FY 2004
Annual Report of Accomplishments and Results

West Virginia Agricultural and Forestry
Experiment Station

And

Davis College of Agriculture, Forestry and Consumer Sciences
West Virginia University

W. E. Vinson, Associate Director
Ph: (304) 293-4421 email: wvinson@wvu.edu

TABLE OF CONTENTS

Introduction

The West Virginia Agricultural and Forestry Experiment Station is administered within the Davis College of Agriculture, Forestry and Consumer Sciences at West Virginia University. The College is relatively broad in academic and research discipline areas, including within the College, Divisions (academic program units equivalent to departments) of Family and Consumer Sciences (includes Child Development, Interior Design, Human Nutrition and Fashion Merchandising) and Forestry (Forest Resource Management, Wood Science, Parks and Recreation and Wildlife Management) in addition to the more typical Animal Sciences, Plant and Soil Sciences, and Resource Management (agricultural economics, agricultural education and, less typical, landscape architecture).

The College has approximately 100 full-time faculty to direct research and teaching programs in the College. West Virginia University Extension is administered independently of the Davis College, but Extension and the College have several jointly appointed faculty and conduct a number of integrated programs. The Davis College and WVU Extension have discussed joint accomplishments reporting and development of a joint plan of work for FY 2007-11, but this report covers only research and integrated, research-extension programs.

The West Virginia Experiment Station supports approximately 35 FTE research faculty positions distributed across about twice this number of individual scientists. The Station also supports approximately 25 FTE technical positions, 35 clerical and farm/forest worker positions and 40 professional support positions (mostly graduate students). The West Virginia Station operates seven farms and two forests which support research. Four of the farms (Animal and Veterinary Sciences farms in Morgantown and Reidsville, Horticultural and Agronomy farms in Morgantown) and the University Forest are sufficiently close to the University to be used extensively to support academic programs in addition to research. Outlying farms include the Reymann Memorial Farm (beef, sheep, agronomic crops and bull testing station) and Kearneysville Tree Fruit Research Farm (primarily apples and peaches) in northeastern West Virginia; the Willow Bend Farm in the southeast (pasture raised and finished beef cooperative project with ARS); and the Tagart Valley Forest (mostly oak regeneration and disease control research) in east-central West Virginia. All but Tagart Valley Forest are extension as well as research centers and, in fact, approximately half the FTE faculty positions at the Kearneysville Farm are Extension appointments.

In addition to competitive, sponsored research, Station faculty participate in approximately 60 formula funded projects (Hatch or McIntire-Stennis), about 15 multi-state research projects, and an additional ten state supported projects. Federal formula funding of approximately $3 million is slightly more than matched by about $4 million in state support. Faculty also generate an additional $5.5-$6.0 million annually in externally supported research.

The focus of research programs in the West Virginia Station is on economic activities for which West Virginia conditions provide some degree of competitive advantage for state producers, or on problems having impact on rural families and communities in the state. Examples of the former include proximity to large urban population centers of potential demand for specialty or niche market products; an expanse of exceptional hardwood forests; a topography, soil and climate well suited to the production or forages and/or pasture-reared livestock; a rich history, scenic beauty, abundant wildlife and varied recreational opportunities which are highly attractive to tourists; and extensive water resources well suited to the production of cool and cold water fish for food and recreation. Most common problems impacting rural communities in West Virginia include a state population which is decreasing in size and aging as well due to a disproportionate loss of younger citizens; a largely rural population with limited access to health and nutritional information and a consequent tendency towards poorly balanced, calorie-dense diets; and an extreme need for environmentally friendly and sustainable economic development which will provide jobs to replace the many which have been lost in coal and timber harvesting industries.

A. Planned Programs

Program 1 (National Goal 1): Develop and support globally competitive agricultural and forestry production systems.

Overview

West Virginia has extensive supplies of rapidly flowing, constant temperature, cool waters which are well suited for the production of cool and cold water fish for food or recreational use. West Virginia also is blessed with numerous ideal settings for sport fishing. Aquaculture research at the West Virginia Station has emphasized the creation and testing of methods to use state water resources (which often flow from abandoned mine sites at heavy volume and near constant 60^{o}F temperature but many, more recently mined, with high mineral content and relatively acetic) in aquaculture production, and on developing a significant fee fishing industry in the state. Specific projects have examined survival, growth and tissue composition of fish reared in treated and untreated mine water; evaluated various rations with respect to rates of gain and feed efficiency; compared different strains of fish for vigor, growth and ultimate size; constructed and tested alternative raceway rearing systems; and surveyed the health status of fish at production facilities throughout the state.

Beef production is among the largest agricultural enterprises in West Virginia, with approximately 13,000 producers statewide. Pasture-based systems to carry cattle from birth to market, as opposed to raising feeder cattle to be finished elsewhere, could significantly enhance the competitive position of state producers by using the abundant and inexpensive grassland resources available to many producers. Pasture raised beef research at the West Virginia Station is conducted cooperatively with scientists at Virginia Tech, the University of Georgia and at the ARS Appalachian Farming Systems Research Center. Research has centered on pasture plant species and management, optimum animal stocking rates, enhancing forage intake and digestibility, eliminating

endophyte toxicity to grazing animals in various grasses, minimizing supplemental feeding, attaining market weight and condition at reasonable ages, and maintaining carcass quality characteristics of pasture finished beef.

Hardwood forests cover approximately 80% of the state of West Virginia and represent an enormous state resource for the production of timber, for value-added further processing of wood products, and for development of a lucrative tourism industry. Station research is focused on efficient, environmentally friendly, sustainable timber management and harvest, protection of our forest resources from disease and invasive species, the development of unique, innovative uses for timber and value-added wood products, and the optimum use of woodland and wildlife resources to support tourism.

Farmers in West Virginia, and in the Northeast US generally, are poorly positioned to compete in US commodity markets for fruits, vegetables, field crops and livestock products (due to small acreages, dense population, high land and labor prices, etc.). To remain viable, many West Virginia producers are seeking either to increase the value of what they produce or to produce their products at significantly lower cost.

Markets for organically produced food products have increased in volume approximately 20% annually for the last several years and generally are characterized by product prices which are substantially higher than corresponding commodity markets. At the same time, requirements for transitioning to certified organic production are stringent, potentially costly, and lacking sufficient research-based recommended management practices. The West Virginia University Organic Research Project, supported by Hatch funding and the USDA Sustainable Agriculture Research and Education program, was established to develop and test alternative, low cost systems for transitioning from conventional to organic production of vegetables, fruits, field crops and/or livestock. The primary objective is to define practices most environmentally sustainable and economically efficient during the period of transition and early certification.

A focus of the project is on a comparison of systems which transition from conventional to organic production using green manure and cover crops (low input) and those which rely on compost amendments from off-farm sources (high input). Systems are being assessed in market garden vegetable trials (cropped to beans, peas, tomato, pepper, squash, pumpkin, lettuce, and spinach) and in field crop trials (potato, wheat, soybean, Brussels sprouts, and red clover/orchard grass as forage), with and without livestock. Comparisons between systems have involved crop yields; soil organic matter and mineral content; populations of earthworms and nematodes; insect and disease damage; weed infestation levels; and the use of companion crop plantings. Results of this project are being used extensively by producers in transitioning from conventional to organic production. The recent report, *State of the States 2nd Edition: Organic Farming Systems Research at Land Grant Institutions* ranks this project among the five best nationally. Efficient reproduction is prerequisite to profitable production of all livestock species, on pasture or in confinement. Research at the West Virginia Station has focused on neuroendocrine control of ovarian function, role of the uterus in luteolysis, and follicular development, rupture and persistence in order to develop management programs which

increase conception rates, reduce embryonic and fetal mortality, and maintain ideal birth weights in cattle and sheep.

Poultry production is West Virginia's most lucrative livestock industry with production of broilers doubling in the last ten years. Recent results from the West Virginia Station suggest that uric acid is a potent antioxidant in poultry with moderate reduction in concentrations of plasma uric acid leading to increased measures of oxidative stress. Methods are being developed to increase plasma uric acid as a means of protecting against oxidative stress and promoting increased growth rate.

The importance of understanding lysine metabolism arises from the fact that lysine is one the most common limiting amino acids in diets of swine and poultry and likely fish as well. Studies of the enzyme, lysine alpha-ketoglutarate reductase (LKR) are particularly informative since LKR catalyzes the initial step in the known major routes of lysine degradation. The most important economic advantage conferred by an understanding of lysine metabolism is the potential to produce more animal product with less feed, which represents the largest expense item in the production of animal protein.

Farm production of cut flowers has increased rapidly in recent years among small-scale producers of vegetables and field crops, as a means of diversifying production, capitalizing on higher value crops, and better utilizing farm resources. The focus of ornamental horticulture research at the West Virginia Station is to understand the role of ethylene and its relationship to the process of flower senescence and to thereby control flower longevity. Primary interest would be in increasing longevity for greater cut flower value or increased time for fruit and/or seed set. However, a shortening of flower longevity and consequent reduced fruit and seed set, is equally valuable for many landscape plantings.

Assessment of Progress

All projects discussed have made, and are making, significant contributions toward enhancing competitiveness of state and regional industries of agriculture and forestry. We are particularly pleased with the maturation of our timber management program, the growth of our wood products research and the increased interest in the Station's organic production research on the part of producers. Producer interest is likewise high in results of the pasture raised and finished beef project conducted jointly with USDA-ARS, Virginia Tech and the University of Georgia. The project has produced pasture-finished beef of excellent quality, indicating the possibility of future transition from producer sales of feeder cattle to sales of finished beef. Evaluation of alternative systems of timber harvest and the ability to accurately predict yields of various products from standing timber will increase sustainability, economic efficiency, and public acceptance of timber harvest while additional uses for value-added wood products can contribute significantly to state economic development.

Expenditures and SY for Program 1 (Goal 1)

Source	$ or SY
Formula	**1,260,902**
State Funding	**2,659,586**
SY's (FTE)	**20.4**

Key Theme 1.1 – Aquaculture

a) Description: Assess potential and develop optimum economic and environmental production practices and provide support for the establishment and success of food and recreational fish production enterprises.

b) Impacts:

Eight thousand rainbow trout were successfully raised in treated water from an abandoned coal mine. Even though water ion concentrations often exceeded recommended levels for Fe, Al, Mg, Ca, and SO_4, fish grew well with 98.6% survival, a feed conversion rate of 1.4, and stocking density at harvest of 52.6 $kg.m^3$. There was no evidence of metal accumulation in fish tissue. There were no differences in growth rate among three strains of trout tested nor between fish grown in treated mine water and spring water.

Hybrid bluegill show promise as an alternative species for fee fishing businesses. Two strains were initially stocked at 5, 10, and 20 thousand/a in earthen ponds and fed one of four commercial diets. Gross production in about 400 days was 1011, 1521 and 3561 lbs./a. Production per acre was highest at the highest stocking rate even after adjustment for 11%, 19% and 33% fish of sub-marketable size (<7"). A diet with 42% crude protein and 16% fat yielded most growth; the Georgia Giant strain grew more rapidly than the other strain tested but with no greater feed efficiency.

Effects of strain and diet were investigated in conjunction with scientists at West Virginia State University. Five diets were fed to two strains of hybrid bluegill for a period of three months. The finding of significant variation in feed efficiency among diets has led to improved feed formulations for hybrid bluegill. Variation among strains was significant for weight gain but not for feed efficiency nor for efficiency of N or lysine retention. Perturbations in lysine metabolism in different strains of rainbow trout when fed or fasted also was investigated. Results suggest post-translational modification of lysine alpha-ketoglutarate (LKR) which catalyzes the initial step in the presumed major routes of lysine degradation, since a decrease in LKR mRNA levels was detected with fasting but no change in LKR enzyme activity was found. ###

Niche products have the potential to enhance farm profitability while contributing to economic development and to the maintenance of environmental quality in the central Appalachian region. A comprehensive economic analysis was conducted of production systems for hybrid bluegill, a species particularly suited for the recreational market. A sensitivity analysis was conducted to determine the effects of

changes in selected parameters such as stocking densities, feed type and price, fish size and market price, etc. Production budgets developed allow producers to project economic returns from available production alternatives. For example, most profitable stocking density is a function of feed type and price and especially any existing minimum acceptable market size (below which the price paid is zero).

Analyses also have been conducted to determine optimum shipping patterns for aquaculture producers and processors in West Virginia. Results were used to develop web-based tools in the form of a computerized decision support system, to facilitate price, product and location decisions for producers and processors. ###

Customer preference and satisfaction surveys were conducted at three fee fishing sites (220 participants). Results showed hybrid bluegill can be a popular and profitable species, especially among families with children. 43% of respondents were willing to pay $30 under a catch and keep format. Hybrid stripped bass, stocked to complement hybrid bluegill, initially were aggressive but later became hook-shy. The average respondent caught one hybrid stripped bass per hour. Mail surveys sent to 5,000 out of state residents who previously requested WV travel information (691 or 14.9% response rate for 4628 of surveys apparently received) showed recreational fee fishing would attractive to potential visitors and that most would favor fishing be included as part of an activity package.

c) Funding: Hatch, State and special grant research

d) Scope of Impact: Integrated research and extension

Key Theme 1.2 – Pasture Raised and Finished Beef

a) Description: Cooperative project with USDA ARS Appalachian Farming Systems Research Center and College of Agriculture and Life Sciences, Virginia Tech, and the College of Agriculture and Environmental Sciences to develop and implement beef cattle, birth-to-market production systems capitalizing on low-cost, Appalachian grasslands as a major production input.

b) Impacts:
Pasture finished beef has the potential to substantially increase returns to beef producers in the Appalachian region. For three years pasture-finished steers (all harvested at 22 mo of age) were reared four steers per hectare from turnout (mid April) until early summer (early July; treatment initiation) when pasture height averaged 9.9 cm. Stocking rates of two or four steers per hectare with and without supplementation (@1.25% body weight) were used in years one and two while in year three, treatments were three or four steers per hectare with supplementation and or 1 and 2 steers per hectare without supplementation. Three replicates representing topographical differences (steep, moderate and bottomland) were in each treatment. Steers were rotationally grazed in their plots from 4/47 – 7/14 gaining an average of 1.01 kg/day with no difference detected among treatments. Steers grazing steep terrain gained significantly less that those on moderate slope and bottomland, most likely due to less forage DM available on the former. Treatments (combinations of

stocking rate and supplementation) had no significant effect on body or carcass weight, or percentage of kidney, pelvic or heart fat. ###

A continuous culture (rumen simulation) study was conducted to evaluate the time of grain supplementation as well as the rates of fermentation of high-energy supplements in relation to the daily forage intake pattern of pasture grazed cattle. Cattle grazing high quality pastures typically consume excess digestible protein. Excess rumen degradable protein is degraded to ammonia with substantial amounts being excreted as urea. Providing readily fermentable carbohydrates at times when ammonia is released may aid in efficiency of which dietary nutrients are used. Cultures were fed ground early spring pasture (DM, 24.6%; CP, 18.9%; ADF, 26.7%) duplicating meal patterns of pasture grazed cows. The largest meal occurred in the morning followed by an intermediate sized meal early midday and a subsequently larger meal in the late afternoon/early evening. Grain supplementation occurred in relation to the morning and afternoon meals. Energy in the grain supplements (A and B: 16.4 vs. 13% CP, 32.8 vs. 9.9% NDF, and 7.4 vs. 3.5% EE) was either a mixture of starch, fiber and fat or mainly starch based, respectively, and fed at equal rates.

Digestibility's of DM and non-starch carbohydrates were unaffected by supplement type or time of feeding. Supplement A allowed greater fiber digestion than supplement B. The p.m. feeding decreased digestion of fiber in the B supplement with no effect on fiber digestion in supplement A. CP digestion was not different between the two supplements, however, digestion of both supplements increased with the p.m. feeding. Total microbial produced volatile fatty acid flow was unaffected by treatment. Ammonia nitrogen generation was higher on supplement A than B. Time of feeding did not affect ammonia concentration, but there was a tendency for the p.m. feedings to have lower ammonia than the a.m. feedings. Non-ammonia nitrogen (NAN) flow was greatest on the A supplement, with the p.m. feeding increasing flow of NAN of both supplements. Microbial growth measured in g microbial N flow/day was increased for both supplements at the p.m. feeding. Supplement A showed a tendency to increase flow of microbial N. Flow of by-pass feed nitrogen was unaffected by supplement type, but was decreased with p.m. feeding. Microbial efficiency was increased as a result of the p.m. feedings. In conclusion, PM feeding of grain was more effective than was AM, regardless of supplement. Supplement A, when given in the PM supported high levels of fiber and NSC digestion, and slightly higher microbial growth than did AM supplementation with either A or B. PM supplementation with B was equal to A in most digestion and microbial growth responses, with the highest microbial efficiency, in spite of having 3.4% less CP.

c) Funding: Hatch, State and Special Research Grant

d) Scope of Impact: Multi-state integrated research and extension
CA-B, CA-O, CO, CT-NH, FL, GA, IN, KS, MA, MD, MN, NV, NY-G, NY-I, OR, PA, RI, SD, UT, VA, WA, WI, USDA

Key Theme 1.3 – Forest Management and Wood Products

a) Description: Research to increase efficiency, profitability and sustainability of forest and timber management; control threats to timber production from insects, diseases, and invasive species; develop innovative hardwood products and structures.

b) Impacts:

Public demands increasingly are for forest harvesting techniques other than clear-cutting on both public and private lands. These techniques are nearly always more expensive and frequently have greater negative impact on the environment than alternatives due to required more frequent entry into the forest. Higher cost and greater environmental damage are especially characteristic of central Appalachian forests which have some of the most difficult harvesting conditions due to steep and uneven topography.

Simulation is a valuable tool for evaluating multiple harvesting techniques as they are affected by direct and interacting effects of various goals and conditions associated with timber harvest. Three harvesting systems of chainsaw/cable skidder, feller-bunch/grapple skidder, and harvester/forwarder were modeled and simulated on five generated Appalachian hardwood stands of different ages. Five harvest methods were examined including clearcut, shelterwood cut, crop tree release cut, diameter limit cut and selective cut.

Simulation results showed that felling production and cost were primarily affected by tree size removed, removal intensity, distance traveled between harvested trees, and felling machines. The feller-buncher was the most cost-effective and productive while harvester was more sensitive to individual tree size. Clearcutting always presented the highest productivity while the shelterwood cut was the least productive method. Unit cost of harvester was higher than that of feller-buncher or chainsaw. Extraction operation was sensitive to payload size, average extraction distance, extraction pattern, and extraction machine. The forwarder was the most productive machine under the simulated extraction prescriptions. The cable skidder resulted in higher unit cost than that of grapple skidder or forwarder.

Harvesting system productivity increased from chainsaw/cable skidder system to harvester/forwarder system, and to feller-buncher/grapple skidder system. The feller-buncher/grapple skidder system could produce 28484 ft^3 or 177 thousand board feet (MBF) per week with a unit cost of $27 per 100 cubit feet (cunit) or $44/MBF. For chainsaw/cable skidder and harvester/forwarder systems, the weekly production rate was 12146 ft^3 (76 MBF) and 16714 ft^3 (104 MBF), with unit cost of $35/cunit ($57/MBF) and $44/c unit ($70 MBF), respectively. System productivity also varied among harvest methods. The weekly production rates decreased and unit costs increased from clearcut to selective and diameter limit cut, and to crop tree release and shelterwood cut. Traffic intensity (TI) was one of the major indexes for soil compaction. The results indicated that harvester/forwarder system resulted in less affected areas while feller-buncher/grapple skidder system caused more site compaction and disturbance. ###

Including crown ratio (length of crown to total tree height) was examined as a means of improving the accuracy of diameter and volume predictions for yellow poplar trees in West Virginia. Forty-four trees from two regions (26 in Region 1, 18 in Region 2) were felled at ground level and measured for diameter at breast height, total height and height to the crown. One-inch thick sample disks were obtained at 0.3, 0.6, 1.37, 1.8 and every 1.2 m from the base to an approximate 7.6 cm top diameter outside bark. Samples were sealed and saved for later analysis. Sample trees ranged from 17.3 to 56.1 cm in diameter and from 18.8 to 38.5 m in total height.

Taper and volume equations were fit simultaneously, concurrently minimizing prediction error sums of squares. Equations initially were fit using data from Region 1 and tested on the independent data set from Region 2. Subsequently, equations were fit separately for each region to detect differences and examine the value of including crown ratio.

Outside bark taper prediction error for the proposed model using the fitted data set (Region 1) had a average bias of .0153 cm and a standard error of 1.2798. Volume prediction error had an average bias of -.00002 m^3 and a standard error of the estimate of .0045 m^3. Tests with an independent data set (region 2) showed the proposed model had the lowest overall outside bark prediction error as well as the smallest error in five of the seven relative height classes tested.

Including crown ratio as a continuous variable in prediction models generally improved fit and accuracy of volume prediction especially in Region 2. Region 2 receives less rainfall than Region 1 (45 vs. 60 inches per year), is at lower elevation (850 vs. 2,200 feet) and generally contains better growing sites and conditions than Region 1. Parameter estimates were significantly different by region indicating a need to determine separate sets of parameter estimates for different eco-regions. ###

Copper is one of the primary biocidal ingredients of commercial wood preservatives. The fact that some wood decaying fungi are tolerant to copper is a major industry problem. Copper tolerance has been associated with fungal production of oxalic acid. It is hypothesized that the consequent formation of lowly soluble copper oxalates reduces the concentration of copper ions in the media and thereby reduced the biocidal effect.

A study to determine extracellular protein and organic acid production in response to elevated copper concentrations examined pure cultures of two strains of brown rot fungi, *Antrodia vaillantii*, and *Aureobasidium pullulans*. Copper sulfate solution was added to the growth media on the 7^{th} day at 0, 1, 3, and 5 mM and cultured for 21 days. Media were collected, concentrated 10-fold and analyzed for protein and organic acid content.

Very small concentrations of proteins in the molecular weight range of 14,400 – 97,400 were observed in the presence and absence of copper sulfate. This indicates

minimal protein production or the production of proteins outside the molecular weight range examined, or proteins tightly bound to fungal myceliae and not released into the growth media. Oxalic acid was the only organic acid detected, occurring in both the presence and absence of copper sulfate but varying by copper sulfate concentration and fungal species. Generally production of oxalic acid were increased to 3mM concentrations of copper sulfate and decreased thereafter. Copper oxalate crystals were observed by electron microscope in all cultures containing copper salts. Results are consistent with reduced bioavailability of copper through chelation and precipitation of copper oxalates as the source of copper tolerance by these fungi. ###

Retrofitting and maintenance of ageing wooden structures is greatly facilitated by non-destructive evaluations of residual strength and stiffness of structural elements. Such evaluations additionally would be extremely useful in monitoring field performance of newly developed structural composites and in aiding designers and contractors in salvaging useful wooden materials from older structures. This research investigated non-destructive methodologies for evaluating the modulus of rupture (MOR) and modulus of elasticity (MOE) of structural lumbers and composite products. Methods included stress wave time for dynamic MOE determination and screw withdrawal measurements using a portable, field measuring devise. Standard ASTM testing procedures determined further mechanical and physical properties such as MOR, apparent/true MOE, density and moisture content. Statistical relationships between variables were identified and simple prediction models developed to estimate design properties. Materials involved in the analysis included red oak, yellow poplar, spruce-pine-fir and southern yellow pine lumbers. Laminated veneer lumber and parallel strand lumber also were tested. Results indicated that stress wave timing is a useful tool for evaluating actual MOE. However, it requires proper moisture content determination for accurate analysis. The screw withdrawal resistance is a good indicator of density and combined with the dynamic MOE provides a reasonably accurate estimation of MOR. An extensive database has been established during the course of this project which includes parameters and simple models to measure strength and stiffness of structural, built-in wood materials. ###

Among non-native invasive species, Ailanthus or “tree of heaven” is one of the most significant in causing negative changes to native hardwood forests. The species spreads by windborne seeds and establishes particularly in areas disturbed by timber harvest and transport. Field tests comparing triclopyr, imazapyr mixed with triclopyr, EZ-Ject (two basal sprays and one solid cartridge stamped into the trees) are underway to develop a herbicide control method which is easy, inexpensive and does minimal damage to high-valued hardwood stems. Testing sites include a recent timber harvest area and two interstate roadcuts. Initial data indicate significant top kill from triclopyr basal sprays on ailanthus stems less than six inches diameter at breast height. However, some root resprouts from treated stems have been observed. These observations will be validated and quantitated in the summer of 2005 and alternative treatments compared. ###

Phytophthora ramorun, the causal agent of sudden oak death, has had substantial negative impact in the central coast areas of California and may threaten forest in the eastern US. Sampling and characterization of Phytophtoras species in eastern oak forests were conducted in nine states including West Virginia during the spring of 2004. Soil samples removed from the bases of trees were subjected to a baiting procedure in the laboratory using oak leaflets floated on soil samples after flooding with water. When baitings successfully trapped Phytophthora, a selective medium was used to isolate the organism. Among 490 trees sampled at 97 sites, at least 50% of the sites yielded isolates of Phytophthora. Isolates included at least eight different species, with P. cinnamoni being the most frequent isolate. At least four previously unidentified species were discovered and are undergoing characterization and molecular analysis. Tests also are underway to evaluate the pathogenicity of the of the recovered isolates with respect to a variety of oak species.

c) Funding: Hatch, State and special research grant.

d) Scope of impact: Integrated research and extension

Key Theme 1.4 – Organic Production Systems

a) Description: Compare alternative systems of conversion from conventional to organic production of vegetables, field crops and/or livestock products; determine practices most environmentally sustainable and economically efficient during periods of transition and early certification.

b) Impacts:

Low input organic farming systems using green manure and cover crops were compared to high input systems that included 10 T/acre dairy manure compost. Systems were assessed in a market garden vegetable and field crop trial. The field crop trial included with and without livestock (sheep) treatments with factorial treatments in a randomized complete block design. Soil and plant samples were analyzed and pests were monitored and controlled following organic standards. Small plot trials evaluated compost rates, pest management and plant varieties to optimize yields and reduce insect and disease problems.

Yields of potatoes, pumpkins, spinach and tomato were greater from plots with compost than from plots without. Root rot of spinach was significantly lower in plots with compost. Sheep produced healthy lambs which gained equally well on plots with and without compost but compost allowed a higher stocking rate producing greater total gain per acre. Compost application totaling 38 metric tons/ha fresh material over five years supplied 177 kg N, 59 kg P, and 152 kg K/ha and resulted in higher pasture and hay production from tall fescue, orchard grass and red clover grassland. Soil organic matter and mineral nutrients were increased in plots with annual compost application.

In compost rate trials, tomato yields increased as compost rates increased from 0 to 20 tons per acre. Early blight was significantly higher at lower compost rates. Fall cover crop biomass also increased with increasing levels of compost with larger yield response with white mustard, Essex rape or forage radish than with rye. ###

Weed management trials in potato showed that hand cultivated plots yielded more than plots where weeds were managed with acetic acid sprays. A study of the economic feasibility of organic farming during the transition phase (three year period during which a traditional operation must use exclusively organic practices before being certified organic) showed that the market garden consisting of a variety of vegetables was profitable during the transition period. Field crops including wheat, soybeans and potatoes and a livestock enterprise including sheep and grassland were not profitable during the transition phase. Their profitability in subsequent years needs to be investigated. ###

Plant parasitic nematodes can significantly reduce crop yields particularly in organic production systems where chemical control is not possible. Tests have shown endophyte infected fescue used as an orchard ground cover crop, suppressed nematodes in apple roots in microplot trials. Popolation densities of *P crenatus* were lower on endophyte infected K-31 fescue than on endophyte-free Stargrazer but predatory nematodes (Monochidae) were significantly greater in bare soil than with Stargrazer.

Organic systems vegetable and field crop trials evaluated a high input, compost intensive management system (10 tons/acre composted dairy manure annually) and a low input system which relied on cover crops plowed in as green manure. Soil samples were analyzed for plant parasitic and predatory nematodes and assayed for nematode biocontrol agent activity. *P. crenatus*, *Xiphinema revesi*, *Helicotylenchus* spp., *Tylenchorhynchus* spp., *Meloidogyne hapla*, and *Clarkus papillatus* (predator) were the most common nematodes present. Population densities remained low for all plant parasites throughout the four years of this study and differences among compost treatments were not significant suggesting the presence of suppressive soils.

Predatory nematode populations also were low but were significantly higher in plots with compost than in plots without compost. No differences in biocontrol activity were detected. These results provide evidence of significant ecological influences of soil management systems on nematode population dynamics in soils. Soil amendments and suppressive fescue crops have significant effects on overall crop growth in spite of their limited and variable effects on nematode populations. Compost amendments generally increased yields but differences in microbial activity and nematode population densities were not significant.

c) Funding: Hatch, State

d) Scope of Impact: Integrated research and extension

Key Theme 1.5 – Agricultural and Forest Profitability

a) Description: Support state economic development of agriculture and forest industries with a focus on activities offering competitive advantage to state producers.

b) Impacts:

Out of season breeding and lambing offer numerous advantages to sheep producers if it can be made to work consistently. A survey of 15 cooperators in a research project revealed increases in production and sales over the project period. There have been significant increases in retentions of fall born lambs and an average increase in production from these 15 cooperators exceeding 35%.

Previous work has shown progesterone given at ram introduction to be effective in producing fertile estrus and lambing in 65-75% of ewes during anestrus. Since progesterone treatment is not approved for sheep, GnRH was used in place of progesterone in conjunction with ram introduction. Treatments of 100 micrograms GnRH on day 4 (G4) after ram introduction or on days 1 and 4 (G1/4) after ram introduction were compared to no treatment (C) or treatment with 20 mg progesterone (P) at ram introduction. All ewes were treated with 20 mg prostaglandin F-2-alpha 12 days after ram introduction. Percentage of ewes marked by rams were: C – 28.5; G4 – 50; G1/4 – 52; and P – 57. Ewes lambing to 1st and two services were 19 and 52 for C, 32 and 73 for G4, 33 and 71 for G1/4 and 43 and 71 for P. A single treatment of GnRH on day 4 after ram introduction was an effective treatment for out of season breeding. ###

A more complete understanding of progesterone metabolism should provide a key to development of treatments to increase concentrations of progesterone during critical phases of the gestation cycle. During ultrasonographic monitoring of cattle for pregnancy it has been noted that embryos in which allantoic expansion was first detected on days 22 through 23 post-insemination suffered 42.0% embryonic or fetal loss before pregnancy on day 60. Embryos in which allantoic expansion occurred on d 24 through 26 suffered no loss. Beef cows (39) were selected at random to receive either high progesterone (HP; n=19) or low progesterone (LP; n=20) beginning on day 28 of pregnancy using controlled internal drug releasing inserts (CIDR's, replaced every five days). Corpora lutea were removed by transrectal manipulation on day 29. Retention of pregnancy was evaluated daily by ultrasonography between days 28 and 38 and every fifth day thereafter through day 53.

Loss of pregnancy before day 53 was affected by an interaction of progesterone treatment and age. Losses were high in older cows regardless of progesterone treatment (39%, n=18), but young cows had no losses on HP and 30% (n=12) losses on LP (n=10). Pregnancy did not differ with body condition score. Pregnancy appears to be sensitive to concentrations of progesterone during placentation in both beef and dairy breeds and particularly in older cows. ###

The GrowSafe 4000E system was used to measure individual feed intake during two successive West Virginia Bull Test Evaluation programs. Following a three week

acclimation period, bulls were weighed and put on test with feed consumption and weight gain measured over 105 days (2003-4) and 84 days (2004-05). Most of 117 and 144 bulls completing the tests in 2003-04 and 2004-05 respectively were Angus. Raw feed efficiency (F:G) ranged from 4.49 to 8.93 in the 03-04 test and 4.41 to 9.67 in 04-05.

Residual feed intake (RFI) is the difference between expected and actual feed intake with "expected" determined from regression predictions adjusted for age, breed, mature size, etc. RFI is expressed relative to a contemporary group mean and ranged from –8.39 to +7.22 in 2003-04 and –8.30 to +7.52 in 2004-05. ###

Forty-nine spring calving cow-calf pairs were used in an 87d trial to determine the effect of cow age (2,3,&>5 years), initial cow body condition (<4.5, 4.5-5.5, >5.5), and sex of calf on feed intake, gain conversion of feed resources and concentration of NEFA in maternal plasma over the experimental period. Animals were fed *ad libitum* a total mixed ration containing 10% crude protein. For the first 45d, the rations contained 90% fine chopped grass hay and 10% corn/urea based grain mix. Concentrations of NEFA decreased significantly across time but a differing rates due to age of dam, sex of calf and body condition of the dam. There was no interaction involving sex of calf or body condition within age across time. Residual feed intake decreased with increasing age of dam but was unaffected by calf sex, or gain, or dam body condition. Amount of feed consumed was greatest in calves of 2-year old cows and their dams compared to other age groups. Sex of calf or body condition of the dam had little effect on amount of feed consumed. Efficiency of feed conversion (cow and calf weight gain/cow and calf feed consumed) was unaffected by age or body condition of the dam or sex of the calf. ###

Uric acid (UA) has been proposed as the dominant antioxidant in birds. In vitro studies were conducted to determine the quenching effect of varying concentrations of UA, including those found in avian plasma, on specific reactive oxygen species (ROS) and to determine the ability of UA to protect DNA and cellular membranes from ROS mediated damage.

Hydroxyl and superoxide radicals were detected with electron spin resonance (ESR) and their presence was reduced significantly upon addition of UA. UA also significantly inhibited hydroxyl mediated Hind III DNA damage. Lipid peroxidation of silica exposed RAW cell membranes was significantly less with the addition of UA to the cell incubation mixture.

A second objective was to establish models of oxidative stress in poultry. In the first study, the ability of hemin (iron containing protein) to generate oxidative stress was investigated in broilers. Inclusion of hemin at 5, 10 and 20 mg/kg feed/body weight resulted in a dose dependent increase in oxidative stress as measured by leukocyte oxidative activity (LOA). Body weight was depressed in treated animals. In a second study the inclusion of allopurinol (reduces concentrations of plasma UA) in the diet of hemin-treated birds did not further exacerbate the increase in LOA activity.

Results indicate UA has a concentration dependent effect of scavenging hydroxyl radicals and superoxide and inhibits oxidation of DNA and lipids in cellular membranes. The ability of UA to prevent reactive species oxidation of biological components gives it a crucial antioxidant role in vivo, slowing the accumulation of reactive species mediated markers of tissue injury. Results also suggest UA protects birds from reactive species mediated tissue damage and thus contributes to avian longevity. ###

The importance of understanding lysine metabolism arises from the fact that lysine is one the most common limiting amino acids in diets of swine and poultry. Studies of the enzyme, lysine alpha-ketoglutarate reductase LKR) are particularly informative since LKR catalyzes the initial step in the known major routes of lysine degradation.

Experiments using mice as a pilot organism show liver LKR activity in mice fed 50% casein was approximately twice that of mice fed 20% casein with no significant change in the abundance of LKR or in LKR mRNA, the latter suggesting regulation occurs post-transcriptionally.

LKR and lysine oxidation were found to be widely distributed in tissues of the broiler chicken. Lysyl oxidase, an enzyme believed important only for the modification of lysine residues, was likewise widely dispersed in chicken tissues. Collectively these results indicate routes of lysine degradation other than the LKR pathway and locations of lysine degradations other than the liver. ###

Understanding which allows control of flower senescence could increase economic value of plants through longer vase life of cut flowers and increased seed and/or fruit set. Conversely, increasing flower senescence may enhance breeding efforts or landscape applications by limiting fruit and/or seed set.

Transcript levels for three EIN3-like cDNA's (DC-IEL2-4) and of one additional gene, CEBP (putative function in ethylene signaling) were characterized during flower development and upon ethylene exposure and pollination. mRNA levels showed limited regulation in petals, ovaries and styles of both DC-EIL2 and 4 during flower development. Similarly, limited changes in mRNA levels of DC-EIL2 and 4 were observed upon ethylene exposure, pollination and wounding of leaves. DC-EIL3 mRNA levels however, were highly regulated in a number of tissues. DC-EIL3 mRNA increased throughout flower development in petals and styles and decreased in ovaries. In contrast, CEBP transcript level decreased dramatically concurrently with DC-EIL3 increase in petals and styles. These changes in mRNA are important due to the observed association of DC-EIL3 (positive) and CEBP (negative) mRNA's levels with ethylene responsiveness during petal development. Both putative gene products interact with the same promoter elements in senescence related genes implying that competition between these transcription factors determines ethylene responsiveness of petals and therefore their likelihood to enter senescence. Procedures to decrease or eliminate DC-EIL3 expression or increase CEBP expression in petals and styles should lead to increased longevity. Additionally, since

DC-EIL3 and CEBP act downstream from the ethylene receptor, this alteration may increase flower longevity without some of the negative effects such as increased disease susceptibility, associated with genetically engineered ethylene insensitivity at the whole tissue or plant level by blocking ethylene perception. ###

Feed costs are the largest single expense item in broiler production and both nutrient content and physical form can have significant impact on animal performance. An on-going project to quantitate effects of ingredient ration and grain particle size on feed manufacture, pellet quality and broiler performance has shown: (1) feeding medium corn containing diets increased live weight gains while increasing particle size from fine to course decreased feed efficiency and breast yield but increased gizzard yield; (2) increased live weight gain of broilers fed pelleted diets was more likely due to feed form than improved nutrient utilization; feed efficiency differences between mash and pelleted diets was most likely due to a high fines percentage associated with pelleted diets; (3) when an array of particle size is available to broilers, preference is noted for the medium to large particle size range. As particle size variability decreases with time, broilers show a preference for larger particles that may remain in the feed trough; (4) feeding smaller particle corn may shorten feed passage time while larger particles may be retained in the upper GI tract longer thus lengthening feed passage time and possibly increasing nutrient utilization. ###

Maryblyt and Cougarblight are computer programs which forecast risk of fire blight based on environmental condition thresholds. Cooperators in British Columbia, Quebec, England, Michigan, New York, Vermont, Washington State and West Virginia contributed 243 sets of historical environmental and disease incidence data for individual orchard blocks. Data sets were classified either as “cases” if fire blight was observed that season or “controls” if fire blight was not observed. Weather data from each data set were entered into Maryblyt and Cougarblight. The frequency of cases and controls for each set of single and combined threshold values was recorded for both forecasters. For each possible threshold value tested, the prediction was recorded and subsequently compared to field observations. Cougerblight was evaluated with and without an optional rain threshold.

For each threshold value, the numbers of true negatives, false negatives, false positives and true positives were recorded. Receiver operating characteristics curves were created for both forecasters as a plot of sensitivity (true positives/# cases) versus 1-specificity (false positives /# controls) as a measure of forecaster performance. Data were analyzed as a whole as well as by region and cultivar susceptibility. Frequency distributions of “cases” and “controls” for each model were plotted as a function of their tested threshold values.

The majority of cases were classified as value 7 (infection) in Maryblyt. Cases were more evenly distributed across values for Cougarblight, with or without the rain threshold. Cougarblight generated fewer false positives than Maryblyt, improving specificity. The Cougarblight category “high risk” appears equivalent to the Maryblyt category “infection” and the Cougarblight category “exreme” has good

specificity but is not particularly sensitive. These results indicate that both forecasters performed similarly for all regions and cultivar susceptibility levels and have equivalent predictive capacity. Both forecasters could be improved by the inclusion of cultivar susceptibility.

Program 2 (National Goal 2 and 3): Ensure a healthy, well-nourished population with access to a safe and secure food system.

Overview

Program 2 combines National Goals 2 and 3 due to the strong relationships between these goals and the small size of both programs in West Virginia. The small program size is partly due to loss of faculty and an inability to hire suitable replacements until recently. We have recently hired two human nutritionists and therefore expect to make a considerably greater contribution to these national goals in our 2007-11 Plan of Work.

The scope of Program 2 research efforts has included research in food quality and safety in support of state beef, poultry and aquaculture industries. Because fish proteins are especially susceptible to freeze and freeze-thaw cycle induced denaturation, one research focus has been on developing superior (measured by product quality and safety) methods of cryopreservation for fish fillet and restructured fish products. A recently instituted and related area or research involves developing improved methods for protein and lipid recovery from trout processing by-products. Finally, research is being instituted to evaluate and develop non-thermal electron beam treatment as a critical control point to minimize microbial contamination, particularly in ground meat products..

Assessment of Progress

Program 2 (National Goals 2 and 3) currently represents a very limited area of research in the West Virginia Station. Our expectation is that efforts in this area will increase considerably in the next 5-year Plan of Work. Given the limited personnel and operating support afforded these goals, progress has been acceptable.

Expenditures and SY for Program 2 (Goal 2 & 3)

Source	$ or SY
Formula	**164,894**
State Funding	**194,406**
SY's (FTE)	**0.8**

Key Theme 2.1 – Enhancing Safety and Quality of Food Products

a) Description: Research to increase food safety and product quality, focused on beef, poultry and aquaculture industries

b) Impacts:
E. coli is a serious economic and food safety problem in meats, particularly beef and poultry. Inactivation kinetics using electron beam (e-beam) irradiation at various combinations of temperature, ionic strength (IS) and water activity (Aw) was applied to E. coli O157:H7 inoculated into fresh ground beef, fresh boneless and skinless chicken breast, and in trout fillets. Levels of ionic strength were 0.05 (control), 0.44, and 0.76 (NaCl added at 0.0, 3.5, and 7.0%, respectively); Aw levels were 1.0 (control), .99, and .96 achieved by freeze drying. Electron beam doses were 0 (control), 0.5, 1.0, 2.0, 2.5, and 3.0 kGy with beam energy fixed and 10MeV. E, coli survivors were enumerated by spread-plating on E. coli petrifilms using a 10-fold serial dilution procedure. Survivor counts were used to plot a survivor curve.

Results indicated that E. coli inoculated in trout were least resistant to e- beam radiation, followed by inoculations in beef and chicken. Regardless of species, meat temperature during e-beam processing was critical – the lower the meat temperature during processing the greater the survival of E. coli. Lowering Aw y freeze drying in the tested meat samples increased resistance of E. coli to e-beam processing. Increasing IS by addition of NaCl induced a shoulder effect in microbial survival. Results indicated a 12-D safety level for E. coli would require an e-beam dose of 2.2 – 4.4 kGy. Irradiation of poultry currently is approved up to 3.0 kGy while red meat is approved up to 4.5 kGy for fresh and 7.0 for frozen products. ###

Vacuum tumbling of trout fillets was evaluated to enhance sucrose penetration and thereby protect against protein denaturation during frozen storage. Cryoprotectant treatments (8% sucrose/sorbitol – SS; 8% trehalose – T; 8% trehalose/sorbitol – TS; and 2% sodium lactate – SL) were evaluated in restructured trout following 1, 3, 5, 10 and 15 freeze-thaw cycles. SS. T, and TS treatments reduced thaw loss and product toughening caused by freeze-thaw cycles. SL reduced lipid oxidation and bacterial growth without adversely affecting color.

c) Source of Funding: Hatch, State

d) Scope of Impact: Integrated research and extension

Key Theme 2.2 – Promoting Healthy Nutrition for Rural Families

a) Description: Research to document and improve nutritional and dietary practices of rural families.

b) Impacts:
A rapid, nondestructive method of assessing textural changes during thermal processing would enhance development of low-fat, consumer optimized muscle foods. The objective of this study was to develop a method to predict storage modulus (G', the elastic component) of low-fat beef or trout batters, with and without NaCl, using near infrared spectral analysis (NIR).

Skinned rainbow trout fillets and unpeeled beef knuckles (IMPS#167) were minced and formulated to contain 10% fat, 30% added water and either 0 or 2% NaCl. Batters were stuffed into molds and cooked to 72^0 C in a water bath. Gels were removed when internal temperature reached 50, 60 or 72^0 C. NIR spectra between 800 and 1700 nm were collected on each gel. The dynamic rheological property of batters were determined using a rheometer at 50-Pa stress and 0.1 hz frequency. Batters were heated from 10 to 72^0 C at a temperature ramp of 1^0 C/min and the rheological property was expressed in terms of storage modulus. Partial least squares analysis was used to predict storage modulus from NIR spectra of gels from 96 data sets. A cross-validation model used log (1/R). The experiment was conducted with eight replicates.

Optimum NIR prediction of storage modulus occurred with six factors in the model (SEP = 0.56; r=.89) with similar performance using the model developed in the validation data set (SEP=0.52; r=.91). During thermal processing NIR can be used to predict storage modulus of low-fat meat batters prepared from beef and trout muscle at differing salt levels. Application of NIR spectroscopy to texture assessment during thermal processing will facilitate the design of muscle foods most appealing to consumers. ###

A project is underway to develop value added foods using protein and lipid recovered from trout processing by-products (approximate 40% of initial weight). Solubility of myofibrillar and sarcoplasmic proteins was highest at pH values of 2.5 and 12.5 with precipitation highest at pH 5.5 where recovery yields approached 90%. Proteins recovered were used to develop protein gels which exhibited superior gel strength. Food products reconstituted using protein and lipid recovered from trout processing byproducts showed omega-3 and omega-6 concentrations in recovered lipids generally three times higher than in trout muscle. Concentrations of linolenic, EPA, DHA, linoleic, and arachidonic acids ranged from three to five times higher than in trout muscle. Additionally, preliminary results show rainbow trout fed flax oil yield fillets with increased levels of omega-3 fatty acids.

c) Funding Source: Hatch, State

d) Scope of Impact: State specific

Program 3 (National Goal 4) – Greater harmony between agriculture and forestry practices and the environment

Overview

Research to support preservation of West Virginia's soil, water, forest and wildlife resources is an increasingly high priority in the West Virginia Station. Key research themes include protecting soil and water quality and developing economically effective and environmentally sustainable management practices for agriculture and forestry.

Contamination of soil and eventually ground water with acid mine drainage from abandoned mines, and from more recent surface mining, is a growing state concern. Research is being conducted to characterize the nature and scope of these problems and to develop effective and cost effective remediation programs.

Most acid mine drainage sites involve complex mixtures of contaminants. Efforts to define the nature and scope of the contamination have used both actual mine drainage sites and simulated drainage situations. Examples of the former inclued comparing wetlands impacted by the release of metal-laden sediments from acid mine drainage and those not so impacted. Research with simulated mine drainage is measuring, under laboratory conditions, impacts of sulfate, neutralizing cation action and endpoint pH on acid mine drainage neutralization with the goal of designing more efficient acid mine drainage treatment systems.

Research to develop environmentally sustainable practices for managing farms and forests is an important component of overall Station goals to position state producers to compete more effectively in organic or "green" markets and to preserve West Virginia lands, forests, wildlife, soil and water resources for future generations. Examples include the development of soft chemical and mating disruption programs to minimize insect damage to tree fruit orchards, efforts to document and correct as necessary, impacts on non-target species from efforts to control gypsy moth defoliation of state forest lands, and developing methods to objectively assess value of environmentally sustainable practices.

Assessment of Progress

Progress toward achieving the objectives of Program 3 (National Goal 4) is acceptable. Of particular note are results documenting impacts on wetlands from surface and acid mine drainage and improving remediation methods as well as the successful simulation of acid mine drainage remediation under laboratory conditions.

Expenditures and SY for Program 3 (Goal 4)

Source	$ or SY
Formula	**661,860**
State Funding	**736,876**
SY's (FTE)	**6.9**

Key Theme 3.1 – Protecting Soil and Water Quality

a) Description: Research to evaluate soil and water quality, develop methods to prevent soil and water contamination and, where necessary, develop effective and cost efficient remediation programs

b) Impacts:
Due to the mountainous topography of the central Appalachian region, highway construction requires expansive cut and fill areas that often contain acetic of alkaline materials. The disturbance and mixing of these materials with the original soil produces new soil that differs considerable from the surrounding native soils.

Objectives of this research was to identify physical and chemical properties of such soils to assist builders in improving soil handling practices during highway construction.

Cut, fill and on-grade areas within sections of Interstates 68, 79 and 81 were selected randomly as sampling sites. Soil pits located at 10- m increments along transects perpendicular to these four-lane highways have been sampled at 0-10 cm and 10-20 cm depths and described according to USDA methods. Surface samples also were taken near the edge of the highway. Field pH values of all sites ranged from 5 to 8. At newly created sites (1-5 yrs), thin A horizons developed within 1 to 2 years in rapidly weathering surface materials. In these young soils, little development is observed beneath a weakly developed A horizon, commonly creating an A-C1-C2 or A-AC-C horizon sequence. Soils of intermediate ages (9-12 yrs) were similar to young soils, although at some sites a more developed soil profile was occasionally observed (A-Bw-C1-C2). The most developed soil profiles were observed on sites where soils had been constructed 25 to 43 years ago. At these locations, multiple B horizon sequences were common creating A-Bw1-Bw2-C or A-Bw-BC-C horizons. ###

Excessive concentrations of trace elements in soils are of concern due to potentially toxic effects on humans and the environment. Trace element content of three major soil series in Major Land Resource Area (MLRA) 126 of the Appalachian region was assessed by two extraction techniques. Three pedons each of Upshur and Vandalia (both Typic Hapludalfs), and Gilpin (Typic Hapludults) soil series in three distinct areas of this region were described and sampled. Bulk density, texture, pH, cation exchange capacity (CEC), base saturation, and total carbon were determined for each described horizon. For the A, Bt, and C horizons of each soil series, concentrations of ten trace elements (As, Ba, Cd, Cr, Cu, Mn, Ni, Pb, Se, Zn) were determined by ICPAES after microwave digestion by USEPA Method 3051 and an HF method.

Trace element concentrations using USEPA 3051 were about 1.5 to 5 times lower than the amounts extracted by the HF method, except for Mn. Copper, Mn, and Ni contents were significantly higher in the Alfisols (Upshur and Vandalia) compared to the Ultisol (Gilpin) when extracted by the 3051 method, but only Ni was significantly higher in Alfisols with the HF method. No differences were found among soils for As, Ba, Cd, Cr, Pb, Se, and Zn using either extraction method. Average concentrations (mg/kg) in A horizons of these soils for both Method 3051 and HF digestion were: As below detection limits (BDL), BDL; Ba 120, 255; Cd 1.5, 3.0; Cr 17, 22; Cu 16, 31; Mn 1470, 1360; Ni 11, 19; Pb BDL, 8; Se BDL, BDL; and Zn 65, 87. Based on the HF method, no elements exceeded the cumulative loading rate concentrations allowed by the USEPA 503 regulations. However, Cd concentrations were up to ten times higher in these soils compared with similar soils in nearby areas, and exceeded the Northeastern U.S. Regional Research recommended values for waste material application. ###

Previous work has established that at least one arbuscular mycorrhizal fungus (AMF), Glomus clarum, confers aluminum (Al) resistance in Andropogon virginicus in acid

minesoils. Isolates of this species, as well as those of two additional AMF species, were tested for variation in conferring Al tolerance. Broomsedge plants colonized by all isolates of Acaulospora morrowiae were sensitive to Al. Isolates of Scutellospora heterogama exhibited the widest range of variation, from high to low Al resistance. All isolates of G. clarum, regardless of geographic origin, conferred high Al resistance. High rates of mycorrhizal colonization and low plant tissue Al concentrations correlated with Al resistance. ###

The effectiveness of home aeration units (HAUs) and small, subsurface flow constructed wetlands was examined for removal of pollutants from domestic wastes and for subsequent potential impact on groundwater quality in rural communities. Findings indicate that many HAUs discharged effluents of unacceptable quality with respect to detected levels of fecal coliform bacteria, biochemical oxygen demand (BOD), and/or total suspended solids. Passage of domestic wastewater through constructed wetlands resulted in at least a 99% reduction of coliform bacteria, even during winter months when the wetland surface was frozen. Similar reductions were observed for total heterotrophic bacteria. Community level physiological profiles (CLPP) of heterotrophic bacteria were evaluated to determine if the functional bacterial community varied by season or plant species treatment. CCLP patterns varied significantly by season, indicating reduced functional microbial diversity during months of active plant growth (April to October). Despite such differences, treatment efficiency with respect to removal of BOD or fecal indicator bacteria was not significantly changed as a function of growing season or plant treatment. Differential survival of heterotrophs occurred as a result of cell size. Small cells capable of passage through 0.45 micrometer filters were readily recovered in the wetland influent, but were absent in the effluent. A reduction in the diversity of small-celled bacteria, as measured by molecular techniques, was observed as wastewater passed from the influent to the wetland effluent.

In a related study, the persistence of the gastrointestinal pathogen Arcobacter butzleri was compared to Escherichia coli in nutrient-depleted ground water. An inverse relationship between survival and water temperature was observed for both organisms, but the persistence of A. butzleri exceeded that of E. coli. Application of culture-based methods for detection of A. butzleri from environmental samples proved to be relatively ineffective. In particular, overgrowth by competing microflora indicates that modifications of commonly available media are necessary in order to enhance selectivity for arcobacters from water samples. ###

There may be a beneficial effect to using coal combustion byproducts (CCBs) in mine environments as there is the potential to address two waste streams, CCBs and acid mine drainage (AMD). However, there are concerns about the potential for metals from the CCBs to leach into ground and surface waters. To assess the effect of using CCBs in mine environments, accessible literature on field studies of such uses was reviewed. The Mine Water Leaching Procedure (MWLP)was performed on specific CCB-AMD combinations. A separate experiment to determine the effect of initial iron concentrations in AMD on Cu, Ni and Zn concentrations was also performed.

Elements of concern present when CCBs were in contact with distilled, deionized water included Sb, Cr, Pb, Tl, Be, Cd, B, and As, some of which exceeded drinking water standards. Elements of concern present when CCBs were in contact with AMD included Ni, Be, Cu, Mn, Cr, Pb and Cd. The source of the AMD had a significant effect on leachate metal concentrations. A particular CCB could be a sink or a source for elements of concern depending on the AMD source. Percent reductions in Cu, Ni and Zn concentrations were significantly higher at acidic pH when solutions contained higher initial iron concentrations. Calcium-sodium exchange on Wyoming bentonite in methanol, ethanol and acetone-water systems were investigated at constant total chloride concentration (0.03N) and at room temperature. When compared to water, bentonite surfaces exhibited a larger preference for the divalent cation in all treatments at various cosolvent fractions. This preference became apparent only after correction of the fractional isotherm for CaCl+ formation in solution and on the surface. This indicates that calcium-sodium exchange in the studied solvents is more of a surface than a solution controlled phenomena, involving electrostatic and specific solvent-surface interactions.

These results suggest that CCBs should not be placed in close proximity to primary drinking water supplies, even when the CCBs are not expected to be in contact with AMD. Because metals release from CCBs depends on the specific CCB-AMD combination, CCBs should be tested for their potential to release metals in waters comparable to what is expected at the site (i.e. MWLP) rather than simple acid solutions or simulated AMD. Additional study is needed of the geochemical controls on metal release when CCBs are in contact with circumneutral waters (groundwaters) and into the specific mechanism by which metals are retained or released during the AMD leaching process. The practical implications of the Ca-Na exchange experiments in cosolvents are that when solvents are part of a waste stream, as they often are, enhanced flocculation of clay particles is expected, leading to increased hydraulic conductivity, and more rapid migration of contaminants. ###

Field experiments were established in 2003 at West Virginia University to evaluate the effect of composted poultry litter on the establishment of turfgrasses in disturbed soils. To simulate typical construction disturbance, existing topsoil was stripped off to a depth of 20 cm and the nutrient-deficient subsoil was exposed. A commerical composted poultry litter (Borderline Products, Baker, WV) was incorporated at a depth of 12.5 cm at 10, 20, and 40% (vol/vol). These treatments were compared to conventionally fertilized plots and untreated plots (control). Plots were seeded, at recommended rates, or sodded. Turf was maintained at a mowing height of 8 cm. Percent bare area was estimated using transect lines in April and Sep. 2004. Weed counts by species were also recorded. In seeded plots, highest turfgrass cover (85%) recorded in April was in plots that received 20% compost followed by 76 and 64% cover in plots that received 40 and 10% compost, respectively. By Sep. 2004, all compost-treated plots exhibited 100% turf cover. Turf cover in fertilized plots increased from 11 to 76% while that in control plots increased from 26 to 67% at this time. The most dominant weed species were white clover [Trifolium repens] and dandelion [Taraxacum officinale] followed by buckhorn plantain [Plantago

lanceolata], red clover [Trifolium pratense], yellow woodsorrel [Oxalis stricta], large crabgrass [Digitaria sanguinalis], and wild carrot [Daucus carota]. No weeds were present in any of the sodded plots in April 2004 while seeded plots that received compost had less than one weed per plot. In September, seeded plots with 20 and 40% had 6% and 72% fewer total weeds, respectively, than controls. However, plots that received 10% compost had twice the number of white clover to controls whereas those that received 40% compost had 80% fewer white clovers. Interestingly, dandelion numbers in composted plote were higher than that of controls. Fertilized plots had a weed pressure similar to control plots. Overall, compost treatments were able to maintain superior turf cover and quality compared to fertilized control plots.

c) Funding: Hatch, McIntire-Stennis and State

d) Scope of Impact: Multi-state, integrated research and extension
CT-NH, NA, ME, NH, NJ, NY-G, OA, VT

Key Theme 3.2 – Sustainable Agricultural and Forestry Practices

a) Description: Research to devise, evaluate, and implement alternative, sustainable agricultural and forestry practices.

b) Impacts:
Conclusions drawn from the 7 year Bacillus thuringiensis kurstaki nontarget study include the following: The specificity of Btk bioinsecticide to forest caterpillars present at the time of application was demonstrated. Recovery of most affected Lepidoptera species occurred by the second or third post treatment year. Multivoltine species recovered more rapidly than univoltine species. Gypchek viral product is specific to gypsy moth. Indirect negative impacts were found to certain predators and parasitoids that are most dependent on caterpillars as prey including a carabid beetle, and selected groups of tachinid flies, braconid and ichneumonid wasps, and predatory stink bugs. Negative impacts did not appear to occur to herbivorous sawfly larvae or to spiders. ###

Development of an improved trap for stink bug monitoring has the potential to increase fruit quality and reduce pesticide use for stink bug control. Trapping studies were conducted to evaluate a re-designed pyramid trap jar top to reduce stink bug escape, determine the effect of insecticide ear tag size on trap captures and stink bug kill, and to evaluate the effect of trap color on stink bug capture. Four replications of seven yellow pyramid trap treatments were evaluated in a commercial apple orchard. Pyramid traps included 1.22 m and 0.61 m high plastic, and 1.22 m high masonite types. Plastic pyramids were fitted with plastic jar tops of either 1.9 L with 5 cm diameter cone opening, or 3.8 L with 1.6 cm diameter cone opening. The 1.9 L jar top contained ¼ piece of insecticide ear tag, whereas the 3.8 L jar top contained one of four ear tag sizes (none, ¼, ½, or whole). The masonite pyramid was fitted on top with a two-layered cone-shaped aluminum screen cage and contained ¼ ear tag. All traps were baited with IPM Tech lures containing Euschistus spp. aggregation

pheromone, methyl (2E,4Z)-decadienoate. Lures and ear tags were replaced every 4 or 6 weeks. Traps were installed on April 7 in border rows adjacent to a woods, either between trees (1.22 m high pyramids) or within the tree canopy (0.61 m high pyramid, 3.8 L jar, ¼ ear tag) and checked weekly until October 14 (27 weeks).

For the ground pyramids, traps fitted with the new 3.8 L jar top captured four times as many stink bugs as traps fitted with the 1.9 L jar top that was used in 2003, with intermediate captures in the masonite pyramid/screen top traps. There was no significant difference in trap capture due to ear tag size, indicating that changing the jar top design prevented most of the escape (brown stink bug escape in a separate study was 56% and 20% from 1.9 L and 3.8 L jars, respectively after 7 days). Captures were highest in the tree pyramid traps, but not significantly different from the best ground pyramids. Similar numbers of brown stink bugs were captured in tree and ground pyramid traps, but captures of dusky and green stink bugs were higher in tree pyramid traps. Stink bug mortality in 3.8 L jar tops ranged from 40% with no ear tag to 64% with a whole ear tag. Brown stink bug was less susceptible to the ear tag than green stink bug, with dusky stink bug exhibiting high mortality in traps without ear tag and no difference in mortality due to ear tag size.

In a separate study, the response of stink bugs to ground plastic pyramid traps (3.8 L jar, ¼ ear tag) of various colors including yellow, green, white, black and clear was evaluated in an unsprayed peach orchard. Traps were either baited with the Euschistus spp. aggregation pheromone or unbaited. Significantly more stink bugs were captured in baited than in unbaited traps, and in clear and green pyramid traps than in black pyramid traps, with captures in white and yellow pyramid traps being intermediate. These results indicate that visual cues used by Euschistus spp. stink bugs require further study, based on significantly greater captures in clear versus the standard yellow pyramid trap baited with the aggregation pheromone. ###

Cropland nutrient budgets are being developed for states, counties, physiographic regions and watersheds within the Mid-Atlantic region. To date, the focus has been on phosphorus (P) with budgets being estimates of major P inputs (manure and fertilizer) and outputs (harvested crops) for cropland. P balance for cropland is defined as the difference between P inputs and outputs. State-level budget trends indicate that manure P production has been increasing throughout the region since 1939, primarily due to increases in poultry production. Although significant reductions in fertilizer use since 1978 have offset some of the recent manure P increases at the state level, significant P surpluses still exist. County-level budgets indicate that areas with intensive animal production correspond with P surplus areas. ###

A bench scale biofilter for removing ammonia from poultry house exhaust, and conserving energy in a poultry house by recirculating air through a biofilter to harvest ammonia, has been developed. The high cost of energy is likely to further erode profit margins for growers. Treating stale air from the poultry house in a compost biofilter to remove ammonia and tempering the incoming fresh air would reduce the heat lost

during the ventilation process. Harvesting ammonia in a compost biofilter and land-application of the ammonia-rich spent biofilter medium would allow use of ammonia for crop production. High ammonia levels in poultry houses adversely affect both bird performance and worker health. The initial effort evaluated the use of a biofilter to remediate ammonia generated by a small flock of broilers. This bench scale study showed that compost had a high affinity for trapping air borne ammonia during the length of the study period. With these favorable results, a whole house study was designed that would not only evaluate the effectiveness of a compost biofilter to remove ammonia but also reduce the heating needs of the poultry house. ###

The natural biological control of the chestnut blight fungus is known in several locations in North America and Europe. Our field and laboratory tests are designed to understand the mechanisms by which these hypoviruses (the agents responsible for biologcial control) become established and spread. The ultimate goal is to employ hypoviruses as control agents in eastern hardwood forests.

Canker treatments with hypovirus-laden inoculum were made from 1992-1997. In 2003 and 2004, hypovirus introductions were resumed after analyses demonstrated that hypovirus spread was restricted principally to trees that had received treatment inoculum. In 2004, approximately 850 cankers were sampled in 12 permanent plots. Year-to-year trends indicate that hypoviruses persist very well on trees where they are introduced by canker treatment but become poorly established on adjacent, untreated trees. Hypovirus treatment has prolonged the life of treated trees when compared to non-treated ones. The number of vegetative compatibility types of Cryphonectria parasitica, while increasing, is still dominated by founder types. A second study in WV has focused on procedures to introduce hypovirulent inoculum to virulent cankers. Treatment procedures involved a variety of wounding protocols and canker coverings. Success of treatment was evaluated by assessing hypovirus transmission to the canker inciting strain. The study concluded that wounding was an important treatment prerequisite and covering made little difference except in the survival of the treatment inoculum. Another WV study compared the performance of Cryphonectria parasitica isolates that had been infected with several different hypoviruses by transfection or anastomosis. Their growth and sporulation was compared in laboratory and field tests. In general, the manner of hypovirus infection did not significantly alter their ability to form cankers or produce asexual hypovirulent inoculum. However, different hypoviruses and host backgrounds often influenced their performance. An additional field study was initiated in 2004 to evaluate the biological control potential of C. parasitica strains containing an infectious cDNA copy of the CHV1-Euro7 hypovirus. This study will compare inoculum production, sexual reproduction and dissemination of cytoplasmic and trangenic isolates. ###

Recent research analyzed the performance of alternative incentive designs and payment levels if farmers were paid to adopt land uses and management practices that raise soil carbon levels. At payment levels below $10 per metric ton for permanently sequestered carbon, analysis suggests landowners would find it more cost effective to adopt changes in rotations and tillage practices. At higher payment levels,

afforestation dominates sequestration activities, mostly through conversion of pastureland. The most cost-effective payment design adjusts payment levels to account both for the length of time farmers are willing to commit to sequestration activities and for net sequestration. A 50-percent cost-share for cropland conversion to forestry or grasslands would increase sequestration at low carbon payment levels but not at high payment levels.

c) Funding: Hatch, McIntire-Stennis and State

d) Scope of Impact: Multi-state, integrated research and extension
CT-NH, MA, ME, NH, NJ, NY-G, NY-I, PA, VT

Program 4 (National Goal 5): Enhance economic opportunity and quality of life for rural citizens and communities.

Overview

Stagnant or declining per capita income, population outflow and unemployment are chronic problems in some areas of West Virginia. Research to develop technologies and management systems which promote economic development consequently represents a high priority in the West Virginia Station. Additionally, research which supports improvements in factors independent of income which affect quality of life may be equally important in stemming outflows of human capital.

The predominantly rural character of West Virginia dictates that Station research will focus on economic development and quality of life issues primarily in rural communities having agricultural and/or forest based economies.

Assessment of Progress

Progress toward achieving objectives of Program 4 (National Goal 5) were modest but acceptable given the limited resources allocated to this program. Results documenting a potential to substantially increase producer income with integrated systems of birth to market beef production are encouraging as is the ability to utilize treated mine drainage in aquaculture production. Working with numerous community-based projects to develop forest heritage tourism and direct marketing opportunities for farmers have been extremely successful to date and results showing small business to collectively have a substantial impact on economic development is encouraging. Obtaining premium prices for hardwood products produced by sustainable methods also may offer potential for small, niche markets

Expenditures and SY for Program 4 (Goal 5)

Source	$ or SY
Formula	**516,365**
State Funding	**652,795**
SY's (FTE)	**9.0**

Key Theme 4.1 – Enhancing Community Economic Development

a) Description: Research to assist rural communities in developing profitable and sustainable local industries.

b) Impacts:

Pasture-raised beef is experiencing growing demand presumably due to perceptions of health benefits, environmental sustainability and local production. Aggregate analysis of state-wide adoption of pasture-raised / direct marketing of beef indicated significant economic development potential. For example, if all beef currently used in school lunch programs in West Virginia were from pasture-raised cattle, increased demand would necessitate the production of 40 million additional pounds of cattle, would add 1,700 additional jobs in various sectors and would increase industry output by 46% (from $250 to $365 million annually). ###

Collectively, small businesses make a large contribution to the economic diversity of rural communities. Through their capital investments they create jobs and new opportunities to promote community-building and social activities in rural areas. The main objective of this study was to evaluate the promotion of small businesses as an appropriate strategy for rural economic development and poverty alleviation for rural regions. The basic premise and focus of the study is that starting new and expanding existing businesses is the most effective way to create employment, generate income, and give households a way out of poverty. Statistical and simulation analyses were developed to determine the linkage between small business and rural economic development in relation to local public services, labor mobility (migration), and rural poverty. Based on the empirical results, policy alternatives will be specified and evaluated.

The relationship between small business development, economic growth, and poverty alleviation in West Virginia was analyzed using time-series data from 1980 to 2001. Four econometric equations in double-log form were regressed using ordinary and two-stage least squares. Results show: (1) there is a robust, positive relationship between the relative size of small business and economic growth; (2) there is a strong inverse relationship between the relative size of small business and the incidence of poverty; (3) there is a strong inverse relationship between the per capita income growth and the incidence of poverty; (4) the autonomous impact of the relative size of small business on poverty rate is mild and insignificant, indicating that the strong inverse relation given in (2) is through economic growth rather than a direct one. Thus, the anti-poverty impact of small business development is mainly through its impact on economic growth of the economy as given in (1). The empirical result establishes the link between small business development, economic growth, and poverty alleviation. ###

Information regarding the effects of spatial and regional demographic characteristics on direct marketing sales can be used in farmers' year-to-year production decisions (both type of products and type of production practices) as well as their long term

strategic decisions (such as new farm purchases or land leases). Such information can also assist government agencies or policy makers in targeting farmland preservation programs, environmental cost-share programs, or programs promoting the sale of local farm products.

In collaboration with state Cooperative Extension faculty, we visited most farmers' markets in West Virginia in order to build a database of the state's markets. This led to the creation of a web page

http://www.wvu.edu/~agexten/farmman2/frmmrktindex.htm

that can help consumers find information on WV farmers' markets, and also provide information and links for farmers' market managers and vendors. This website will make it easier for farmers' markets to get started and be successful in WV as well as for customers to attend the markets. ###

U.S. hardwood exporters were surveyed to determine the current international markets for certified hardwood products (CHWP) and to document the experiences of hardwood exporters concerning CHWP and certification. There was a 42 percent response rate to the 265 mailed surveys. Twenty-six percent of exporting companies received requests for CHWP but these requests represented less than 5 percent of the companies total export business. The experiences of the responding exporters parallels that reported in previously published studies. Willingness to pay a premium is low. Over half of the exporters indicated that customers will not pay any premium. Chain-of-custody issues are a major problem and the supply of certified hardwood lumber is small. Only large companies owning their own forests have no problem with certification, chain-of-custody documentation, or supply. The markets remain predominantly niche markets centered in northern Europe. China is emerging as a major market for primary CHWP. There is a high level of skepticism among exporters, but certified hardwood products represent a niche export market that is a profitable product line for some. ###

The Appalachian Forest Heritage Area (AFHA) is the result of the Forestry Heritage Trail project funded by the USDA Fund for Rural America grant. The project has gained active support from more than 200 stakeholders and works in 16 counties in West Virginia and two in western Maryland. Goals of the project include providing education and awareness regarding forestry and wood products industries, providing an appreciation of regional history, natural resources and culture, encouraging heritage tourism, and contributing to regional economic development.

The AFHA has supported in excess of 25 community-based projects ranging from architectural rehabilitations planning to an artisan's website; from and interpretive exhibit on "The Resilient Forest" to guided forest industry tours. Task groups of volunteers have developed community and regional asset map databases, conducted base-line visitor and forest industry research, created interpretive themes, worked on interpretive products including exhibits, trails and museum planning, and currently

are engaged in branding, brochure and logo development. The project has leveraged, partnered, or provided direct match from 11 additional grants totaling nearly $230,000 for community projects or organizational efforts. ###

Research supporting a growing forensic industry in West Virginia has provided greater understanding of the biology and development of forensic arthropods in various regions, seasons, and elevations in the state including various elevations between 2400'-2900' in Mineral, Nicholas and Preston Counties and 3500'-4000' in Tucker and Randolph Counties. The following key indicator species were collected: Phormia regina, Calliphora vomitoria, Calliphora vicina, Protophormia terraenovae, Cochliomyia macellaria, Cynomyopsis cadaverina, Lucilia illustris, Phaenicia sericata, Phaenicia caeruleiviridis (Calliphoridae), Muscina stabulans, Muscina pascuorum, Fannia spp., Hydrotaea leucostoma, Eudasyphora cyanicolor setosa (Muscidae), Prochyliza xanthostoma, Piophila casei (Piophilidae) and many others.

In 2003,Muscina pascuorum was misidentified as Lispoides aequifrons (Muscidae). Muscina pascuorum (verified by Vockeroth, Ottawa, Canada) is a large, black fly resembling Calliphora vicina; it came to pig carrion in large numbers from late September to December in both years - greatest numbers appeared in November. Large numbers entered houses in November joining Pollenia rudis [cluster fly]. Second and third instar larvae of Muscina pascuorum were collected at the soil surface (water-logged) under pig remains, 29 Oct 2004 (13 days after placement). Dead pigs were again placed inside a vacated house near an open window at the WVU Reedsville Exp Farm throughout 2004; Phormia regina entered the room and began laying eggs within 15 minutes in three trials in late May, July and September; Calliphora vomitoria entered the room and laid eggs within 48 hours in October. At most sites in West Virginia, below 1900 feet, Calliphora vomitoria was dominant in spring then disappeared by early June and did not return to pig carrion until late September, becoming dominant in October and November. At lower elevations, Phaenicia caeruleiviridis was usually dominant on fresh carrion (first 24 hours), then replaced by Phormia regina. At elevations of 1900' to 2400', a few Calliphora vomitoria were collected in all summer months; at 3500' to 4000', Calliphora vomitoria was dominant throughout the year. ###

Data from West Virginia field studies designed to evaluate biomass production of lowland and upland cultivars of switchgrass under different cutting and nitrogen managements were combined with results from seven other locations in four states in the upper Southeast transition zone. Included in the studies were lowland cultivars Cave-in-Rock (CIR) and Shelter and the upland cultivars Alamo and Kanlow. Highest biomass yields in West Virginia were obtained when upland cultivars were fertilized with 100 kg/ha of N in April and harvested once in November. Biomass yields of the two upland cultivars, Alamo and Kanlow, cut once per season were not significantly different and averaged 17.5 and 18.0 Mg/ha, respectively, over a 3-year period.

Biomass yields of the two lowland cultivars, CIR and Shelter, were significantly lower and averaged 10.8 and 10.3 Mg/ha, respectively. In West Virginia, biomass

yields of the early maturing upland cultivars increased (15.3 and 13.6 vs. 10.8 and 10.3 Mg/ha) when cut twice per growing season, in mid-June and early November, and those of the later maturing lowland cultivars decreased (16.3 and 16.4 vs. 17.5 and 18.0 Mg/ha). For all plots cut twice per growing season N fertilizer was applied at the rate of 50 kg/ha in April and 50 kg/ha after the first cutting in June. Fuel quality of the biomass produced under different cutting managements was not investigated. In the first 5 years of this 10-year study, the combination of 100 kg/ha of N in April and one cut per season reduced the stand density of all cultivars; therefore, N fertilization rate was reduced after a transition period to 50 kg/ha for the one-cut per season management. Biomass yield data were collected for another 3-year period. During this period of study, the mean yields of the lowland cultivars were again higher than those of the upland cultivars; however, yields of Kanlow were higher than those of Alamo and the yields of CIR were higher than those of Shelter. In West Virginia mean biomass yields and mean stand ratings (0 to 10 scale) of all of the cultivars were higher than those for the first 3-year period of the study. Switchgrass cultivars managed for biomass production in West Virginia maintained their perenniality during the 10-year study.

c) Source of Funding: Hatch, State

d) Scope of Impact: Multi-state research
CT-NH, MD, NJ, NY-C, PA, VA

Key Theme 4.2 – Improving Quality of Life for State Citizens

a) Description: Research to enhance quality of life for state citizens

b) Impacts:
Cytochrome P4501A1 (CYP1A1) metabolizes polycyclic aromatic hydrocarbons in cigarette smoke to DNA-binding reactive intermediates associated with carcinogenesis. Epidemiologic studies indicate that the majority of coal miners are smokers but have a lower risk of lung cancer than other smokers. We hypothesized that coal dust (CD) exposure modifies pulmonary carcinogenesis by altering CYP1A1 induction. Therefore, male Sprague Dawley rats were intratracheally instilled with 2.5, 10, 20, or 40 mg CD/rat or vehicle (saline); and 11 d later, pulmonary CYP1A1 was induced by intraperitoneal injection of B-naphthoflavone (BNF; 50 mg/kg). Fourteen days after CD exposure, CYP1A1 protein and activity were measured by Western blot and 7-ethoxyresorufin-O-deethylase activity, respectively. CYP1A1 and the alveolar type II markers, cytokeratins 8/18, were localized and quantified in lung sections by dual immunofluorescence with morphometry. The area of CYP1A1 expression in alveolar septa and alveolar type II cells in response to BNF was reduced by exposure to 20 or 40 mg CD compared with BNF-induced 7-ethoxyresorufin-O-deethylase activity in a dose-responsive manner. By Western blot, induction of CYP1A1 protein by BNF was significantly reduced by 40 mg CD compared with BNF alone. These findings indicate that CD decreases BNF-induced CYP1A1 protein expression and activity in the lung. ###

The unique rural agriculture and natural landscape of the Spruce Knob-Seneca Rocks National Recreation Area (NRA; Monongahela National Forest) affords outstanding opportunities for outdoor recreation, wildlife habitat, cultural resource protection (including cattle and sheep grazing), timber production, natural gas production, and scientific study. However, the pressures placed on these resources will continue to increase as socio-economic conditions (e.g., population growth) change in the area. Visitation to the area is also expected to grow as tourism markets develop in West Virginia and as access to the area improves (i.e., upon completion of Corridor H highway that will link the District of Columbia-metro area to the NRA). Given those trends, the US Forest Service is revisiting the future management direction of the area.

The purpose of this research project is to support the NRA plan revision process by gaining a better understanding of the history, issues, and supply and demand of recreation opportunities in the NRA. This project began in 2004 and includes 4 phases: (1) visitor assessment of the recreation product (quality and quantity); (2) historical analysis of the NRA; (3) community resident assessment; and (4) NRA plan development. The first two phases of the project have been completed. The preliminary results suggest that visitors perceive quality (measured on a 7-point scale ranging from poor to excellent) and quantity (measured on a 7-point scale ranging from uneventful to eventful) as two different, but compatible measures of the recreation product. Both measures were positively correlated; however the average quality scores were significantly higher than eventfulness scores perhaps because visitors self-select desirable activities in preferred settings

Given that the typical visitor to the Spruce Knob-Seneca Rocks National Recreation Area is a first time visitor, mangers should consider adding more directional and interpretive signage, where appropriate, to enhance the first impressions visitors have of the area. Adding looping trails, road improvements, pull-offs, kiosks, shelters, and shuttle services are other examples of improvements that can contribute to a more eventful visit. Traditionally, marginal utility measures have been used to examine satisfaction on a per person, per user day, per acre, or per visit basis. This study suggests that these productivity estimates can potentially provide different information to the researcher, depending on the perceived eventfulness of a visit. In our studies, we used the "event" as the temporal and spatial unit of analysis and suggest that each event affords a set of qualities. Providing visitors with more things to see and do can enhance the quantity of their experience, and packaging these events in a way that meets visitor needs can enhance overall quality. More attention needs to be given to the creation of opportunities that contribute to more eventful visits, assuming the additional opportunities are consistent with management objectives and setting classifications. ###

A decision-making tool was developed to assist in prioritizing land for conservation easements. The approach used involved integrating measures of personal preferences with GIS data in a spatial multi-criteria framework. Participants in the study were segregated into groups including outside experts and local stakeholders; the latter

group was further segregated as board members and local residents. We found differences in preferences across conservation criteria that may be attributed to local knowledge of place and global knowledge of conservation issues.

The mapping of priority areas for conservation was significantly affected by these different preferences; however, we found actual locations with multifunctional landscape characteristics to be insensitive to the preferences and therefore able to meet the desires of various constituents. In addition, a parcel prioritization model was developed that directly incorporates a land trust's goals and budget limits in the form of a goal compromise programming model. By combining the landscape model with a parcel level modeling approach, land trusts and other land-use agencies now have a very holistic management tool. An added advantage is a documented decision making process that has helped the Land Trust secure additional conservation funding opportunities. ###

Urban forests and street trees were found to generate significant amenity benefits relative to planting and maintenance costs in Morgantown, WV. The net present value of planting street trees on a single suitable street was $20,491.32 with a benefit-cost ratio of 2.25:1. Therefore, an urban forest policy to increase street planting at suitable Morgantown streets appears to be economically feasible. ###

Black bear (Ursus americanus) populations have increased from historic lows and are currently expanding their range in Virginia, Pennsylvania, and West Virginia. In West Virginia, minimum population estimates indicated black bear numbers nearly quadrupled within a 10-year frame, 1989-1998, increasing at an average annual rate of 16.9% from 182 animals to 699 animals within a 4 county area (Kanawha, Fayette, Raleigh, and Boone) in southern West Virginia. Nuisance black bear activity is increasing annually in southern West Virginia due to rising bear populations coupled with the availability of human refuse. Efforts are currently underway to understand nuisance activity and possible management strategies to curb unwanted behavior.

We tested the effectiveness of the West Virginia Division of Natural Resources aversive conditioning technique (rubber buckshot and cracker shells) on altering nuisance black bear behavior and determined that this aversive conditioning technique was not effective. We evaluated characteristics of nuisance bears to non-nuisance bears and determined that nuisance bears were generally older and more likely to survive fall archery and rifle season. We also determined that bears moved greater distances were less likely to be repeat offenders of nuisance activity than bears moved shorter distances. ###

Nest site selection and habitat use of the endangered West Virginia northern flying squirrel (*Glaucomys sabrinus fuscus*) is poorly understood. Because access to suitable nesting sites and habitats could be limiting factors, it is important to investigate these ecological requirements to further conservation efforts of the species. This study examined characteristics of 31 nest sites (22 cavity; 8 leaf; 1 undetermined) from 4 radio-collared West Virginia northern flying squirrels. Nest

trees used were similar to random trees within their homeranges but tended to have more overstory trees and snags. Furthermore, females nested in these types of areas more than males.

Results also suggest that the West Virginia northern flying squirrel may be more of a generalist in terms of nest tree selection than previously thought, and that other factors may be more critical in managing for the species. Home ranges estimated for 2 radio-collared West Virginia northern flying squirrels determined 40 locations on a female flying squirrel in 2002 and 54 locations on a male flying squirrel in 2003. The female's 95% adaptive kernel home range was 3.4 ha with a core use (50%) area of 0.3 ha. The male' s 95% adaptive kernel home range was 24.7 ha with a core use area of 5.0 ha. These estimates are smaller than previously published home ranges for *G.s. fuscus*. Whereas the female used cover types proportional to their availability, the male used areas closer to streams and grassy edge more often than randomly available and avoided deciduous forest. At the local scale the female used proportionately more mixed forest and grassy edge than was available, but avoided deciduous forest, and the male used more grassy edge than was available. Across the study site the female used much less deciduous forest than was available, but both squirrels used proportionately more grassy edge than was available. The home ranges of these individuals included grassy edge adjacent to roads, which may have skewed the results. The use of mixed conifer-hardwood forests indicates that management for this forest type would benefit the subspecies.

Nest boxes have been used in West Virginia since 1986 to supply the West Virginia northern flying squirrel with additional nest sites and as a means of capturing flying squirrels during periodic checks. Despite their widespread and increasing use as a method of determining West Virginia northern flying squirrel presence, no examination has been conducted to determine their efficacy and efficiency. The success of these boxes is low (1.5%), suggesting that naturally occurring nest sites may not be limiting in the locations. Using vegetation, elevation, and the West Virginia northern flying squirrel likelihood of presence model, a logistic model was created to predict nest box success. Although the model was significant, it accounted for only 1.4% of the variation in success among boxes. Nest boxes in optimal sites had greater success than marginal and submarginal sites. The presence of and number of flying squirrels in nest boxes differed among seasons, with most captures occurring in spring and summer. The data suggest nest boxes are not an effective tool for capturing *G.s. fuscus*, and that they may underestimate the range of the species when used to determine presence.

Kumbrabow State Forest, in Randolph County, West Virginia is a 3,840 ha mostly forested tract with a mixture of forest types and a confirmed West Virginia northern flying squirrel population. Although Kumbrabow State Forest currently has northern flying squirrel habitat, with proper management, the amount of forest that could support northern flying squirrel populations could be increased. Three stands (16.1 ha) in the forest have been identified that have red spruce (*Picea rubens*) in the understory and could become optimal West Virginia northern flying squirrel habitat if

managed for montane forest characteristics. Currently, 1,359 ha (35.4%) of Kumbrabow State Forest is considered marginal or optimal in the northern flying squirrel likelihood of presence model. With intensive management, the entire forest could be included in the model including 2,073 ha (54.0%) as optimal and 1,767 ha (46.0%) as marginal sites. ###

A psychosocial conception of ego strengths is presented in relation to adolescent involvement in adult-sponsored structured youth activities. Five hundred and seventeen high school students completed measures on their involvement in structured activities and on eight ego strengths. Gender, age, and SES were controlled in a MANCOVA procedure and it was found that extracurricular activities of sports, student government, and belonging to an issues group, as well as engagement in volunteerism were related to several of the ego strengths. Religious attendance was not related to the ego strengths. In longitudinal analysis, it was shown that ego strength at Time 1 predicted involvement in structured activities at Time 2 (eight mo later), but structured activities at Time 1 did not predict ego strength at Time 2.

The Psychosocial Inventory of Ego Strengths (PIES) was devised as a measure of Erikson's eight ego strengths. Initial tests of the measure with university samples in the U.S. and Canada revealed evidence for reliability and validity. The present investigation extended earlier research by examining the PIES and related measures among 516 high school students, and reporting additional findings from the university samples. Reliability of the PIES was shown through coefficients of internal consistency. Females scored higher than males in several of the ego strengths, and the university sample scored higher than the high school sample in purpose, fidelity, and love. Construct validity was shown through positive correlations between the PIES and identity achievement, self-esteem, locus of control, empathic concern, perspective-taking, and positive forms of coping. As expected, there were negative correlations between the ego strengths and the less mature identity statuses, personal distress, and less desirable forms of coping. In short, the PIES was shown to be a reliable and valid measure of ego strengths for high school age adolescents. ###

Research was undertaken as preliminary programming for the redesign of public Family and Consumer Sciences (FCS) classrooms. The targeted classrooms will be implementing a new teaching model, Personal Resource Systems Management (PRSM), having the primary goal of improving quality of life by fostering the development of healthy, caring, and responsible individuals. A multi-method approach was taken for this research project to enable the researchers to collect visual images from the students and clearly understand their intent behind the images. By working directly with students to collect their ideas about classroom redesign, this study has established a preliminary set of physical attributes for middle and high school classrooms that is genuinely responsive to the emerging mandate for learner-centered lifelong learning.

Overwhelming consistency was found in the ideas expressed by the students. Forty individual characteristics were identified as important to the students and included

elements such as environments that allowed for comfort and relaxation; more interest in the classroom by using color, details, and art; variety and flexibility in lighting; more supportive furniture; and more access to resources such as reference books, computers, and magazines. When analyzed through the PRSM model, three major areas of concern emerged. First, students felt a need to have the material dimension modified to provide more emotional support in the classroom. The second area of emphasis identified was the need to modify the material dimension to provide more physical support in the classroom. Finally, photographs illustrated a need to manipulate the social dimension to improve students emotional states. For example, students wanted to change social elements of the classroom by including more friends, animals, and creating a more "homey" feel to improve their emotional state while in the classroom. This would allow them to relax and engage more fully in the activities during the class period. While much of the information provided by the students was not surprising, the seriousness with which they approached the project, and their complexity and depth of thought was impressive. The results also show that students feel that the current classes must be improved to better meet their physical and emotional needs, thus supporting their learning more fully.

The data from this study indicate that students consistently identify similar issues that must be addressed in the redesign of their "student-centered" classroom spaces. The material environment must be modified to more fully meet their emotional and physical needs, while the social environment must be addressed to more fully support emotional needs within the classroom. Additional data (mandates and constraints) are needed from teachers and administrators before a final recommendation can be made for the FCS classroom but the visual input from the students was overwhelmingly consistent in identifying their classroom needs. ###

Data analyses were conducted to identify demographic variables and leisure activities which were best predictors of body satisfaction, overweight preoccupation; health, fitness and appearance orientations; and, self-evaluations of appearance, health, and fitness. Regression analyses were also conducted to determine which demographic variables and measures of health, fitness and appearance orientations; and, self-evaluations of appearance, health, and fitness were the best predictors of self-esteem. Orientation scores indicated one's commitment to and investment in the indicated constructs while evaluation scores were the participant's self-evaluation for the construct.

Results showed 1) reasonably strong correlations between orientation and evaluation scores for the constructs of "health" and "fitness" but not for the construct "appearance"; 2) parent education; student grade level (7^{th} or 10^{th}); involvement with sports and sports media; television involvement with games, DVDs and network programming; extracurricular participation; and self-reported weight class in combination accounted for 15.6% of the variance in Health Orientation scores; 3) parent education, involvement with sports and sports media; and, extracurricular participation were the best predictors of Fitness Orientation, and in combination accounted for 35.9% of the variance in Fitness Orientation scores; 4) involvement

with sports and sports media; fashion and pop media exposure; extracurricular participation; and, weight class were the best predictors of Fitness Evaluation and in combination accounted for 22.4% of the variance in Fitness Evaluation scores; and 5) fashion and pop media exposure was the best predictor of Appearance Orientation (13.8% of variance) while self-reported weight class was the best predictor of Appearance Evaluation (11.0% of variance).

Analyses of Overweight Preoccupation showed that sex, having an older sister, media exposure, and self-reported weight class in combination accounted for 25.7% of the variance in these scores. Media exposure accounted for 7.6% of the variance and self-reported weight class accounted for 14.8% of the variance in Overweight preoccupation scores. Additionally, body area satisfaction was the best predictor of Total Self-Esteem, and accounted for 19.1% of the variance in Self-Esteem scores. Parent education, household composition, and having an older sister accounted of an additional 7.9% of the variance in Self-esteem scores.

A scale for measuring adolescent risk behaviors associated with body management created by the investigator was also validated. Factors that emerged from data reduction were: 1) body management risk behaviors; 2) vigilance over body size and shape; 3) body reducing orientation; 4) fitness and body building orientation; and, 4) concern with appearance. Regression analyses will be conducted to determine the best predictors of these factors and to determine how well these factors predict body satisfaction, overweight preoccupation; health, fitness and appearance orientations; and, self-evaluations of appearance, health, and fitness; and self-esteem.

B. Stakeholder Input Process

Most stakeholder input has been collected in conjunction with West Virginia University Extension (administratively distinct from the College of Agriculture, Forestry and Life Sciences) since we share a large majority of stakeholders. We discontinued special meetings which had the gathering of stakeholder input as their sole purpose, and instead, have relied on input gathered at meetings with other primary purposes (annual or regular meetings of West Virginia Farm Bureau, West Virginia Forestry Association, West Virginia Grasslands Steering Committee, State Aquaculture Forum, Organic Research Project annual meeting, etc.). We find the new procedure much more efficient and, when suggestions from all meetings are combined, to represent a much larger and more diverse segment of our stakeholders.

Input also originates from various advisory groups associated with specific interest areas within College Divisions (e.g., Organic Research Project Steering Committee within the Division of Plant and Soil Sciences; Appalachian Hardwood Council Advisory Board in the Division of Forestry, etc.) as well as from advisory groups established at the College/Station level (Davis College Visiting Committee; Experiment Station Advisory Board). Examples ranging from the very specific (Organic Research Project Steering Committee) to the very broad (Experiment Station Advisory Board) will serve to illustrate the process.

The Organic Research Project has a Steering Committee of organic producers chosen by the Mountain State Organic Growers and Buyers Association. The Steering Committee, with members from West Virginia, Pennsylvania and Maryland, meets twice yearly to review planned research, develop new research areas, suggest changes to improve farming systems and production practices. The Committee also helps communicate results to other growers.

A majority of suggestions from the Steering Committee are suggestions of research projects which are thought likely to contribute to producer profitability. Examples of suggestions from the Steering Committee acted upon by the project team include suggestions to conduct research trials to investigate the impact of growing disease resistant and susceptible varieties as companion plantings, to study control of insects using compost tea, to compare yields from monocultures and from companion plantings of differing species. A more recent recommendation, which will be acted upon beginning in the coming growing season, is to develop and distribute cost-of-production and income budgets for individual vegetables in addition to those for the entire "market garden" as has been the past practice.

The West Virginia Agriculture and Forestry Advisory Board is appointed based on suggestions originating from Divisions in the College to represent the broad range of industries and disciplines served by the Davis College and West Virginia Experiment Station. The Board meets twice annually with an agenda focused on research issues but which quickly broadens to include many academic and outreach concerns which are linked to research. Examples of suggestions from the Advisory Board which have been adopted or currently being considered by College administration include, strong encouragement to work with WVU Extension to develop procedures and processes to better integrate College and Extension programs. Additional suggestions have been to focus on fewer research areas in the College/Station; to incorporate a list of questions provided by the Board to assist faculty in preparing research reports, and to anchor our Station Plan of Work for 2007 – 2011 on clearly defined and uniformly understood vision and mission statements from the College/Station and from each Division in the College.

C. Program Review Process

There have been no changes in the merit review process from that indicated in the Plan of Work.

D. **Evaluation of the Success of Multi and Joint Activities**

Personnel from the West Virginia Station participated in 9 Northeastern, four Southern, one Western and one Northcentral regional projects during 2004. Subject matter addressed ranged from breeding improved forage crops (for feed and/or biomass), to developing TMDL assessment tools, to management of wildlife damage, to determining impacts of out-of-school experiences on youth development.

West Virginia scientists participate in two Southern regional projects designed to identify, remediate and protect water resources. S-1004 is testing the reliability of various models to develop TMDL standards in agricultural watersheds as well as methods

to evaluate existing situations and provide remediation where necessary, considering both biologic and economic variables. Project S-297 is investigating a variety of techniques to distinguish human vs. livestock vs. wildlife fecal contamination to more quickly identify and eliminate sources of contamination. The latter project also is identifying microbial agents which either biodegrade or enable plant uptake of chemical contaminants. Both of these projects are extremely important for economic development and quality of life in West Virginia.

Multi-state projects relevant to specific, economically important plant commodities in West Virginia include projects to evaluate new apple cultivars, to control (extend or shorten) flowering and seed set periods in horticultural plants, and to develop biologically based IPM systems for the management of plant parasitic nematodes as well as oak and chestnut pathogens. Production of horticultural crops, including tree fruits and especially apples, represent areas of potential economic growth for West Virginia stakeholders. Evaluation of yield and quality for apple cultivars relevant to specific geographic areas and conditions, and the selection of those best suited for specific micro-environments, has enabled regional and national producers to remain globally competitive, keeping prices low for consumers without sacrifice of product quality.

The abundant wildlife in West Virginia is both an asset and potential liability. Property and personal damage from deer, bear, geese and other species are increasing rapidly in frequency and cost. West Virginia participates in NE-1005, *Management of Wildlife Damage in Suburban and Rural Landscapes*, which seeks to document and minimize damage to individuals and property from excessive contact with wildlife. Cooperation among researchers from seven northeastern states recently has assessed the impact of Sunday hunting on annual deer kill, developed and tested methods for dispersing Canada geese, significantly reduced repeat offending nuisance bears, and studied feasibility of controlling fertility in white-tailed deer.

Plant parasitic nematodes and Chestnut blight represent chronic and acute problems, respectively, having extreme economic consequences. Compounding these problems are growing stakeholder concerns with the use of synthetic pesticides to control plant pests and diseases. Alternative control options, such as breeding of resistant plant strains, improved cultural practices, mating disruption and the identification/introduction of pest predators, are ensuring more sustainable and environmentally friendly crop production systems while reducing pesticide exposure risks.

Multi-state research projects involving pasture-based production systems for beef, sheep and dairy; projects related to animal waste management and those developing methods for more efficient reproduction in pasture maintained livestock, are of key importance in enabling West Virginia producers to capitalize on abundant state grasslands. Again many of the stakeholders in these projects represent low income, rural and often underserved citizens seeking to supplement family income with a relatively low-intensity agricultural operation. The low cost production and improved marketing systems being evaluated in these projects, as well as the reproductive and animal waste management programs which

have been developed, have the potential to contribute markedly to the economic growth of our rural communities.

Joint, integrated research and extension activities have been a central focus at West Virginia University during the past several years. Integrated projects span all divisions of the College (Animal and Veterinary Sciences, Family and Consumer Sciences, Forestry, Plant Sciences and Resource Management) with the most mature and extensive examples being the aquaculture and organic farming projects discussed in Program 1. The aquaculture project is a multidisciplinary, multi-college, multi-institutional integrated project to develop food fish and recreational fishing industries in the state with continued research involvement by faculty at West Virginia State (West Virginia's 1890 Land Grant), and Bluefield State Colleges. The direction of focus for this project is from the ultimate user to the technology delivery to the technology development, with needs of the first defining the structure of latter two. Similarly, the organic farming project involves both Davis College and WVU Extension faculty in horticulture, agronomy, plant physiology, soil science, entomology, plant pathology, and economics in a holistic, user centric approach to sustainable production. Additional examples of integrated activities include joint programs to foster increased use of abundant, low cost grasslands for the pasture production of beef, sheep and dairy; research and extension programs to support an expanding poultry industry; and coordinated efforts with farmers, foresters and the general public to improve state water quality.

E. Integrated Research and Extension Activities

Program expenditures listed in Appendix C are described briefly as follows:

1. ***Pasture Production of Livestock*** involves research and technology transfer related to developing superior strains of grass; eliminating the toxic effect of the endophyte fungus; devising more profitable livestock management systems for beef, sheep and dairy; pasture finishing of beef; improving animal marketing systems; and producing economic data, budgets and forecasts which enable profitable enterprises.
2. ***Competitive Poultry Industry*** includes research and technology transfer to enhance poultry growth rate and efficiency, improve product quality and safety, anticipate market trends and changes, and responsibly dispose of animal waste.
3. ***Develop / Support Aquaculture*** is a comprehensive, integrated effort to develop sustainable, profitable food fish and recreational fishing industries with focus on the production, processing, and marketing of value-added products, as well as the use of abandoned mine water sources.
4. ***Improve Water Quality*** is a state-wide, integrated effort to improve water quality actually or potentially compromised by acid mine drainage, improper animal waste management and poorly maintained septic systems.

Appendix C

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

State _____West Virginia_____

Check one: **_____ Multistate Extension Activities**
__X__ Integrated Activities (Hatch Act Funds)
_____ Integrated Activities (Smith-Lever Act Funds)

Actual Expenditures

Title of Planned Program/Activity	FY 2000	FY 2001	FY 2002	FY 2003	FY 2004
1. Pasture Production of Livestock	280,135	325,127	571,673	703,207	1,099,206
2. Competitive Poultry Industry	279,656	140,078	265,064	310,876	486,298
3. Develop/Support Aquaculture	160,762	244,047	429,663	480,105	851,900
4. Improved Water Quality	169,940	162,058	257,827	660,445	741,000
Total	890,493	871,310	1,524,259	2,154,636	3,178,404

_____ 4/1/05

Form CSREES-REPT (2/00) **Director** **Date**