training, teen parents may neglect the health and nutrition needs for child. Since life and career skills are a part of the 4-H Youth Development program, 4-H offered a child care program for youth, ages 13-18. The program improved teen knowledge and skills in proper care, health of, and nutrition for infants and toddlers. Youth also learned how to market their skills for future child care employment. As a result of this program, 100 percent of the teens acquired new behavioral patterns, hands-on skills, positive discipline, and life skills to promote proper child care. All of the teens noted

improvement in their ability to recognize infants' or toddlers' basic needs and a harmful or dangerous environment. All of the teens also noted they gained knowledge and skills in creating and designing marketing tools to promote their child care experience for employment.

Source of Funding: Smith-Lever, state funds, local funds, grant funds

Scope of Impact: State specific

Underserved audiences: Grandparents raising children, children raised by grandparents, teen parents

Promoting Business Programs

Extension Programs

Retaining Young People in Rural Areas through Entrepreneurship. Rural areas often lose the best, brightest, and most entrepreneurial youth to less rural areas with more opportunities. Through an Appalachian Regional Commission \$18,000 Flex-E grant to promote entrepreneurship, local stakeholders in one rural county worked to foster an entrepreneurial mindset in students in the county schools. The County Board of Supervisors provided a \$4,000 match for the program. With input from county and school decision-makers, the 4-H Be the E project taught entrepreneurship through teachers in a train-the-trainer format. A total of 453 students participated over the last two years. An exhibit of youth entrepreneurship activities in two counties was also displayed fairs, festivals, and professional conferences. Teachers indicated they were pleased with the project and students demonstrated a basic grasp of entrepreneurial skills such as business vocabulary, ethics, and legal and civic responsibilities. One teacher reported an increase in confidence in several students from a belief that they would follow through with their business plans and start a small business. Overall, teachers believed this youth entrepreneurship program fostered an entrepreneurial mindset in 12 to 14-year-olds.

Source of Funding: Smith-Lever, state funds, local funds, grant funds

Scope of Impact: Region specific

Underserved audiences: Rural youth leaving communities

Supplemental Income Strategies

Extension Programs

Tangier Island Tourism. Tangier Island in the Chesapeake Bay has an economy based on crabbing and some day tourism, but lack of economic opportunity has caused population declines and difficulty in maintaining the island's public services. The island's population has dropped while the rest of the area grows and many island families have incomes below the poverty level. However, infrastructure is in place to support income producing overnight experiential tourism crabbing with Chesapeake Bay watermen. Extended-stay experiential tourism could bring direct income to crabbers and improve community viability. Extension faculty conducted a survey on extended-stay tourism to determine the feasibility of this type of tourism and what additional assistance would be needed to make experiential tourism successful on the island. One hundred seventy-three people, a response rate of about 70 percent, completed an online survey measuring their interest in visiting Tangier to experience local crabbing life and culture. Preliminary analysis of the surveys indicates many tourists would be willing to pay \$335 for a two-night,

three-day stay on the island to experience the work and culture of Tangier. As part of the pilot project, crabbers also took tourists and faculty members out on boats and into crab sheds to show them how crabbers make a living. Both the crabbers, who were paid for the tours and the tourists were positive about the experience. Island meetings on this topic resulted in islanders considering next steps for initiating experiential tourism. Several crabbers have committed to participating in required courses and to passing Coast Guard tests to take paying tourists on their boats. Promotional website assistance is being offered by the Virginia Tourism Corporation with plans to begin business in the summer of 2007.

Exploring New Economic Opportunities to Replace the Dying Manufacturing Industry.

Southwest Virginia recently lost over 1,500 jobs in the manufacturing industry and area officials identified the need to transition the region's economy away from traditional manufacturing towards alternative economic opportunities. Extension works with the Crossroads Institute, local governments, and other partners to help identify and pursue new economic opportunities. The initiative kicked off with a conference titled, "Smart Communities: Building a Brighter Future." As a result, the Smart Communities Initiative developed a regional technology consortium and events planned to highlight entrepreneurship. Over 130 persons attended the conference. In a follow-up survey, participants identified future directions for the initiative, including technology/last-mile broadband deployment, greater support for local entrepreneurship, engaging and retaining the region's youth, and local leadership development. The local planning director also pledged to fund this work.

Source of Funding: Smith-Lever, state funds, local funds

Scope of Impact: Region specific

Underserved audiences: At-Risk watermen, underemployed adults, beginning farmers

Youth Development/4-H

Extension Programs

Operation Military Kids. The Iraq and Afghanistan conflicts often cause distress for many youth, especially if a family member or friend is deployed overseas. The national 4-H Operation Military Kids (OMK) Program allowed 30 4-H high school youth to participate in two service learning opportunities that helped families of deployed soldiers. The group made 75 Hero Packs for children of deployed soldiers to help them communicate with their parent soldier. The OMK participants also learned about the culture and history of Iraq and one family's story about dealing with deployment. Delegates stated they had a better appreciation for the challenges of deployed soldiers' families and felt they could make a difference for the soldiers and their families. They also contributed more than 750 pounds of donated items to soldiers. A military chaplain gratefully acknowledged the receipt of the donations for the soldiers under his charge. One participant stated she was, "touched" knowing that "I was a part of the joy brought to this family through OMK." Twenty additional 4-H'ers participated in the OMK "Bug Out" Program. They experienced a simulated deployment exercise and wrote note cards to deployed soldiers. These youth indicated they had a better understanding of the challenges facing families of deployed soldiers.

4-H Camp Promotes Positive Youth Development. Youth need safe and supportive environments to be successful. 4-H residential and day camping programs conducted at local, district, and state levels in Virginia 4-H provide this environment as well as life skill development through hands-on learning in a supportive environment. During the last 4-H year, 25,599 youth participated in 4-H camping programs in Virginia. Youth from all 107 counties and cities throughout the Commonwealth participated in the 4-H camping at six 4-H educational centers. One 4-H Camp evaluation this year added to the growing body of research in camp-based youth development suggesting that summer camps play an important role in the development of young campers. Parents reported their child's social skills improved more than other skills from attending 4-H Camp (parent mean 1.73, with 1="strongly agree," 4="strongly disagree". Youth agreed even more frequently with this statement (youth mean 1.60). Youth reported their teamwork skills improved most from attending 4-H Camp (youth mean 1.68).

Envirothon Enhances Youth Environmental Education. Many youth and adults lack awareness and understanding of environmental issues. In response, VCE worked with the Virginia Association of Soil and Water Conservation Districts to develop 4-H natural resource and environmental education programs, including Envirothon, a national competitive program. Local soil and water conservation districts coordinate district, area, and state competitions while Extension specialists provide training and information resources for participants. Extension's trainings involved 165 youth and adults in 16 hours of instruction in water quality. Training evaluations indicated a 74 percent increase in knowledge of water-related issues and processes.

4-H Impact on Youth. Youth encounter many challenges that require strong life skills to continue on the path to success. A recent evaluation of 46 4-H parents in Virginia found that due to participation in the 4-H program 98 percent reported positive impact on their child's decision-making skills; 100 percent reported positive impact on communication skills; 93 percent reported positive impact on leadership skills; 85 percent reported positive impact on healthy lifestyle choices; 96 percent reported positive impact on wise use of resources; 91 percent reported higher acceptance of differences in others; and 96 percent reported their child's participation in 4-H positively impacted the youth's development of useful or marketable skills.

4-H Camping and Life Skills Outcomes. (see Multistate Extension description on page 101)

Kids' Marketplace Focuses on Money Management. (see Family Resource Management description on page 76)

K-12 Biotechnology Outreach. (see Integrated Research and Extension description on page 117)

Reality Store Improves Youth Money Management. (see Family Resource Management description on page 76)

Source of Funding: Smith-Lever, state funds, local funds, grant funds

Scope of Impact: State-specific and national

Underserved audiences: African American youth, Hispanic youth, at-risk youth

Funding and FTE's

Federal Smith Lever Funds: \$1,565,555

Federal Hatch Funds: \$696,524

State Matching Funds:	\$2,562,720
Local Government Funds:	\$2,859,974
Grant and External Funds:	\$7,696,716

FTE: 122.68

C. Stakeholder Input Process

This section provides an overview of the process Virginia Polytechnic Institute and State University Agricultural Experiment Station (VAES) and Virginia Cooperative Extension (VCE) individually and collaboratively facilitate for stakeholder input into programmatic planning, design, implementation, evaluation, and reporting.

VCE and the Agricultural Research and Extension Centers (AREC) have long facilitated grassroots involvement and ownership in local programs. VCE formally connects with the grassroots of the state through partnerships with Extension Leadership Councils (ELC). For the VAES, advisory councils provide stakeholder input. At the local level, these partnerships represent the diversity of the local clientele. Representation on ELCs include all VCE programming areas – 4-H/Youth Development (4-H), Family and Community Sciences (FCS), Agriculture and Natural Resources (ANR), and Community Viability, community leaders, and other community representatives and commodity groups. Currently, all 107 Extension units in Virginia have an organized local ELC and all ARECs have active advisory councils.

At the state level, VCE works with stakeholders through the state Leadership Council. The group’s membership includes:

- volunteer leaders representing the 22 planning districts in Virginia
- at-large members appointed by the director of VCE
- leaders representing Virginia’s diverse population, businesses, agencies, and organizations
- VCE District Directors
- chairs or designees of VCE FCS, 4-H, and ANR leadership councils
- VCE Director from Virginia Tech (VT)
- VCE Administrator from Virginia State University (VSU)
- VCE staff from VT and VSU
- Director of the VAES
- 1890 Director of Research
- Director of Governmental Relations at VT

A VCE situation analysis process systematically analyzes demographic, economic, agricultural, health, environmental, and other factors affecting people and their communities. Each VCE unit conducts and updates a formal situational analysis annually. This analysis serves as a major foundation for educational program planning throughout VCE. Extension staff and ELC members work together in the situation analysis process to determine needs and then establish program priorities, plan and implement solutions, identify and secure resources, market VCE and its programs, and evaluate and report program results/impacts to program stakeholders.

A variety of people representative of the population are involved in the situation analysis process. Deciding “what should be” or “which is more desirable” of several program options involves the consensus of judgments made by individuals. Both users and non-users of VCE are vital participants in situation analysis. An aggressive recruitment effort ensures under-served groups and minorities are represented.

From the research perspective, each AREC with its respective advisory council, conducts a research and educational needs assessment. This assessment mirrors the VCE situation analysis process but the community of interest is commodity based. For example, the Virginia Seafood AREC and its advisory council conducted a needs assessment survey of 136 meat/poultry/seafood processing firms in Virginia. The results of the survey were used to develop outreach and Extension training programs and workshops for the food processing industry. In addition, a second needs assessment was conducted with five other universities and sent to more than 3,000 food processing companies throughout the U.S. The results of this survey are being used to develop an Internet based train-the-trainer course on good manufacturing practices and employee practices for the industry in both English and Spanish. The Ag Research Station at VSU also ensures research is based on client needs by requiring that all full Evans-Allen proposals address the needs of the people of Virginia. Reviewers of these grant proposals are asked to pay particular attention to this criteria for funding research.

VCE agents also gather stakeholder input through local government reports to their representatives. Although county and city governments differ on preferred report formats, timing, and audience, these reports inform governmental officials and constituents of VCE educational programming efforts and allows them to provide feedback on educational needs.

The Dean of the VT College of Agriculture and Life Sciences conducts listening sessions with key stakeholders and agricultural commodity groups to ensure stakeholder input at the college level. These individuals and groups have a direct relationship with the work of the College, including VCE and VAES. Each professionally facilitated session uses the same format and questions including a general question about their perception of the College and then questions applying specifically to their industry. This process provides information specific enough to take appropriate action. College listening session questions include:

1. What are your perceptions of College?
2. What are the issues facing you (or your industry) and your community?
3. Who is addressing those issues?
4. Is there a role for the College in addressing these issues?

The following listening sessions were conducted in the last three years with plans for follow-up sessions:

- Farm Bureau Young Farmers
- Poultry industry
- VT College of Agriculture and Life Sciences Leadership Council
- Grape and wine industry

- Equine industry
- Christmas Tree Growers Association
- Virginia Agri-business Council

Finally, greater linkages with stakeholder groups are formed by VCE faculty serving as ex-officio members of state agricultural commodity groups. Faculty are also members of the Virginia Department of Agriculture and Consumer Service's (VDACS) Board of Agriculture. VCE and the College of Agriculture and Life Sciences also have active representation on the Council for Rural Virginia and partner with the Virginia Association of Counties and the Virginia Municipality League in conducting Virginia's Rural Caucus where residents provide input regarding on the needs of rural citizens.

D. Program Review Process

Review Process for Research

**Virginia Agricultural Experiment Station
Virginia Polytechnic Institute and State University**

Rationale and Review Committee Structure

Research under the Hatch, McIntire-Stennis, and Animal Health and Disease Acts is conducted in three colleges that constitute the Virginia Agricultural Experiment Station (VAES):

1. College of Agriculture and Life Sciences,
2. College of Natural Resources, and
3. Virginia-Maryland Regional College of Veterinary Medicine.

For each VAES project proposal submitted, the assistant or associate VAES director in the project leader's college will chair the review (hereafter referred to as the chair). The chair is responsible for selecting the project review committee consisting of three or more members who are proficient in the subject of the proposed project. These may be chosen from outside the university if recommended by the department/unit head or deemed appropriate by the chair.

Faculty from other units within the university may be eligible for VAES support. Such research would have to be reviewed by this policy, fit within the mission of VAES, and approved by the director. The VAES director or College of Agriculture and Life Sciences assistant director or associate director will chair the project review committee.

Proposal Development

The project leader will prepare the proposal as specified in Essentials of a Project Proposal in the Administrative Manual for the Hatch (Experiment Station) Act as Amended, the Administrative Manual for the McIntire-Stennis Cooperative Forestry Program, and the Administrative Manual for the Continuing Animal Health and Disease Research Program (1992), Appendix F. Early in the new-project development process, the project leader is strongly encouraged to initiate a

subject search using the USDA/CSREES Current Research Information System (CRIS) - <http://cris.csrees.usda.gov/Welcome.html>

The proposed research project should be reviewed by a statistician to assure the experimental design and statistical analyses are adequate. The project leader may meet with a member of the Statistics Consulting Center or the department/unit head may designate someone with statistical expertise to serve as a departmental reviewer. The project leader will then submit the proposal to his/her department/unit head for peer review in accordance with departmental procedures. If the research involves animals, human subjects, or recombinant DNA, the project leader is responsible for submitting the required protocol forms to the appropriate university review committee(s). Proposals will not be forwarded to USDA/CSREES without required approvals.

Proposal Submission and Review Procedures

The department/unit head will transmit the departmentally approved project proposal to the chair of the project review committee for that college. It is preferable that the following items be transmitted to the chair electronically. Items to be transmitted include:

1. Four copies of the proposal (if not transmitted electronically),
2. Four copies of the project leader's vita [2-page maximum] (if not transmitted electronically),
3. The Project Certification Form,
4. A Research Project Review Form,
5. Verification of statistical review, and
6. List of three or more suggested peer reviewers.

The chair will select reviewers and distribute copies of the proposal to the Project Review Committee, which will return the Project Review Forms and comments to the chair by a specified date (after at least three weeks).

Each proposal will be evaluated according to the following criteria:

1. Is the proposed research relevant to the goals of the department and college, the needs of the people the research would serve, and the priorities established by task forces, work groups, or commodity research committees?
2. Are the objectives and procedures clearly stated?
3. Is the proposed duration realistic for the research that is proposed?
4. Are the appropriate or desirable individuals cooperating on this project?
5. Does the project list impacts to Virginia (and elsewhere) or anticipated economic importance?
6. Does the project leader's vita indicate the level of competence required to do the proposed research?

Each reviewer recommends that the proposal be:

1. Approved with no changes,
2. Approved with minor changes,
3. Revised and resubmitted, or
4. Rejected.

The chair will convene the committee, the project leader, and the department head to review the proposal. The chair will forward reviewers' comments to the project leader and department head prior to the oral review. The oral review may be omitted for revised/replacement projects, at the discretion of the chair, if a majority of the review forms are checked by the reviewers as "approved with no changes" or "approved with minor changes." If an oral review is not conducted, the chair will provide a written summary of the review committee comments to the project leader with a copy to the department/unit head and the review committee. An oral review is required for a project leader's initial VAES Project.

NOTE: Faculty located at off-campus Agricultural Research and Extension Centers (ARECs) will submit proposals to the center director who will contact the appropriate department head on campus regarding departmental policy for securing a peer review before the proposal is sent to VAES for review. The center director will forward the proposal and departmental review, if applicable, to the VAES director, who will serve as chair. The chair will forward the proposal to the review committee and to the subject-matter department head, who will be invited to attend the oral review.

Final Submission

The project leader will comply with the recommendations of the Project Review Committee and submit the revised proposal to the department/unit head, accompanied by a letter delineating the changes that were made in response to the recommendations of the reviewers and/or a rebuttal for any recommendations, which the Project Leader does not accept. The project leader will enter CRIS Forms AD-416 and AD-417 on the CRIS website - <http://cwf.uvm.edu/cris/> and send a copy of the proposal electronically to the VAES office. The department/unit head will transmit to the chair:

1. Completed and signed CRIS Form AD-416,
2. Copy of approval letter from Human Subjects, Laboratory Animal Care, or Biotechnology Oversight Committee approval (if required), and
3. Transmittal letter from project leader.

The chair will sign Form AD-416 and transmit the above items to the VAES director accompanied by a letter listing names of the reviewers and date of the oral review (if applicable). For McIntire-Stennis proposals, the Administrative-Technical Representative (A-TR) must sign Form AD-416, certifying that the proposal complies with the purposes of the McIntire-Stennis Act.

The VAES director will meet with the chair, the department head, and the project leader if there are any questions or concerns. When the project leader, the department/unit head, the chair of the project review committee, and the director agree that the proposed project should be accepted, the director will approve it, assign a project number, enter Form CSREES-2008, and transmit the proposal, CRIS Forms AD-416, AD-417, and CSREES-2008 electronically to CRIS/CSREES/USDA. The CSREES project reviewer may possibly contact the director, assistant/associate director, or project leader if he/she has questions or requires additional information. If a proposed project is deferred, the CSREES project reviewer will notify the

director, who will confer with the project leader, department/unit head, and chair of the project review committee to resolve the concerns.

After approval by CSREES, the director sends copies of Forms CSREES-166 (Project Review and Comment Sheet), AD-416, AD-417, and CSREES-2008 to the chair of the project review committee, the department/unit head, and the project leader. These documents, the proposal, and all pertinent correspondence will be retained in the official project file in the VAES director's office. Project files will be retained for three years after termination of the project.

Review Process for Extension

The review process for Extension programs covers all programs conducted by Virginia Cooperative Extension (VCE), a joint program of Virginia Tech and Virginia State University. VCE Program Leadership Teams (PLT) develop Extension programs and review programs on an annual basis and make decisions to maintain, modify, or create new programs to meet the needs identified through external and internal stakeholder input.

VCE addresses a broad range of problems and issues facing citizens of the Commonwealth through focused educational programming. This is accomplished and reported through VCE's Web-based planning and reporting system, which includes long-range goals operationalized by annual program plans and reports. Plans are built on strategic issues through situation analysis. This process collaboratively determines social, economic, and environmental problems at local, regional, and state levels. A decision is then made based on which issues have become of major public concern. This becomes the background and rationale for deciding which problems and issues can be addressed with VCE time, energy, and human and fiscal resources.

Problems and issues identified through situation analysis are communicated throughout VCE and educational program plans are developed by interdisciplinary PLTs composed of specialists and agents. These teams are organized around and reflect the breadth and scope of priority problems and issues facing the citizens of the Commonwealth. Program proposals identify programming outputs and outcomes and related indicators of impact to be addressed by the PLTs. The program proposals are reviewed by VCE programming leadership.

Program proposals from PLTs are distributed to all agent and specialist faculty on the VCE intranet and electronic planning "buy in" process. Faculty select programs for their situation by providing specific information, including the amount of time they plan to devote to the program. At the end of the year, each local unit and campus faculty member completes an annual accomplishment report documenting program relevance, response, and results through a narrative and impact statements.

E. Evaluation of the Success of Multi and Joint Activities

In 2006, an evaluation of Multistate Extension Activities and Integrated Research and Extension Activities was conducted using the electronic Faculty Annual Reporting System (eFARS) for

research and Virginia Cooperative Extension (VCE) faculty. The definitions used for these activities were those provided by USDA/CSREES:

Multistate Extension Activities – Collaborative efforts that reflect the programs of institutions located in at least two or more states or territories.

Integrated Research and Extension Activities – Jointly planned, funded, and interwoven activities between research and Extension. This includes the generation of knowledge and the transfer of information and technology.

Faculty submitted multistate Extension activities and integrated research and Extension activities through the eFARS reporting system and were asked the relevance of the effort, their response, the results of the effort, and the collaborators involved. A summary of responses follows.

Addressing Critical Issues

Critical issues addressed through multistate Extension and integrated activities were driven by input from stakeholder groups and research, Extension, industry, and government agency input and active involvement through meetings and groups/boards. Many of these efforts are collaborative in nature, rather than advisory. Faculty find this input very important in identifying high-priority issues and shaping research and Extension educational responses.

Addressing Needs of Underserved and Underrepresented Audiences

Faculty find their efforts to gain input from a broad representation of stakeholder groups enhances their ability to include underserved and underrepresented audiences and their needs. Some projects/programs were specifically designed to address the needs of underserved and underrepresented audiences. Faculty overall are sensitive to this issue and design projects and programs to openly incorporate input and needs from underserved and underrepresented audiences. In addition, many faculty develop projects and programs to address all levels and types of audiences, including underserved and underrepresented audiences.

Documentation of Outcomes and Impacts

The documented expected outcomes and impacts of projects and programs varied by the nature and maturity of the effort. In some cases, goals and objectives, which included outcomes and impacts, were identified by the stakeholder groups involved in the process. These were monitored throughout the lifecycle of the project or program, typically through annual project and program reviews. Project activities, outputs, outcomes, and impacts were typically documented in annual and periodic reports, journal articles, and publications written about the project or program.

Brief Summaries of Selected Multistate Extension Activities

Goal 1: To achieve an agricultural production system that is highly competitive in the global economy

Developing Markets for Pasture-Bred Beef. Pasture-feeding beef production systems are becoming more popular across the U.S.; however, markets for pasture-fed beef (PFB) have received little study. The development of PFB markets requires identifying specific consumer groups and market outlets. Extension agents are often the first to encounter direct marketing questions from potential PFB and other producers. Additionally, farmers are increasingly interested in direct marketing their products. Two Sustainable Agriculture Research and Education (SARE) grants were obtained to enhance direct marketing. The first grant provided funding to study the viability of PFB in Virginia and the second to fund a comprehensive direct marketing conference to help Extension agents teach about direct marketing. The PFB study was conducted in Rappahannock County to determine the structure of the PFB marketing channels currently in use by Mt. Vernon Farm and to identify constraints and inefficiencies. The findings from the first study were presented at the direct marketing conference and helped Extension agents, state specialists, and Virginia Department of Agriculture and Consumers Services (VDACS) personnel learn how to assist producers with direct market issues. The direct marketing conference included representatives from a four-state area. The effort included a development and dissemination of a training manual, "Direct Answers for Direct Marketing." Conference attendees indicated they will use this resource to teach local producers about direct marketing as an alternative strategy to increase farm profits.

Regional Horticulture Conference Reaches Appalachian Growers. Discussions with VCE agents and specialists, VDACS employees, and other agricultural workers and growers revealed a need for horticultural education meeting in Southwest Virginia. These stakeholders wanted the conference to focus on marketing (direct and wholesale), commercial fruit and vegetable production, organic production and alternative crops, focusing on sustainability. A committee of VCE agents and specialists, VDACS representatives, the Southwest Virginia Farmer's Market manager and Appalachian Sustainable Development representatives determined topics, dates, and a location for the meeting. A comprehensive program including a trade show was developed. The first annual Appalachian Regional Horticulture Conference was held on January 13 and 14, 2006; at the Southwest Virginia Higher Education Center in Abingdon. Approximately 140 participants attended from Virginia, Tennessee, and North Carolina. Also, speakers and growers from Tennessee and North Carolina participated in the training. Participants rated the conference as excellent in a post survey. One participant stated, "Excellent meeting, providing needed information." In response to the positive feedback a second meeting was planned.

Forum for Rural Innovation. The number of farms in Loudoun County, has grown by 61 percent since 1997 while the number of acres devoted to agricultural production has dropped by 18 percent since 2002. A majority of farms cannot rely on traditional "economy of scale" production to remain sustainable. Many local farmers are looking for innovative new techniques to increase farm revenue and improve profitability. The Loudoun County Extension office worked with the Winchester Fruit Research Lab and the agricultural development offices of Clarke, Fauquier, Frederick, and Loudoun Counties in Virginia, Jefferson and Berkeley Counties in West Virginia, and the Potomac Head Waters Resource, Conservation, and Development

Council to offer a six-hour educational forum for landowners. This program showcased new research and replicable, innovative ideas to enhance farm or rural business profitability; conserve farmland or natural resources; and develop new production approaches viable in an expensive farmland upscale consumer market. Presentations and testimonials emphasized farming for high profitability using innovative and sound business approaches suited to the Mid-Atlantic Region. Two hundred forty-six producers representing Virginia, Maryland, West Virginia, and Pennsylvania attended the forum. A post forum survey showed 84 percent of the responding participants wanted additional training or information on one or more of the topics presented. Thirty percent of the participants were considering implementing one or more of the strategies presented into their operations in the next year.

Agriculture Diversification Using Freshwater Shrimp as an Alternative Enterprise in Tobacco Growing Regions. Many Virginia tobacco farmers are seeking alternative crops to supplement decreasing farm incomes. Many of these farms have unproductive fields and underutilized aquatic pond resources. Alternative crops to supplement farm income also need to be demonstrated. Virginia State Universities' (VSU's) Aquaculture Program worked with farmers, including existing tobacco growers, to diversify into and expand freshwater shrimp production. Working with one tobacco farmer and his county agriculture agent, pond establishment, shrimp procurement, water quality, feeding, harvesting, and marketing guidance was provided. Extension staff helped monitor management practices. Shrimp culture demonstration ponds were operated at VSU's aquaculture facility to examine low-cost alternative feeds. To promote freshwater shrimp culture, workshops were conducted, presentations made at regional professional meetings, information sheets distributed, and shrimp populations displayed at agricultural fairs. Multi-state workshops and information exchanges were held to increase shrimp farming development. Markets and distribution techniques were also identified. As a result of these efforts, freshwater shrimp were successfully harvested from six commercial ponds with a surface area of approximately three acres. Approximately 2,800 pounds of shrimp were sold fresh on ice at \$7-8 per pound. Guaranteed markets were established for most of the production. More than 10 prospective shrimp farmers are preparing for shrimp stocking next year.

Allegheny Highlands Agricultural Center. The Allegheny Highlands encompass Highland and Bath counties in Virginia and Pocahontas and Pendleton Counties in West Virginia. This mountainous and isolated region is host to small scale farms, small population centers, and mostly forage-based sheep and beef production. A value-added opportunities study revealed a lack of a reliable USDA inspected slaughtering and processing facility was limiting producers in the region from developing beef and sheep niche marketing opportunities. Extension took the lead to further explore the lack of infrastructure for the region's producers. VCE organized a steering committee of producers and Extension agents in the region to evaluate the feasibility of a slaughter facility. A \$32,000 Appalachian Regional Council (ARC) grant was obtained to help fund the study. The steering committee also hired an agricultural center director and a consultant to complete a comprehensive needs assessment. VCE used a \$2,000 Risk Management Grant to conduct three workshops to educate 119 potential users about the project and teach how to market branded meat products. Surveys indicated a strong interest in a local processing facility; and 77 percent of the 64 survey respondents indicated they would be interested in a cooperative marketing venture with other producers. The feasibility study was completed along with a

business plan; and the Agricultural Center is moving into a finance phase and a more formal organization of the potential participating producers.

Virginia Beef Quality Assurance Program. The Virginia Beef Quality Assurance (BQA) Program educates and certifies beef producers in best management practices that improve the safety and quality of beef. One thousand three hundred and nine Virginia beef producers obtained initial or recertification during 2006. This brings the total number of certified producers in Virginia to 3,707, which makes Virginia one of the national leaders in BQA. The Virginia BQA is a founding member of the Mid-Atlantic BQA program and hosts the Mid-Atlantic BQA website. Mid-Atlantic BQA is an eight-state consortium of Extension and industry personnel who work together to create like training materials and programming across the region. Results from Virginian BQA and Mid-Atlantic BQA were featured at the National Cattleman's Beef Association (NCBA) National BQA Coordinators meeting, and information from these programs influenced the recent NCBA white paper on the national impact of BQA.

Professional Dairy Heifer Grower's Association. Over the past eleven years VCE provided advice and leadership for the formation and growth of the Professional Dairy Heifer Growers Association. This organization developed out of a Natural Resource Agriculture Engineering Service heifer meeting in Harrisburg, Pennsylvania. Efforts included securing industry support for the first dairy calf and heifer meeting and development of bylaws and an organizational structure. Over the ensuing ten years VCE faculty served as conference chair, secretary of the board of directors, advisor to the board of directors. This organization has grown, from twelve people to over 500 members with an annual conference budget approaching \$250,000. This organization is now recognized as the source of information for the heifer management business. The annual conference is the premier event of its kind in the U.S. and internationally.

Meat Goat Quality Assurance Program. From 2005 to 2006 the number of meat and other goats in Virginia increased to 41,000 head. Extension agents have seen an increase in not only the numbers of goats, but the number of new goat producers, and the number of clients requesting information about meat goat production and marketing. One agent in Pittsylvania County worked with a meat goat producer who serves as an officer in the North Carolina Meat Goat Producers Cooperative (NCMGP). They worked with VCE, North Carolina Cooperative Extension and the NCMGP to offer the North Carolina Meat Goat Quality Assurance Certification Course to Virginia producers. Sixteen participants from ten different farms in Virginia and North Carolina attended the course and learned about nutrition, management, economics, and marketing of meat goats. One hundred percent of the participants passed the certification exam and can access group marketing avenues provided by NCMGP for increased profit. One participant stated she was glad to have had this opportunity and would like to see more workshops and classes pertaining to meat goat production. Meat goat producers are an underserved audience in Virginia, and this opportunity utilized information and specialists from both states to offer useful education opportunities for producers.

National Animal Identification. A forty-eight-hour trace-back of animal disease in the event of an outbreak has been established as a national priority by USDA to protect animal health and enhance biosecurity. Extension faculty worked with producers to register animal premises and to inform producers of the national program to trace animal disease. This educational effort

included flyers, pamphlets, registration forms, educational programs, demonstrations, presentations, and onsite registration. As of September, the latest month by data available, Culpeper County registered 55 premises, a change in ranking since January from 28th to 14th position and a change in total count from 36 to 55 registrations, a 65 percent increase. The premise registration count for Culpeper will easily exceeded 60 and could approach 70. This program engendered producer support and cooperation through a national, multi-state initiative.

Beef Cattle Process Verification and Marketing. A collaborative effort between VCE, the University of Kentucky Cooperative Extension, the Virginia Cattlemen's Association, Southeast Livestock Network, and beef cattle producers provides training and certification to beef producers to market feeder cattle as USDA Process Verified. VCE agents and beef industry leaders received in-depth training and became certified to implement USDA Process Verification standards through the program. Subsequent certification of beef producers carried out by VCE agents, allowed producers to market feeder cattle certified as export-eligible through the USDA Process Verification standards. Since August 2006, over 200 Virginia beef producers enrolled as USDA-approved suppliers. These producers marketed 5,195 USDA Age Verified cattle, which contributed to \$197,410 in value-added income. Program implementation involved coordination and cooperation with an Extension specialist from the University of Kentucky working through the Southeastern Livestock Network.

Regional Viticulture In-service. Wine grape production is an expanding agriculture sector throughout the East. Cooperative Extension agents increasingly address local needs for this industry, including providing expertise on vineyard site selection, vineyard management, and pest management. Few agents are equipped to adequately address these requests. In response, two viticulture in-service training programs for regional Cooperative Extension agents were conducted. The first training was attended by 32 agents from five states, Virginia, Maryland, North Carolina, Pennsylvania, and Massachusetts, and 22 agents from eight states attended the second training. An exit comprehension test used after the first training showed attendees strongly agreed they had gained knowledge that would increase their ability to serve local clientele. All participants felt they were less dependent upon specialists for routine vineyard site selection visits or input on routine vineyard management issues, and they were in a better position to ask the right questions about why their clientele were exploring grape production. A follow-up impact survey after both trainings showed lasting confidence in addressing common viticultural issues and questions. They had multiple occasions since the workshops to apply the knowledge gained. An agent from North Carolina stated, "After attending the training in 2006; I identified Pierce's Disease in four separate vineyards in the Piedmont of North Carolina. Before the training I did not feel confident in identifying the disease. These training (programs) have been extremely useful to me. I really appreciate Virginia being open to training agents from other states." A Massachusetts agent stated: "The workshop gave me more confidence on how to look for information if I did not know it and to accurately give out information if I did know it. I guess the biggest thing for me (re: the workshop) is that I could understand the needs of the grower better and ask more intelligent questions to help the grower obtain advice or answers for their situation."

Improving Economic Returns for Small Scale Producers. Virginia has over three million acres of agricultural pastureland devoted to livestock production. In 2004, the sale of cattle and

calves resulted in over \$401 million in gross receipts for Virginia cattle producers. The use of more legumes, combining forages, and the improved grazing management of forages and cattle would contribute to increased efficiency and greater economic returns for small-scale producers in Virginia. The Pasture-based Beef Production Systems for Appalachia project, a joint effort between Virginia Tech (VT), West Virginia University, University of Georgia, and the USDA-Agriculture Research Station (ARS) is developing economically viable pasture-based beef production systems, from conception to consumption, to produce pasture finished beef calves with the carcass merit and quality demanded by the consumer. Researchers from VT are conducting research at the Southwest Virginia AREC on cow-calf forage systems, pre- and post-weaning calf health and nutrition, heifer development on forages from weaning to breeding, conventional feedlot finishing, and the economic analysis of cow-calf production systems. The cow-calf grazing systems were renovated in 2006 to incorporate rotational grazing and creep grazing for calves in each system and improve the forage for creep grazing. Future research will examine animal size and efficiency to design a forage program that reduces and /or eliminates the use of harvested forage for winter feeding. Agricultural producers from Virginia and surrounding states have attended Field Days and special producer meetings to learn about the preliminary results of these projects, pasture-finishing projects conducted by USDA-ARS, and meat analysis by Clemson University.

Development and Dissemination of Disease Resistant Small Grain Varieties. (see Integrated Research and Extension description on page 105)

Evaluation of Nitrogen for Maximum Yields and Profits of Burley Tobacco. (see Integrated Research and Extension description on page 117)

New Barley Varieties Result in Exports and Potential New Markets. (see Integrated Research and Extension description on page 105)

Onions Offer a Source of Revenue for Southwest Virginia Producers. (see Integrated Research and Extension description on page 104)

Goal 2: To provide a safe and secure food and fiber system

Good Agricultural Practices. Outbreaks of foodborne illness associated with fresh produce have increased. Several high-profile outbreaks of foodborne illness linked to fresh produce in 2006 enhances the need for food safety management on the farm. The Good Agricultural Practices (GAP) program, a multi-state Extension educational effort, was developed to teach on-farm management practices that improve the safety of fresh fruits and vegetables. The GAP project includes VT, Cornell, North Carolina State University (NCSU), and the University of California at Davis in improving safety of fresh fruits and vegetables. Extension agent training as an important component of this program has been supported through grant collaboration with NCSU. Extension specialists and county agents trained 70 commercial vegetable and fruit growers in GAP principles. This resulted in a stronger relationship with tomato growers on the Eastern Shore, where the annual production of tomatoes in one county is a \$57 million industry. Outbreaks of foodborne illness in the last five years have been linked with tomatoes grown on the Eastern Shore. In addition, a meeting of the Food and Drug Administration, VDACS, Virginia Department of Health, and VT representatives met and discussed tomato safety issues that resulted in forming a national tomato-safety network. Additionally, over 400 Virginia

growers are trained in GAPs and recognize the need for on-farm food safety management. As a result, grower “buy-in” to current and future food safety-related efforts has improved.

Dairy Food Safety Practices. Dairy farmers need to understand the impact of their practices on the safety of milk. A survey of dairy farmers in Virginia and West Virginia evaluated standard dairy farm practices to determine producers’ views of important economic and production issues. The survey covered milk quality, milk safety, and farm security. Most dairies reported somatic cell counts below 500,000 SCC/ml, which is well within the legal limit. Fifty-nine percent of producers check milk for abnormalities before milking. However, farm security protocols designed to minimize the possibility of bioterrorism were rarely in place. Fifty-four percent of respondents were not willing to adopt a voluntary third-party quality assurance program comprised of written disease treatment protocols, training for all workers, treatment records, and on-farm bulk tank antibiotic residue testing. These survey results will inform food safety educational programming in the two-state region.

Needs Assessment of Sanitation Training for Food Processors, Wholesalers, and Warehouse Operators. Basic sanitation training for workers helps ensure that employee practices consistently and effectively prevent rather than contribute to incidents of contamination in food handling and processing that could cause foodborne illness. Foodborne infections are estimated to cause approximately 76 million illnesses each year in the U.S. at a cost of \$23 billion. A survey created by VT, the University of Rhode Island, Cornell University, the University of Delaware, and the University of Florida was distributed to food processors, wholesalers, and distributors to determine current training practices and determine if an Internet-based, interactive training course on sanitation, good manufacturing practices and good hygienic practices would be useful. The Northwest Food Processors Association, Food Products Association, National Fisheries Institute, New York Seafood Council, International Dairy Foods Association, the World Food Logistics Organization, and International Association of Refrigerated Warehouses notified members of the online survey and requested participation. Another 25 written surveys were distributed at the warehouse association annual meeting. Of 182 survey respondents, 75 percent categorized themselves as food processors of a variety of processed commodities. Ninety-five percent of respondents indicated food safety, sanitation and/or hygiene employee training existed in their facilities, but 54 percent responded they would use an Internet-based course, and 43 percent wanted to review it prior to implementation. Eighty-two percent indicated Internet-based training could be integrated into the workday. The top four barriers to employee training were time, cost, language, and literacy. The results of the survey are being used to develop an Internet-based inplant training program on good manufacturing practices, sanitation and employee hygiene. This training program will be developed in both English and Spanish to meet stakeholders’ needs.

Train-the-Trainer Workshops on Good Aquaculture Practices. For the past several years, aquacultured species, such as shrimp and finfish, were detained by U.S. Customs and the U.S. FDA due to antibiotic and other banned chemical residues. The Virginia Seafood Ag Research and Extension Center (VSAREC) focused on Extension training programs to help ensure aquacultured products are safe and wholesome. Scientists at the VSAREC developed a train-the-trainer program in Good Aquaculture Practices (GAPS) to reduce the use of unapproved antibiotics and chemicals in aquacultured products from overseas producers. A GAPS train-the-

trainer program tapped the expertise of faculty from VSAREC, the University of Maryland and the U.S. Food and Drug Administration (FDA). Mr. Nguyen Tu Cuong, general director of the National Fisheries Quality Assurance and Veterinary Directorate in Vietnam participated in the program and said, "On behalf of the National Fisheries Quality Assurance and Veterinary Directorate (NAFIQAVED), the Ministry of Fisheries of Vietnam, I would like to present its compliments to you and thank the U.S. FDA and JIFSAN for collaborating with NAFIQAVED to successfully hold the GAP training in Can Tho City, Vietnam, from November 13 to November 17, 2006. The success of this training course marks the beginning of the fruitful cooperation among relevant sides in exchanging experience and jointly holding training programs on fishery hygiene and veterinary management, leading to the mutual recognition in the near future. Additional train-the-trainer workshops are being planned for China and Thailand.

Goal 3: To achieve a healthier, more well-nourished population

Improving Preschool Children's Health. The percentage of overweight and at-risk for overweight children averages almost 23 percent for two to five year olds and over 31 percent for six to eleven year olds. Obese children are more likely than non-obese children to experience significant short-term health problems. Good nutrition and physical activity are important to the growth, development, and emotional wellbeing of young children and to help establish healthy lifestyles that prevent childhood obesity. "Food Friends," an obesity prevention program for preschoolers and their families, intends to increase children's willingness to try new foods to promote healthful food choices. Extension is part of a grant with Colorado State University to implement this program in Virginia. Participating agents are trained to implement this program and Head Start centers participate in this study. Training for participating teachers and program implementation through child care centers will soon begin.

Goal 4: To achieve greater harmony between agriculture and the environment

Composting and Compost Use. Municipal, agricultural, and industrial organic wastes can be sources of excess nutrients, toxic compounds, and animal and plant pathogens and, when applied to land, may harm soil health and water quality. Composting converts raw organic wastes into stabilized organic matter, can eliminate pathogens, and can break down organic toxins into less harmful compounds. To address these issues associated with organic wastes, educational programs were held for compost professionals on economically and environmentally sound practices in the Mid-Atlantic region. Twenty of 32 registrants completed a survey on the Composting School and reported increased knowledge in processes, methods, equipment, feedstock preparation, health and safety, product quality and use, and marketing. Participants in the biosolids composting session demonstrated required knowledge by achieving an 84 percent mean score on the course final exam. Livestock farmers in the Shenandoah Valley, Virginia, and biosolids generators in Beckley, West Virginia, reported their knowledge gain would improve the efficiency of their composting operations.

Pesticide Inspector Residential Training in Structural Pest Control. The Environmental Protection Agency (EPA) sponsors grants to support national training courses for pesticide investigators annually. These courses strengthen pesticide regulatory programs in the U.S., territories, and tribal nations. VT and VDACS held a pesticide inspector residential training

course, and feedback indicated the need for an advanced version of the course for experienced investigators. EPA funded these two agencies to hold that course in 2006. As a result of this training for Structural Pest Control held at Virginia Tech, 27 pesticide investigators from 18 state and federal agencies changed the way they conduct their inspections and investigative methods. This course provided all 18 agencies with investigators ways to conduct better investigations and the ability to transfer information they learned at the training to other investigators in their state pesticide regulatory agencies. This work partnered federal and state agencies, territories, and tribal nations to teach, solve problems, organize, and deliver pest management programs.

Improving Management of a Destructive Disease of Small Grains. Barley yellow dwarf virus (BYDV), a destructive disease of wheat and barley is common to the eastern U.S. Transmitted by aphids as they feed on grain plants, it can cause significant yield reductions. Effective management of this disease requires knowledge of factors that influence disease severity and information on manipulating those factors to limit aphid numbers and crop loss. Extension entomologists and plant pathologists from Virginia, Alabama, Georgia, South Carolina and Kentucky addressed the need for regional information on management of BYDV by pooling data and slides, and developing a draft for a regional publication. The team published *Barley Yellow Dwarf in Small Grains in the Southeast*, Alabama Cooperative Extension, ANR-1082. Growers and crop advisors use this publication to improve management of BYDV throughout the region.

Multi-Use Regional On-Line Courses in Pesticide Safety Education. There is a need for advanced train-the-trainer courses for pesticide safety educators across the U.S., including Extension agents and pesticide certification specialists. The Southern and Northeast Extension Regions, EPA Region III and IV, and other sponsors helped establish pesticide safety education centers in the two regions. These centers offer training annually to agents and certification specialists from the regions. An annual three-day workshop is sponsored by the centers at Penn State in the Northeast and North Carolina State University in the South. Prior to the workshops, participants in training complete an online course in pesticide safety. VT pesticide programs developed and sponsored these courses through their Web-based training system. As a result of hosting two online courses, 80 agents, specialists, regulatory officials, and other pesticide safety educators from the Northeast and Southern states qualified to participate in two three-day, hands-on workshops hosted by North Carolina State University and Penn State. Those workers gained information from the workshops to enhance pesticide applicator education and regulation programs in 26 states. To date, over 270 workers have been trained in this fashion in the two regions. This effort is a collaborative effort of the 26 states that make up the Southern and Northeast Extension Regions.

Fruit Website and Publication. Commercial fruit growers and home owners are looking for convenient ways to access information. However, reductions in public funding limit face-to-face contact to extend information. In response, a website was created for fruit crops grown in Virginia (<http://www.ento.vt.edu/Fruitfiles/VAFS.html>). The Virginia Fruit Home Page received 14,175 visits from January through December 2006. In total, 801,973 visits were made to pages within this website in 2006. This is a 42 percent increase from the previous year. Additional Web use statistics are posted at: <http://www.ento.vt.edu/Fruitfiles/UseStats2006.html>. The Virginia-West Virginia-Maryland 2006 Spray Bulletin for Commercial Tree Fruit Growers, Publication 456-419 has also been a part of this effort.

Grounds Maintenance Conference. Virginia and North Carolina require people who apply pesticides to be certified commercial pesticide applicators. To maintain certification each applicator must attend recertification training specified by each state's regulations. Extension provides this training. Several counties located on the North Carolina–Virginia state line offer recertification training to applicators in both states who apply pesticides on rights-of-way, turf/lawn areas, other landscape areas, gardens, and use pesticides for research and demonstration. The training was attended by 98 certified commercial applicators, three certified private pesticide applicators, and 35 non-certified participants from Virginia and North Carolina. All of the certified participants were recertified at the training. The Virginia certified applicators received two years of recertification credit. The North Carolina certified applicators received five hours of recertification credit.

USDA Pesticide Recordkeeping Inspector Online Course. The USDA/Agricultural Marketing Service, Pesticide Recordkeeping Branch works with and funds VT Pesticide Programs to develop, maintain and sponsor an online course in pesticide recordkeeping. This course replaces multiple workshops at local sites and supplements an annual national cooperator workshop held by USDA. As a result of completing the online course, 370 federal pesticide regulatory inspectors are better prepared to inspect farms and related pesticide application sites. This course saves many localities from conducting this training themselves and saves the costs associated with conducting multiple local workshops.

Southwest Commercial Pesticide Recertification. Pest control businesses, right-of-way workers, farm supply stores, and government employees who give pesticide recommendations all must have a commercial pesticide license to conduct business. Many of these individuals hold more than one commercial category, and some of them from out of state hold similar licenses in other states. Agents in the Southwest District conducted a commercial pesticide training meeting for 120 individuals from four states. They received credit in one area of certification for at least one state and sometimes two states. This recertification saves participants in excess of \$15,000 dollars in training expense and at least that much in lost revenue should they have to go elsewhere to get the training and spend time away from their business.

Improving Chesapeake Bay Water Quality. To safeguard the ecology of the Chesapeake Bay, cooperating states in the Chesapeake Bay Program, including Virginia, committed to reduce nutrient pollution sufficiently to remove the Bay from the list of impaired waters under the federal Clean Water Act by 2010. The partners have committed to reducing nitrogen entering the Bay by 100 million pounds (approximately 37 percent) and phosphorus nutrients by six million pounds (approximately 32 percent). Extension specialists in Virginia, West Virginia, Maryland, Delaware, and Pennsylvania obtained funding from USDA and formed the Mid-Atlantic Regional Water Program (MARWP) to provide environmental education on water quality to state and regional citizens. The MARWP developed cropland nutrient budgets for all counties in the cooperating states that estimate the quantity of phosphorus nutrient applied to county cropland and the quantity of phosphorus removed in crop harvests. Phosphorus balances were also estimated for agricultural census years since 1987. This work revealed trends in the improvement or deterioration of the long-term cropland nutrient balance. These trends are found at the program's website "Nutrient Budgets for the Mid-Atlantic States" at <http://mawaterquality.agecon.vt.edu>. Public agency personnel received orientation on navigating

the site. As a result of the usefulness of this Web tool, the Chesapeake Research Consortium promised funding to expand the site to include nitrogen nutrient budgets and present site results by watershed. Public presentations about Bay nutrient status and trends from the website were conducted across the region. Additional results of this multi-state Extension project are available on the website.

Biological Control of European Corn Borer in Peppers. Peppers are an extremely high value crop for vegetable producers grown on more than 2,500 different farms in Delaware, Maryland, Pennsylvania, New Jersey, and Virginia. Control of European corn borer critical to producing a profitable crop of peppers requires intense insecticide usage – as many as eleven insecticide applications per crop per season. To protect human safety and environmental stewardship long-term strategies are needed to reduce reliance on multiple preventative applications of insecticides in peppers. Funding was obtained from the U.S. EPA and the National Science Foundation Center for Integrated Pest Management (IPM) to improve IPM for peppers in the region. Research showed this was possible by advancing the use of the biological control agent, *Trichogramma ostrinia*. This agent could kill more than 50 percent of corn borers before they hatched by using reduced-risk insecticides instead of more toxic conventional materials. Collaborative research and demonstration projects, as well as numerous presentations at Extension venues, and mailings of IPM manuals to growers and crop consultants in Virginia, Delaware, Maryland, New Jersey, and Pennsylvania helped growers adopt these integrated and reduced-risk insect management practices. A substantial reduction in the use of priority insecticides, such as acephate and pyrethroids, on peppers should occur in the region in the near future while posing minimal economic risks to producers.

Evaluation of Burley Tobacco Breeding Lines for Blue Mold Resistance and Yield Potential. (see Integrated Research and Extension description on page 105)

Management of Billbugs in Orchardgrass. (see Integrated Research and Extension description on page 115)

Managing Tobacco Diseases and Nematodes. (see Integrated Research and Extension description on page 106)

Transitioning Overseeded Turfgrasses. (see Integrated Research and Extension description on page 113)

Goal 5: To enhance economic opportunities and the quality of life among families and communities

Developing Equine Leaders for Improved Youth Development. Volunteer leaders are necessary for the success of the equine 4-H program. In Virginia, 400 equine volunteer leaders give time and other resources to the program. In 2006, the Virginia/North Carolina Equine Volunteer Leaders Conference was established as a two state opportunity for volunteer leaders, agents, or interested parties to enhance youth development through the equine program. The 2006 conference lasted three days and involved 75 participants in 13 presentations on innovative ideas for developing youth of all ages. Conference attendees rated the presentations highly on the conference survey. Leaders commented, "they were going home with fresh ideas and a renewed spirit of giving and were looking forward to the next year's conference."

Extension Communities of Practice. Many citizens rely on the Internet to access up-to-date research on their daily concerns. Therefore, VCE faculty serve on Extension communities of practice with their peers from across the nation to make the best Extension research-based resources available through the Internet. Family and Consumer Science faculty currently serve on the Financial Security for All community of practice as part of the frequently asked questions team and the ask the expert role for estate planning and insurance. A faculty member is also part of the new Family Caregiving community of practice providing the lead on financial issues for family caregivers. Impacts on this work have not yet been collected since Financial Security for All recently had a soft launch nationwide and Family Caregiving is in development.

Ethics for Tax Practitioners. Two hours of ethics is required in many states for practitioners to retain their license to practice as a Certified Public Accountant, Certified Financial Planner, or insurance agent. To support this process, VCE faculty assisted with writing the land-grant Tax Workbook and an ethics problem chapter for instructors in the Land-Grant Tax program. The workbook was used in 25 state programs and studied by 25,700 tax professionals. Twenty-five Land-Grant universities cooperated in drafting the 600-page tax workbook.

Agricultural Risk Management Training. VSU served as the lead institution in a multi-state collaborative effort with the University of Minnesota Center for Farm Financial Management, University of Arkansas Pine Bluffs, Alabama A&M University, North Carolina A&T State University, and the National Crop Insurance Services to implement a risk management project in 2006. The project included training in agricultural risk management tools to provide effective crop insurance and financial education to underserved producers in Virginia, Arkansas, Alabama, and North Carolina. The program developed limited-resource farm case examples that document the actual financial plan and crop insurance decision-making process for representative farms. Collaborators also created crop insurance and financial management educational materials to train producers and educators of limited-resource and socially disadvantaged farmers and ranchers in four states. Training focused on socially disadvantaged producers viewed as early adopters who would successfully utilize crop insurance products and financial management tools and become models for other limited-resource producers. Finally, this multistate project enhanced cooperation among a network of educators and advisors who help limited-resource and socially disadvantaged producers improve their financial management.

4-H Camping and Life Skill Outcomes. The National 4-H Camping Research Consortium (NCRC), a multi-state initiative of Extension educators and researchers plans to better understand and disseminate the impact of the 4-H camping experience through the development and implementation of 4-H camp evaluation strategies. Four resources have been produced in draft format, including recommended practices for 4-H camp evaluation, logic models for 4-H camp evaluation, a questionnaire measuring to what degree camp is a context for positive youth development, and a questionnaire that measures the like skill outcomes of 4-H camping. In the summer of 2006, several states, including Virginia, pilot-tested these resources. The pilot test will be used to improve the instrument. In 2007, the revised questionnaires will be used across multiple states to collect data regarding the context and outcomes of 4-H camping. This data will be pooled and shared nationally. Virginia faculty provided leadership to this multistate consortium in 2006. In addition, VCE faculty will host the 2008 National Camping Institute, a

professional development opportunity for paid and volunteer camp staff nationwide. Both efforts require deep collaboration with Extension camping partners around the nation.

Administrative and Program Support. Extension administrators and program development and evaluation staff with VCE are involved in a variety of multi-state, regional, and national projects from developing curriculum to organizing and/or supporting multistate educational opportunities. These range from Southern Region staff development online modules, to ag biosecurity, youth development, and water quality initiatives.

Brief Summaries of Selected Integrated Activities

Goal 1: To achieve an agricultural production system that is highly competitive in the global economy

Northumberland/Lancaster Soybean Variety Trials. Lancaster and Northumberland soybean producers expressed a need for information on planting the best soybean varieties. Combined, the counties produce 23,000 acres of soybeans that yields an average of 30 bushels per acre and soybeans provide \$4.5 million in annual sales. In response, Extension provided replicated soybean variety trials in 2006. Research and education programs showed that, on average, the best five varieties outperformed the average by four bushels per acre. Results were shared by direct mail with soybean producers in the two counties. An evaluation conducted with 12 farmers revealed that 75 percent intended to switch to better-performing varieties as a result of the program. If as few as 50 percent of county soybean farmers switch from average to higher-performance varieties in the coming year, this would result in nearly \$600,000 in additional soybean sales assuming commodity prices remain constant.

New Business Options with Plants. The decline of tobacco production requires new and profitable agricultural enterprises. In response to this issue, new horticulture enterprises were identified as options for the future in Southside Virginia. In 2004 VCE, Virginia Master Gardeners, the Virginia Nursery, and the Landscape Association applied for grant funds from the Virginia Tobacco Commission to launch a statewide plant introduction program. A grant for \$230,000 was received in 2005 to begin a research and education program. Halifax County was chosen as a research site and county Master Gardeners were responsible for the project. Land was donated by the county for test plots and volunteers made land preparations to plant desired species. Since January of 2006, the program provided hands on teaching of different cultural methods and plant identification. One hundred thirty-four local Master Gardeners donated over 1,000 volunteer hours and Halifax County provided \$18,700 of in-kind donations to support this economic development program. The program introduced entrepreneurs to the green industry and provided training for new business ventures. Commercial growers are also learning the best varieties to plant in Southside Area.

Utilization of Naturalized Forage Species. Natural forage species can enhance livestock production. Research and education programs conducted in the Southern Piedmont and Coastal Plains regions of Virginia increased the use and improved the management of naturalized forage species commonly found in this region. In 2006, these programs exposed more than 1,800 producers, agency, and industry personnel to species such as bermudagrass and crabgrass.

Incorporation of these species into grazing systems increased forage availability during the summer months, allowing production of 20 percent to 30 percent more animals on the same land base and improving animal performance by 50 percent to 100 percent.

Soybean Variety Test and Demonstration Plots. Annually over 20,000 acres of soybeans are produced in Northampton County. Varietal variations and management practices potentially impact yields and profitability of this crop. In 2006, on-farm research was conducted in Northampton County on a 75-acre farm to examine production practices in disease, insect, fertility, weed control, and variety comparisons. Integrated pest management research and growing season variety evaluations were conducted by staff of the Eastern Shore AREC. Thirty-three varieties were included in the test as well as fungicide and insecticide comparisons, foliar fertilizer applications, and pre-and post-emergence herbicide evaluations. The results and conclusions of this research project were delivered to clientele at the 2007 Eastern Shore Ag Conference and Trade Show. Additionally printed variety test results will be mailed to clientele.

Cotton Variety Selection. A small-plot variety trial was performed in 2005 to assess the yield and quality of 60 commercially available cotton varieties. These trials were supplemented by on-farm demonstrations in five counties containing 12 to 20 varieties each. The results were disseminated through Extension meetings, distributor meetings, electronic and hard copy newsletter mailings, and direct contact with producers to support proper variety selection. Approximately 92 percent of cotton acreage in Virginia in 2006 was planted from the top ten varieties in the VT variety trials. Selecting varieties identified in the trials as high yielding over certain lower-yielding varieties saves a 100-acre producer 50 to 500 pounds per acre. Extrapolated for 109,000 acres in Virginia and compared to yield and quality in varieties ranked below the top ten, this project could generate between \$3 - \$20 million from using variety trial information to select elite varieties.

Peanut Production and Maturity. With the loss of the government-supported peanut program, the value of a ton of peanuts has decreased from \$610 per ton to \$400 per ton. This rate is below the cost of production, so it is critical to control production costs and increase yields. Control measures include a way to determine the optimum maturity time to dig and harvest the crop. Consequently, the pod-blasting method was developed by VCE. In September 2006, Extension staff conducted two peanut maturity clinics for 15 peanut producers representing 3,000 acres of peanuts. Growers dug samples from each of their field including different varieties. After the varieties were evaluated each producer could see the maturity of the crop by using the pod blasting method. This method was 95 percent accurate in determining when to begin harvesting the crop for optimum maturity. The maturity clinics added an estimated \$100 per acre or \$300,000 of profit for peanut producers. In addition, Extension assisted in planning and implementing a peanut production program for 100 peanut producers. Growers received educational information on variety selection, proven production practices, and an update on the peanut marketing.

Teff Grain as a Viable Forage and Cash Crop. Forage producers and horse owners have recognized the need to produce and utilize forage that is high in quality and palatability, drought tolerant, endophyte fungus free, and acceptable to horse enthusiasts. Teff grain is utilized in the arid regions of Africa as a grain crop for human consumption and forage for livestock

production. Teff is gaining strong acceptance on the West Coast of the U.S. as forage for both livestock and horse production. Extension developed a strategy for introducing Teff grain to commercial hay production systems through a research demonstration project that addressing the production, harvest, and marketing of Teff hay. This project involved a commercial hay producer in identifying and carrying out planting and production strategies. Harvesting was done as dry hay in small square bale packages suited for the horse industry. The packaged product was marketed to horse producers. This project also looked at the grazing acceptance of Teff by cattle with producers at the annual Corn and Forage Research Update Meeting series held at four locations. The annual yield measured was 4.52 tons/acre, which is equal to or better than most traditional grass forages. Forage quality was very acceptable. The crude protein samples ran from 16 percent to 19 percent and the total digestible nutrients ranged from 58 percent to 64 percent. The horse industry found Teff to be highly palatable and acceptable for horses. Not only was quality good for horses, but the Teff was also endophyte fungus free, making it highly desirable for gestating and lactating mares affected negatively by the endophyte fungus. The economics also proved to be favorable since Teff can be produced and marketed at a value of 15 percent above production costs. Teff was also found to be highly suited for cattle grazing if done late in the growing season. The shallow root system of Teff allows cattle to pull the entire plant from the soil thus reducing plant stand density.

Onions Offer a Source of Revenue for Southwest Virginia Producers. A local grocery chain in Southwest Virginia wanted to purchase locally grown onions and several growers were interested in this enterprise. An onion specialist from New York taught an onion production school. Each participant was given onion sets and shown how to plant them. Additional instructions were given in the field while observing varieties. Two additional trials were conducted in Southwest Virginia to identify acceptable varieties. In 2006, four producers in Southwest Virginia tried onion production on a commercial scale. Three of the producers sold marketable onions and will grow onions again in 2007. One producer said, "I need onions or some other commodity to stay in business." The planned production for 2007 could amount to more than \$100,000 in gross sales.

Disposal of Poultry Mortalities in Response to an Avian Influenza Outbreak. The continued spread of bird flu increases the urgency for research and preparation for on-farm disposal options of poultry mortalities. An outbreak of high pathogenic avian influenza (H5N1) would have high costs to humans and the poultry industry. In-house composting of poultry, particularly on turkey, breeder, and multilevel house operations, has not been considered a viable option because the composting process could keep poultry houses out of production too long and may not work on larger birds or in non-free span houses. Building on the success of in-house composting of broilers in Delaware and Maryland, VCE and the Virginia Department of Environmental Quality conducted two separate studies to evaluate the effectiveness of in-house composting of turkeys and in non-free buildings more specific to Virginia's poultry production industry. As a result of the initial study and success with composting larger birds, the research team worked with industry personnel to evaluate and discuss preparations for in-house composting of all bird types and in all poultry house designs. Results indicate that in-house composting can be an effective and practical disposal method for most bird types and poultry house designs common in Virginia. On-farm disposal methods, such as in-house composting, minimize economic, environmental, and social challenges and offer the poultry industry and health officials a

biosecure and cost-effective option for disease containment and carcass disposal. The Virginia poultry industry now views in-house composting as a preferable disposal method and has prepared to use this method for future outbreaks. These findings and results are referenced in U.S. EPA guidance, were reported to the Virginia Poultry Disease Task Force, USD Animal and Plant Health Inspection Service personnel, industry representatives, the Virginia Department of Agriculture and Consumer Service, and the National Carcass Disposal Symposium. Articles were published in *BioCycle* and fact sheets posted on the Virginia Department of Environmental Quality's avian flu website.

Development and Dissemination of Disease Resistant Small Grain Varieties. Diseases of wheat and barley frequently result in yield losses from 10 to 20 percent in susceptible varieties, requiring one or more fungicide applications at 29.6 dollars per ha, which could cost Virginia small grain producers 2.4 million dollars per year. Development of varieties with durable resistance to prevalent and newly emerging diseases and/or new races, such as fusarium head blight, stripe rust, and stem rust, provide growers, end users, and consumers with a sustainable, economical, and safe food supply. During the past five years, three winter barley and more than 12 soft winter wheat varieties were released and grown in 12 states. Based on seed sales in 2005, more than 1.78 million units of certified seed of these varieties were sown on more than 890,000 acres. Development and release of high-yielding small grain cultivars with durable disease resistance and desirable end use quality result from collaborative research efforts involving universities, USDA-ARS, and private industry. USDA-ARS plays a major role in the evaluation and characterization of potential variety releases for adaptation, resistance to diseases and insects, and end use quality. Extension plays a major role in collecting and disseminating data and information on variety performance, adaptation, and resistance to diseases as well as recommended management practices.

New Barley Varieties Result in Exports and Potential New Markets. Release and production of higher quality hulled feed barley varieties resulted in increases in foreign exports. Hulless barley varieties with lower fiber and higher starch, protein, and metabolizable energy are being evaluated in more than six states as a feedstock for ethanol production. Barley varieties low in phytic acid contributes to improved nutritional value and reduce fecal phosphorous pollution of ground water. Virginia, Maryland, Delaware, Kentucky, Pennsylvania, North Carolina, South Carolina, Oklahoma, Texas, and USDA-ARS collaborate to research, grow, and evaluate experimental hulless barley lines each year. Research on management and production of hulless barley is conducted with the small grains Extension specialist. Assessments of feed value of hulless barley and potential use in poultry rations are made by Perdue Inc. in collaboration with the Virginia Small Grains Association and the Virginia Crop Improvement Association.

Evaluation of Burley Tobacco Breeding Lines for Blue Mold Resistance and Yield Potential. The foliar disease, blue mold, can cause an estimated 20 percent yield loss in burley tobacco fields throughout Southwest Virginia. The 2006 burley tobacco crop has an estimated value of over \$15 million in Virginia. Few fungicides are labeled for control of blue mold in tobacco. Those that are available are difficult to apply, and have limited effectiveness. Two burley varieties possess resistance to blue mold, but they are low yielding and highly susceptible to other important tobacco diseases, such as tobacco black shank. A collaborative research project was conducted by VT tobacco faculty and A tobacco plant breeder from the Universities

of Kentucky and Tennessee from 2004-2006. Several breeding lines were evaluated for yield potential and resistance to blue mold. These breeding lines were compared to popular high-yielding varieties and blue-mold-resistant varieties. In addition, breeding lines were compared to a high-yielding variety protected by a fungicide (control). Several burley tobacco breeding lines experienced less leaf area damage than all other varieties except the current blue-mold-resistant varieties. However, many of the breeding lines produced yields higher than all varieties and equal to the protected control. One of the breeding lines (KTH 2404) will be released as a variety in 2007 (KT 207). Information about this new variety has been shared at growers meetings, field days, and in demonstration plots and Extension newsletters.

Managing Tobacco Diseases and Nematodes. Disease management research and recommendations for tobacco producers in Virginia are coordinated with plant pathologists in Georgia, South Carolina, North Carolina, Kentucky, and Tennessee. Flue-cured tobacco disease resistance results are shared annually at a meeting in Raleigh, North Carolina, with seed companies, plant breeders, and colleagues from North and South Carolina and Georgia. Research plans and recommendations for managing tobacco black shank are coordinated with plant pathologists at North Carolina State University and the University of Kentucky. Germplasm evaluations for resistance in burley tobacco to black shank and bacterial wilt are being planned with plant breeders and plant pathologists in North Carolina, Kentucky, and Tennessee. VCE is an active participant in the Blue Mold Warning System in North America and an annual Blue Mold Oospore Survey, a program coordinated by USDA-APHIS to check infested tobacco fields for the presence of pathogen propagules according to a trade agreement with China. In addition, Virginia participates in the Cooperative Center for Scientific Research Relative to Tobacco international nematode resistance evaluation project to annually evaluate tobacco germplasm for resistance to plant-parasitic nematodes. These collaborations involve facilitating development of cultivars with resistance to diseases and nematodes to reduce pesticide use.

Plant Growth Regulator Product Selection. Plant growth regulator (PGR) prices ranged from \$5.10 to \$44.30/L in 2006. Research indicates little or no difference in PGR efficacy on plant height or maturity. Growth regulators were applied to 42,500 ha of cotton in Virginia, in 2006 at approximately 0.24 L/ha. This research and Extension efforts at county winter production meetings and field days showed producers products being tested were equal in efficacy. Through informal polling, as a result of these research and Extension efforts, 20 percent of producers used the least expensive PGR formulation, which resulted in a reduction in input costs of \$10/ha or more than \$ 500,000 in 2006. Information on PGR efficacy was delivered through county winter production meetings, newsletters, and field days.

Improved Food Processing Technologies Increase Wine Quality and Product Value. To increase market share, the wine industry must improve grape and wine quality and limit or reduce production costs. State-wide surveys determined that grapes often lack the quantitative and qualitative nitrogen profile needed to produce optimum fermentation byproducts. More than 80 percent of Virginia wineries test for nitrogen using a simple system developed in the VT laboratory or use the Enology Service Laboratory for nitrogen testing, resulting in increased wine quality and profitability. Workshops on Winery Planning and Design stimulated industry growth and are, in part, responsible for the six wineries established in the region in 2006. Research-based recommendations to improve wine aroma/ flavor have been adopted by practitioners

nationally and internationally, increasing wine quality and product value. Research on the incorporation of oxygen, seed deportation, and thermal processing of red wines pre- and post-fermentation has been adopted by the industry as methods to increase the rate of wine aging, thus lowering production costs and increasing profitability. Coordinated research and education helped educate the industry through Extension programs and electronic media.

Adding Value to Woodlands with American Ginseng. There are over 12 million acres of privately owned woodlands in Virginia. These forest lands are used for production of lumber, but timber sales often do not produce substantial income. Landowners can increase income from woodlands by establishing populations of American ginseng. This medicinal herb is naturally adapted to grow in the shade of hardwood trees on the forest floor. Market demand for the fresh and dried roots of American ginseng is strong in the U.S., Europe, and China. This research focused on investigating the economic costs and returns of wild-simulated American ginseng in Virginia, the growth requirements of American ginseng, the control of pests, and the control of human theft. Ginseng production research and demonstration plots were established on 160 different farms in 64 counties of Virginia. Educational field programs were held at six sites. A publication entitled "Producing and Marketing Wild Simulated Ginseng in Forest and Agroforestry Systems" was distributed through Extension offices and the VCE website. Over 400 Virginia landowners have established production of American ginseng as a new enterprise for supplemental income. Average annual yield for these growers is about three pounds of dried roots. At \$400 per pound, this amounts to an additional \$480,000 total in farm income.

Baby Lima Beans as Alternative Crop. Traditional peanut production has become less profitable from the loss of federal subsidies for the peanut program. Peanut acreage has been reduced by approximately 75 percent from the loss of the peanut quota program. This has caused financial hardship for small and limited-resource peanut producers in Southeast Virginia and has left many producers looking for profitable agriculture alternatives. The VSU Small Farm Outreach agents and Extension specialists conducted meetings with growers to discuss alternative crops. Baby lima beans (butterbeans) were identified as the alternative with the best potential for growers interested in commercial vegetable production. Research demonstrations, hands on training, and assistance were provided to 30 growers to grow butterbeans on a commercial scale. Results from on-farm demonstrations were used to conduct field days and other educational programs, showing a grower could successfully produce 75 bushels of butterbeans per acre. With an average wholesale market price of \$20.00 per bushel, and estimated production costs of \$480 per acre, the profit potential of \$1,020 per acre is feasible. The thirty growers planted a total of 150 acres of butterbeans and with an average yield of 75 bushels per acre the total gross value was \$225,000 in three counties. These growers generated an extra \$5,100 net profit with just one commodity. This effort was made possible by a USDA grant to purchase a mechanical bean harvester for demonstration use at the VSU Randolph Farm. As a result of the demonstrations and research, 12 mechanical harvesters are spread out over five counties in Southeast Virginia. Several producers increased the average yield per acre to 90 bushels and opened their own roadside stands to sell retail.

Production of Fresh Cut Flowers in Virginia. Over 90 percent of the cut flowers sold in wholesale and retail markets in Virginia are grown outside of the state. American growers generally cannot compete with low cost labor in Colombia, Ecuador, and Costa Rica. Strong

market demand exists within the floral industry for specialty cut flowers that do not have a long enough shelf life to allow wholesale shipments from foreign countries. In response, this research investigated the economic costs and returns of cut flower production in Virginia, the market demand for specific cut flower species in Virginia, the effectiveness of non-chemical and chemical controls of weeds, insects, and diseases in cut flower crop production, methods of field management to enhance yield and quality of cut flower crops, and methods for post-harvest handling of cut flowers. Research and demonstration plots were established at VSU's Randolph Farm and on 12 private farms throughout Virginia. Over 150 people attended the Virginia Cut Flower Growers Conference and cut flower field days. A publication entitled "Growing Everlasting Flowers: A Beginner's Guide" was also distributed through Extension offices across Virginia. Over 200 Virginia farmers established commercial production of cut flowers as a new farm enterprise. These beginning cut flower growers sell an average of \$5,000 of cut flowers each year. Their combined sales have contributed \$1,000,000 in farm income to the state economy.

Organic Vegetable Production. Many small farmers in Virginia attempt to earn income through the production and marketing of vegetables. The profitability of small-scale vegetable operations in Virginia is quite variable. Organic certification is an excellent way for small farmers to separate their vegetable crops from the crops grown by large-scale, conventional growers. Premium prices are often paid for certified organic produce and market demand for these crops is expanding. In response this research investigates the economic costs and returns of organic vegetable production in Virginia, the effectiveness of non-chemical controls of insects and diseases in vegetable crop production, and the effectiveness of using cover crops, compost, and other organic fertilizers to maintain soil fertility. Organic research and demonstration plots were established at VSU's Randolph Farm. Over 250 landowners attended the Virginia Biological Farming conference and learned about production and marketing of organic crops. Fact sheets on organic production of specific crops were distributed through Extension Offices across Virginia. About 120 Virginia farms were certified for organic production in 2006. There are over 6,000 acres in organic production in Virginia

Small Ruminant Parasite Control. If parasites are not controlled, sheep and goats will cease to be a viable industry in Virginia. Control of gastrointestinal nematodes is the leading cause of poor performance and death in small ruminants in Virginia. This research at VSU documented the extent of drug resistance. These results on anthelmintic resistance, non-chemical control options, and fecal analysis were shared in Extension programs. Over half the Extension programs each year by the small ruminant specialist involve presentations in parasite control.

Controlling Invasive Species in Pastures on Reclaimed Coal-Mined Land. Coal-mined land is often restored to support forage-based enterprises. These lands may improve farm productivity if managed correctly. Also, the demand for goat products in the U.S. has increased with Hispanics, Arabs (mainly Muslim), and people of Caribbean descent coming to the U.S. Goats can be grazed with cattle to control unwanted brush and weeds. Goats consume troublesome plants, such as multiflora rose, thistles, blackberry, stinging nettle, and other plants that cattle will not, while increasing the vegetative cover of favorable grasses and legumes. Using goats as biological control agents decreases the need for costly mechanical cutting and herbicide application. In 2006, experiments at the Powell River Project site, explored the effect of goats

grazing alone and mixed with cattle on shrub-infested mined pastureland for herbaceous species utilization patterns. Results show goats grazed with beef cattle offers a unique advantage for producers in Appalachia to utilize vegetation that would otherwise have no value. The project results were highlighted at Extension goat/cattle workshops and field days held at the site with over 200 producers.

Preventing Gray Leaf Spot Disease with No-Tillage Production. Gray leaf spot (GLS) of corn, caused by the fungus *Cercospora zea-maydis*, increased in incidence and severity with the adoption of no-tillage production practices. GLS is endemic in Virginia, particularly in the Piedmont, Western Virginia, and at times under center pivot irrigation in the eastern part of the Commonwealth. Serious losses have occurred in areas of the U.S. Corn Belt and more recently in the southern two thirds of the African Continent. Losses of 60 percent to 80 percent are not unusual for a susceptible hybrid in a conducive environment. Research efforts have resulted in the identification and characterization of new sources of resistance, identification resistance quantitative trait loci (QTL), mapping of these QTL, and development of molecular markers to assist in breeding for resistance to GLS. In addition to the work with corn germplasm the program has evaluated corn hybrids available to Virginia growers for their resistance to GLS. Highly susceptible and susceptible hybrids are discouraged for use by Virginia corn growers. Hybrids of superior resistance or tolerance to GLS are recommended in this project's Pest Management Guide for Field Crops, VCE publication 450-016. Hybrids with higher levels consistently resulted in 20 percent to 60 percent yield increases over more susceptible hybrids. Use of resistant hybrids identified by this project annually saves Virginia corn farmers nearly \$16,000,000 in potential grain losses to GLS on approximately 300,000 acres.

Introducing Bio-fuels Opportunities. The global movement towards developing bio-fuels from oilseed crops, such as soybeans, hopes to decrease dependence on fossil fuels, be carbon neutral, and decrease noxious emissions into the atmosphere. Virginia grows over 500,000 acres of soybeans. Working with Virginia Clean cities, educational programs introduced bio-diesel production from oilseed crops, such as soybean and canola. Collaborators included VT and Virginia State University faculty and an Extension agent. Results from canola production, oil quality research, and other general bio-fuels information, were presented at bio-diesel workshops, academic forums, and stakeholder meetings. One hundred seventy-three producers, educators, and entrepreneurs participated in bio-diesel workshops. The Director of Physical Plant Operations at VT who attended the workshop, stated the University should convert its diesel vehicles to bio-diesel. Participating managers from Prince George County decided to convert their school bus fleet to bio-diesel, and a truck stop owner from Martinsville started producing his own bio-diesel. Finally, representatives from Sage Inc., a bio-fuels company, are considering opening two bio-diesel plants in Virginia.

Improving Economic Returns for Small Scale Producers (see Multistate Extension report on page 94).

Goal 2: To provide a safe and secure food and fiber system

Produce Food Safety. Fresh fruits and vegetables are increasingly associated with outbreaks of foodborne illness. Produce can harbor many naturally occurring microorganisms, some of which

may be harmful to humans. Microorganisms on the surface of raw produce may be difficult to remove for decontamination or microbial sampling due to porous surfaces and microbial attachment. This prompted the development of a research and Extension program to address produce food safety. Chemical agents and ultrasound decreased the amount of bacteria on produce surfaces. Research also examined natural procedures, hydrogen peroxide, and acetic acid as antimicrobials. The studies investigated and linked proper washing procedures for fresh produce with a decreased risk to consumers. Extension activities included radio programs, magazine articles, and web presentations to reach out to consumers. Consumers seeking a natural microbial decontamination procedure adopted the practice of washing produce and kitchen surfaces with a combination of hydrogen peroxide and acetic acid. They found this procedure on several health-related websites that reference this research project's washing procedures. Publishers of the website indicate this portion of the site receives thousands of hits weekly, and a spike in hits is seen each time a new pathogen outbreak with produce occurs.

Goal 3: To achieve a healthier, more well-nourished population

None

Goal 4: To achieve greater harmony between agriculture and the environment

Preventing Weeds in Snap Beans. Approximately 5,000 acres of snap beans are produced annually on Virginia's Eastern Shore, where they are graded and shipped to fresh market or to processing plants. Although snap beans require only 60 days from planting until harvest, weeds reduce yields and interfere with mechanical harvest. Since there is no tolerance for weeds in the harvested crop, fields with only a few weeds may not be harvested, and entire production costs are lost to farmers. Research was conducted for several years to develop management programs that utilize low herbicide rates to control weeds. Farmers have been trained on weed management through presentations at Extension meetings and demonstration plots, newsletter articles, and revisions to the Commercial Vegetable Production Guide. Approximately 98 percent of snap bean producers used the low-rate herbicide programs developed for snap beans. None of the fields were abandoned as a result of weed infestations and average yields were enhanced by as much as 20 percent (30 boxes per acre) compared with previous less effective programs. At an average price of \$10 per box, the increased return to farmers is estimated at \$300 per acre.

Glyphosate-resistant Weeds. Widespread adoption of conservation tillage practices and herbicide-resistant crops have resulted in multiple applications of Glyphosate (Roundup, other brands) annually for weed control. High use of Glyphosate resulted in Glyphosate-resistant weeds that dominate many fields and require five to six times the historic rate of Glyphosate for control. Seed of these resistant weeds are spread by wind, water, and farm equipment and distributed across farms producing corn, soybeans, and vegetable crops. Research shows that many of these weeds can be controlled by alternative herbicides applied in fall and winter. Research at VT's Eastern Shore AREC intends to verify and develop systems to control overwintering weeds economically without Glyphosate. Herbicide mixtures were applied between December and March and soybeans planted in May to confirm crop tolerance. Presentations were made at crop conferences for producers. Electronic newsletters will further distribute information

regarding the need to change current weed management strategies. The adoption of alternative programs for management of Glyphosate-resistant weeds will help sustain the value of Glyphosate for weed management in herbicide-resistant crops. Controlling weeds in advance of planting improves moisture conservation and improve crop emergence. The adoption of these weed management programs should save producers \$7.50/acre in reduced application costs plus yield increases averaging five bushes per acres from improved weed control. These programs should reduce the development of Glyphosate-resistant weeds and their spread to adjoining farms and help sustain the value of Glyphosate.

Plasticulture Best Management Practices for Tomato Producers. In 2006 over 5000 acres of tomatoes were produced in Accomack and Northampton Counties by four Florida-based operations. Water quality concern associated with sediment and nutrient movement from these production areas endangered the fragile coastal estuaries and the multi-million dollar Eastern Shore aquaculture industry. Through a cooperative effort of Northampton County Extension, the VDACS, The Eastern Shore AREC and the Eastern Shore Soil and Water Conservation District, studies were conducted, recommendations made, and the installation of best management practice (BMP) structures were made on six production farms in 2006. Additional recommendations were made and work continues on the establishment of BMP's at other locations to improve water quality and storm water runoff. In the past these producers rarely participated in VCE programs. This ongoing project involves 100 percent of the growers via meetings, personal contacts, e-mails, and direct mailings.

Enhancing Environmental Stewardship through Turfgrass Management. An August 2006-published survey of Virginia's turfgrass industry lists over 1.7 million acres of maintained turf in the state and over 424,000 paid workers in the turfgrass industry. These figures show increases from a 1998 survey of 24 percent and 8 percent, respectively. As society becomes more urban, educational opportunities emphasizing environmental stewardship in turfgrass management are needed. In 2006, outreach programs were modified to meet the diverse array of professional turfgrass managers. One of those efforts was the Virginia Turfgrass Research Field Days, a two-day educational event featuring demonstrations, tours of VT research plots, and research tours for the main sectors of the turfgrass industry: golf, sports, lawn/landscape, and sod production. Of the 250 field day attendees in 2006, 65 evaluation surveys were returned. Results indicate efforts towards promoting environmental stewardship are well received through research activities by VT Turf Team members in on-site presentations of research findings at VT's Turfgrass Research Center and other campus facilities.

Chemistry, Bioavailability, and Toxicity of Constituents in Residuals and Residual-treated Soils. Scientists believe the heavy metal binding capacity of soil declines after bio-solid applications discontinue and heavy metal binding-organic matter decomposes. Then an increase in the solubility of heavy metals from bio-solids applied at rates permitted by the United States Environmental Protection Agency (USEPA) 503 Rule will result in greater plant uptake and leaching potential in coarse-textured soils. This study shows no significant increase in bioavailability of potentially hazardous heavy metals occurs as organic matter decreased following cessation of continuous bio-solids application. However, the inability to account for significant amounts of Cu and Zn in soil raises the probability that considerable amounts of bio-solids-borne heavy metals may be transported through coarse-textured soil. Presentations on this

research were made to state agency personnel, local government officials, farmers, contractors, public utility personnel, local government public information meetings, Extension agent in-service training, certified nutrient management training meetings, and other meetings.

Integrated Plant Nutrient Management. Agro-ecosystems occupy over five million acres in Virginia. These lands are managed to produce food, feed, fiber, and energy. Sustaining these systems require judicious management to maintain soil quality and balance plant available nutrient levels with crop needs while minimizing off-site impacts on water quality. This research and Extension work with continuous no-till has increased soil carbon and nitrogen contents to improved soil quality while maintaining profitability of grain crop production. Nitrogen and phosphorus fertilization research and Extension programs focused on increasing nutrient use efficiency to reduce off-site nutrient enrichment of surface and ground waters. No-tillage production of crops continues to increase in Virginia and the region with over 60 percent of crop acres using some type of reduced tillage production system. Corn and wheat yields per unit of applied nitrogen are continuing to increase with more nitrogen captured by the crop.

The Virginia Phosphorus Feeding Incentive Program. During 2006 this project has grown to include 183 Virginia dairy herds with over 30,000 cows representing over 30 percent of the Virginia dairy industry. This work included analyzing 1,542 feed samples for multiple nutrients. In addition Extension educational programming was conducted for producers and nutritionists. Results from the first group indicate a reduction of P in rations and the manure to be 2.92 grams per day per cow. For a 100 cow herd this is a reduction of 292 grams per day translating to 235 pounds of P yearly that would not be in the manure produced on that farm, thus reducing the potential for water pollution. Expressed over the 30,000 cows in this project this would be a reduction of 35 tons of P per year.

Enhancing Prime Farmland Restoration. Over 5,000 acres of prime farmland will be mined in the Upper Coastal Plain of Virginia over the next 10 years. Return of mined lands to row-crop production was not attempted before this program. Working with Iluka Resources, Inc. and the Virginia Division of Mineral Mining, a multi-year field research program was implemented to determine if these lands could be returned to reasonable levels of post-mining productivity and if there are optimal soil and landscape reconstruction procedures. Field plots and demonstrations indicate that with appropriate tillage, lime, and fertilizer applications these lands can be returned to 75 percent to 80 percent of pre-mining productivity for corn and wheat within two years. Longer-term improvements in soil productivity are possible with further tillage and soil amendment combinations. These results allow landowners to optimize planning for post-mining lands. The findings also provide regulators and local authorities with a better understanding of effects of the mining and reclamation process on the local landscape, water quality, and property values. These research results have been shared with landowners, farmers, local politicians, and regulators through annual on-site research and Extension field days.

Agronomic Uses for Reclaimed Water. Reclaimed water is effluent removed from municipal wastewater and treated for potable water uses. Water reuse conserves potable water for drinking, bathing, cooking, and other uses that require highly treated water and reclaimed water is used for irrigation, cooling water for industries, and street and car washing. During the past year, faculty in the Department of Crop and Soil Environmental Sciences collaborated on research programs

assessing effects of irrigating turf grass with reclaimed water on turf grass performance and soil and water quality. Turf grasses using reclaimed water were less prone to disease and grew better than those irrigated with potable water. The research demonstrated that turf grass assimilated the potentially water-impacting nutrients of nitrogen and phosphorus at a rate that prevented contamination of groundwater. This research will help the Virginia Department of Environmental Quality (VDEQ) and the Hampton Roads Sanitation District conserve millions of gallons of potable water while reaping economic benefits from the sale of the reclaimed water, which is currently discharged without economic benefit into nearby surface water. Research results were delivered at a meeting of wastewater engineers, at a field day at the research/demonstration site, and to the VDEQ Technical Advisory Committee. These activities contributed to technically sound development of a draft state regulation on water reclamation.

Transitioning Overseeded Turfgrasses. To keep a desirable green surface all year, turfgrass managers overseed warm-season turfgrasses temporarily with a cool-season grass, such as perennial ryegrass. The ryegrass serves as an acceptable green playing surface during the winter, but can compete with bermudagrass in the spring. Transitioning overseeded grasses is a challenge for many turfgrass managers. VT, North Carolina State University, University of Tennessee, and University of Georgia faculty conducted 103 replicated field trials and several greenhouse and laboratory studies on this topic. Data demonstrated that sulfonylurea herbicides can be dislodged from the treated area by foot or vehicle traffic and deposited onto neighboring turf, causing injury. Research using radio-labeled herbicide tracing techniques elucidated irrigation regimes as an effective turf grass damage prevention method. By extending research results on herbicide mobility studies, most golf superintendents in Virginia and states to the south and west have adopted the recommended practice of post-treatment irrigation to prevent herbicide persistence on leaf surfaces. This practice is now listed on three herbicide labels and recommended by Extension specialists. Dissemination of these research results helps turfgrass managers choose turfgrass cultivars and pesticide application techniques that reduce environmental, social, and economic impacts of managing overseeded grasses. By limiting mobility of transition-assisting herbicides on eastern transition zone golf courses, 450 kg of sulfonylurea herbicides are perceivably kept on target turfgrass rather than surrounding environments. In 2006, these research results were shared through seven presentations in Virginia and three other states, three magazine articles, and electronically through the "Turfweeds at VT" and "VT Turf" Web pages.

Italian Ryegrass Control in Wheat. Italian ryegrass is a winter annual grass species that infests Virginia's winter wheat present in all wheat-producing areas of the state. Competition from ryegrass reduces wheat yields by as much as 75 percent, and moderate infestation levels cause harvest impairment and seed contamination. Since the 1980s, ryegrass has been controlled selectively with diclofop-methyl. In 1993, however, Italian ryegrass with resistance to diclofop-methyl was confirmed in Virginia. VT College of Agriculture and Life Sciences research demonstrated that post-emergence applications of mesosulfuron-methyl were effective for control of the resistant ryegrass biotype with excellent crop tolerance. The use of mesosulfuron-methyl was discussed extensively in VCE training sessions related to small grain production. As a result of these efforts, mesosulfuron-methyl was applied for ryegrass control in 15,444 acres of Virginia wheat in the second season of registration.

Evaluating Insecticidal Products for Bed Bug Control. The resurgence of the common bed bug made headline news in 2006. In Virginia none of the insecticides labeled for bed bug control have been empirically tested for efficacy. Last year the VT Dodson Urban Pest Management Laboratory (VT-DUPML) submitted the first manuscript since 1966 evaluating the efficacy of pesticide products on bed bugs. That manuscript was published by the Journal of Economic Entomology in December 2006. Since the production of that manuscript, VT researchers tested these same products on field strain bed bugs collected from Virginia apartments. The field strain bed bugs are highly resistant to pyrethroids and not susceptible to other types of residual spray insecticides. Bed bugs were also found to be tolerant of non-insecticidal dusts and survived for more than 30 days when confined on the material. The most important discovery was that bed bugs are not repelled by pyrethroids or other insecticidal products, as previously thought. In fact, they will mate and produce viable offspring while in direct contact with pyrethroid residues. This research was presented at 23 pest management conferences and other meetings to 3,033 participants. The research was also quoted in Virginia newspaper articles, part of a statewide radio show, and highlighted on national television. As a result, VT faculty received \$36,000 to evaluate additional products for bed bug control.

Novel Research Stimulates Practice Changes in the Nursery and Floral Industry. Chlorination of irrigation water with chlorine gas or liquid chlorine is the most cost-effective technology for water decontamination in the horticultural industry. However, there are potential health hazards associated with storage and use of chlorine. Alternative technologies could reduce the risk of health hazards without sacrificing crop health and profitability. Researchers at VT's College of Agriculture and Life Sciences, worked aggressively to address the issue. After multiyear studies the researchers conceptualized a novel irrigation water decontamination technology based on the pathogen's spatial distribution pattern in reservoirs. This novel concept was funded by CSREES Risk Avoid and Mitigation. Water sampling was performed intensively at eight reservoirs throughout Virginia. Results of the research were presented to 300 people at the field day of the Virginia Nursery and Landscape Association (VNLA). One participant said, "We never thought about this approach for water decontamination and disease control." Owners of several large nurseries also inquired about relocating their pump houses and replacing inlets. This research presentation was also featured in the VNLA newsletter.

Discovering Management Solutions for Weeds in Turfgrass. Perennial grass weeds are common invaders of lawns and other turfgrass areas. A recent survey of Virginia's golf course superintendents indicated perennial grasses were among the five most troublesome weed problems for 92 percent of respondents who represented 8 percent of Virginia's golf course superintendents. Scientists have failed to produce selective herbicides to control these weeds in turfgrass. A VT College of Agriculture and Life Sciences researcher conducted over 100 field research trials for perennial grass weed control. Trial results show mesotrione, a herbicide commonly used in agronomic crops, could safely control such weeds without harming common turfgrass species. As a result, additional funding for further research has been obtained, faculty and graduate students gave numerous presentations related to perennial grass control in turf, and seven magazine articles, eight scientific abstracts, and three journal articles have been published. One company indicated this research was a key factor for its pursuit of registration for mesotrione in turfgrass. Mesotrione could save Virginia golf courses over \$5 million in lost revenue if just 10 percent of courses employ its use rather than renovating areas infested with

perennial grasses, assuming an eight-week down time during renovation. By replacing renovation of infested home lawns, mesotrione can save homeowners an estimated 25 work hours and \$400 per acre by eliminating the need for seed establishment after renovation.

Selecting and Characterizing Cold Tolerant Bermudagrasses. Most sports turf in the Piedmont and mountain regions of Virginia consist of annual bluegrass, Kentucky bluegrass, and perennial ryegrass. These grasses adapt to cool climates and professional mowing heights but are susceptible to disease, drought, and heat stress. Since golf and other outdoor sports are played in summer, bermudagrass, which recuperates from wear and is less susceptible to drought and disease, is a better turfgrass option. Annual maintenance costs of bermudagrass fairways in Virginia are estimated at \$370/ha compared to \$5,120/ha for cool-season grasses. VT researchers have evaluated and characterized the cold hardiness and environmental competitiveness of new and standard bermudagrass cultivars. This work resulted in recommending Patriot and Riviera as primary cultivars in Virginia and other cool-climate areas. Forty-four field research trials related to establishment, plant growth retardation, weed management, overseeding, and topdressing Patriot and Riviera bermudagrasses were conducted. In four refereed journal articles, eight trade journal articles, and 20 Extension presentations, the properties of these new cultivars were documented.

Detecting Fungicide Resistance in Grape Pathogens. Grapes are one of the fastest growing crops with 2,000 acres in Virginia. The most economically profitable varieties of grape are highly susceptible to several diseases, so grape crops are treated with frequent fungicide sprays. There is a risk of pathogens becoming resistant to some fungicides. The only way a grower knows if resistance has developed is to have a disease control failure, which may cause severe crop loss or complete crop failure. A fungicide resistance survey of grape powdery and downy mildew was conducted. Researchers at VT's College of Agriculture and Life Sciences discovered that grape downy mildew had developed resistance to strobilurin fungicides in several Virginia locations. This was the first detection of this type of resistance in grape downy mildew in North America. In addition, powdery mildew resistance was also found in several locations. These results were communicated to growers at the annual growers meeting, in newsletter articles, and in the Virginia Extension Pest Management Guide for Horticultural and Forest Crops. Growers are now aware that use of this group of fungicides has changed from being highly recommended to being considered decidedly risky.

Management of Billbugs in Orchardgrass. The combination of sheltered feeding habit and lack of labeled insecticides for orchardgrass have made billbugs one of the most economically important pests of orchardgrass in Virginia. A survey conducted on over 800 acres of orchardgrass in Northern Virginia indicated losses of 40 percent to 100 percent from billbugs in 2005. Orchardgrass, bluegrass, and timothy hay make up about 35 percent of the grass hay in Virginia with an estimated annual value of \$158 million (based on 451,500 ac x 2.5 tons/ac x \$140.00/ton). Assuming a 25 percent loss per acre from billbugs, the statewide loss in lower yields and forage quality could conservatively be \$40 million for 2005. The effectiveness of new insecticide chemistries, targeted at the egg-laying adult stage, were evaluated. Preliminary findings indicated that plots treated once with Warrior or Baythroid XL had significantly fewer billbug grubs and more robust root systems. These findings should increase producer awareness on this pest and provide pest management tools to improve yields and forage quality. These

findings will be included in future editions of the new Grass Hay and Pasture section in the VCE Pest Management Guide for Field Crops. Updates on insect development and research results were sent to Extension agents, producers, and agribusiness professionals.

Horsenettle Control in Virginia Pastures. Horsenettle is the most difficult pasture weed species to control in the state. Researchers at VT's College of Agriculture and Life Sciences demonstrated a 45 percent reduction in forage use by cattle where horsenettle was not controlled. Until 2006, only one treatment was available for horsenettle control. This treatment was constrained by its Restricted Use Pesticide classification and the proximity of sensitive adjacent crops caused its sale to be prohibited in 60 percent of Virginia's counties. This research demonstrated that aminopyralid is extremely effective in horsenettle control. Further, it is characterized by an extremely low use rate and has excellent properties for low toxicity to both animals and non-target plants. It is now registered in Virginia for statewide use and without Restricted Use Pesticide classification. The use of aminopyralid was discussed extensively in VCE training sessions. As a result of these efforts, aminopyralid was applied to 12,548 acres of Virginia pasture in the first use season of registration.

Integrated Weed Management in Landscape Maintenance. To maintain landscapes in commercial or homeowner settings with no adverse impact on the environment, lawn care firms and homeowners must use an integrated weed management program. To address this issue, research trials evaluating combinations of non-chemical and control strategies for enhanced weed management were evaluated. Integrated pest management techniques for weed control were presented at five workshops, two short-courses, and twenty two Extension meetings and grower programs. Techniques presented included integrated use of organic and inorganic mulches, fabrics, films, and herbicides. Over 1,500 individuals were trained in integrated weed management techniques at the Extension and grower meetings. Additional information was presented in two newsletter articles, four articles posted on VT websites, and eleven Extension publications.

Virginia Potato Disease Advisory. Approximately 6,000 acres of Irish Potatoes are produced on the Eastern Shore of Virginia. Proper disease management tactics help sustain a successful production system. If pathogen conditions are favorable, disease development can be severe and cause considerable crop loss. However, if conditions are not favorable, unnecessary fungicide applications can reduce producer profitability. The Virginia Potato Disease Advisory was initiated by the plant pathology program at VT's Eastern Shore AREC and VCE. Thirteen weekly disease advisories with fungicide recommendations were generated by the Eastern Shore AREC and distributed through the VCE Northampton County office. The reports were then delivered electronically to all potato producers and industry stakeholders. The Eastern Shore AREC also posted advisories on the Virginia Ag Pest Advisory Web page. In 2006, environmental conditions did not favor disease development, so on average, five fungicide applications were spared through the Virginia Potato Disease Advisory process. Reduced fungicide applications constituted a savings of \$300,000 in unnecessary inputs for Eastern Shore potato producers.

Efficient Tobacco Fertilization. Proper fertilization of tobacco is essential for efficient production of high-quality tobacco. Fertilizer represents the third largest variable cost in the production of flue-cured tobacco. Excess fertilization use also adversely impacts the environment

from runoff of applied nitrogen and phosphorus. Tobacco fields in Virginia typically have high phosphorus soil test levels from a long history of heavy phosphorus fertilization rates and applied phosphorus usually in excess of recommended levels. Research conducted over the past several years demonstrated the potential to reduce phosphorus fertilization in flue-cured tobacco through transplant starter fertilizer. For new burley growers in southern Virginia, a commercial fertilizer manufacturer was consulted on the formulation of a new burley fertilizer that is more appropriate for the fertilizer practices applied by growers in the region. Use of the new 6-3-18 fertilizer for flue-cured tobacco will reduce phosphorus application rates by half without adversely affecting crop performance and could reduce the cost of fertilization by 10 percent. A survey of tobacco fields revealed this fertilizer would be appropriate for approximately 45 percent of tobacco fields. The new burley fertilizer 11-6-20 was evaluated in field tests with results comparable to traditional fertilize materials. Use of the new fertilizer would reduce burley fertilization costs by 20 to 40 percent and application rates of phosphorus and potash by 50 and 80 percent, respectively. Results have been reported in production guides and presented at on-farm field day and growers production meetings.

Evaluation of Nitrogen for Maximum Yields and Profits of Burley Tobacco. In trying to increase yields to maximize profitability of burley tobacco, many growers think increasing nitrogen fertilization is the answer even though nitrogen is the most expensive nutrient added to tobacco. VT recommends 175-200 lbs/acre of nitrogen, however, other universities recommend up to 350 lbs/acre of nitrogen. Excessive nitrogen rates create curing problems, reduce quality, and lead to undesirable chemical properties in the cured leaf. A collaborative research effort of Extension specialists from Virginia, Tennessee, and Kentucky evaluated nitrogen rates from 80 to 340 lbs/acre of nitrogen. All locations evaluated the same nitrogen treatments/rates on tobacco for yield, quality, and tobacco-specific nitrosamine (known carcinogens) content of the cured leaf. In both years at all locations maximum yields were achieved with 180 lbs/acre of nitrogen. The studies also suggested reduced nitrogen rates lowered tobacco specific nitrosamine content of the cured leaf. This work helped Extension faculty show burley tobacco growers that maximum profits can be realized without excessive fertilization. Growers can save an additional \$102 per acre by not increasing nitrogen rates up to 350 pounds per acre.

Goal 5: To enhance economic opportunities and the quality of life among families and communities

K-12 Biotechnology Outreach. The need for well trained scientists resulted in the Fralin Biotechnology Center's pre-college outreach program. The Partnership for Research and Education in Plants (PREP) brings together high school teachers and research scientists to guide high school students in characterizing genes in *Arabidopsis thaliana*. This plant is used widely in genetic research and one of the few plants whose genome has been sequenced. Scientists provide wild-type (no altered genes) and mutant (one knocked-out gene) seeds and experimental know-how to students. Students design experiments to examine the effects of abiotic stressors on wild-type vs. mutant plants to determine the function of each missing gene. Through PREP and similar education efforts, faculty developed a cohesive research program for comprehensive insights into the integration of science and education by investigating the impacts of engaging students in authentic investigations and examining the impacts of partnering K-12 teachers and

research scientists in educational programming. This research and Extension program is funded primarily by the National Institutes of Health and the National Science Foundation.

Bio-Energy Research Impacts Economic Development. Energy demands continue to increase expanding dependency on oil imports even though oil sold for over \$80 a barrel in 2006. Community leaders want to link economic development efforts to state-of-the art technologies related to bio-energy with the goal to establish local resources for energy production. Extension joined with Virginia Farm Bureau and VDACS, to secure \$1.2 million grant funding from the Virginia Tobacco Indemnification and Community Revitalization Commission (VTICRC) to develop and commercialize a bio-oil product using bio-feed stocks. Researchers and VCE presented current bio-energy research results to Virginia's community leaders through a regional bio-energy research symposium attended by 30 representatives from county government, economic development offices, and VCE agents. One economic developer indicated that based on the information gained at the symposium, he would position his county to participate in the bio-energy market. All of the symposium participants surveyed felt the symposium was relevant and reported an improved understanding of ethanol, bio-diesel, and the development process.

**United States Department of Agriculture
 Cooperative State Research, Education, and Extension Service
 Supplement to the Annual Report of Accomplishments and Results
 Actual Expenditures of Federal Funding for Multistate Extension and Integrated Activities
 (Attach Brief Summaries)**

Fiscal Year: 2006

Select One: **Interim** **Final**
Institution: Virginia Polytechnic Institute and State
 University

State:
Virginia

	Integrated Activities (Hatch)		Multistate Extension Activities (Smith- Lever)		Integrated Activities (Smith- Lever)	
<i>Established Target Percentage</i>	14%	%	10%	%	14%	%
<i>This FY Allocation (from 1088)</i>	3,870,678		6,396,116		\$6,396,116	
<i>This FY Target Amount</i>	\$541,895		\$639,612		\$895,456	
<i>Carryover Previously Reported</i>	\$		\$		\$	
Title of Planned Program Activity						
1) Achieve agricultural production system that is highly competitive in the global economy.	\$ 304,865		\$ 253,518		\$ 479,132	
2) Provide a safe and secure food and fiber System	16,045		10,711		20,242	
3) Achieve a healthier, more well-nourished Population.	120,341		103,508		195,623	
4) Achieve greater balance between agriculture production and the environment	184,523		154,870		292,693	
5) Enhance economic opportunities and the quality of life among families and communities.	176,501		150,169		283,810	
Total	\$802,275		\$672,776		\$1,271,500	
Carryover	\$		\$		\$	

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

Sharron Quisenberry
Director

3/23/2007
Date

revised form