CY 2006
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

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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 Textiles and Fashion Merchandising and Interior Design) and Forestry (Forest Resource Management, Wood Science, Parks and Recreation and Wildlife Management) in addition to the more typical Animal and Nutritional Sciences(Animal and Veterinary Sciences renamed this past year), Plant and Soil Sciences, and Resource Management (agricultural and natural resource economics, agricultural and extension education and 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, WVU Extension, and West Virginia State University have jointly developed plans of work for CY 2007-11, but this report covers only research and integrated, research-extension programs of the Davis College for CY 2006.

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 Experiment Station operates seven farms and two forests which support faculty research. Four of the farms (Animal and Veterinary Sciences farms in Morgantown and Reedsville, 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 and ram 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 serve as 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 100 formula funded projects (Hatch or McIntire-Stennis), generally including 15 to 20 multi-state research projects. Federal formula funding of about $3 million is slightly more than matched by about $4 million in state support. Faculty also generate an additional $5.5-$6.5 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 families and communities within 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. The most common problems impacting families and communities in West Virginia include a state population which is decreasing in size and is 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

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 and matching state funding and by 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 management practices and plant varieties 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.

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°F temperature but many, more recently mined, with high mineral content and relatively acetic) in aquaculture production, and on developing a fee fishing industry in the state with significant economic impact. 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 represents a source of relatively inexpensive livestock feed for many producers in West Virginia so long as forages are palatable and in adequate quantity. Unfortunately, many forage grasses are colonized symbiotically by endophytic fungi which produce ergot alkaloids toxic to grazing livestock. Maintaining beneficial fungal contributions to the symbiotic relationship while eliminating the toxic alkaloids would be of significant benefit to producers.

Pasture-based management systems which would 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, Clemson University and at the ARS Appalachian Farming Systems Research Center in Beaver, WV. Research has centered on pasture plant species and management, optimum animal stocking rates, enhancing forage intake and digestibility, minimizing supplemental feeding, attaining market weight and condition at reasonable ages, and maintaining carcass quality characteristics of pasture finished beef.

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, environmental concerns, high land and labor prices, etc.). To remain viable, many West Virginia producers must improve efficiency either by increasing the value of what they produce, by producing at significantly lower cost, or both. Specific strategies include reducing costs of major inputs such as feed, increasing real or perceived product value in specialty or niche markets, improving efficiency of reproduction, diversifying product offerings, etc.

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, follicular development, rupture and persistence, and the role of the uterus in luteolysis in order to develop management programs which increase conception rates, reduce embryonic and fetal mortality, and maintain ideal birth weights in cattle and sheep.

Sheep production is a growing industry in West Virginia which may have significant appeal to many potential producers with under-used pasture resources. The West Virginia Station has provided and continues to provide support to this maturing industry by developing management programs for out of season breeding, financial record keeping, predator control, parasite management, ram breeding soundness determination and product marketing. A pilot program, adapting the feed efficiency measurement system at the Reymann Memorial Farm to ram testing has been completed. The program was opened to sheep producers in the spring of 2006.

Feed costs can represent up to two-thirds of all costs of livestock production. As a result, feed efficiency, or the conversion of feed into body mass, is a major determinant of profitability for meat animal producers. Although considerable variation exists in genetic merit for feed efficiency in populations of beef cattle and sheep, selection for genetic improvement has seldom been attempted due to the considerable difficulty of measuring feed efficiency on sufficiently large numbers of animals. The West Virginia Station recently has installed an electronic system at its Wardensville facility to record feed removals by electronically identified animals and thereby allow efficient and accurate determination of feed efficiency for specific individuals. The electronic system is being used as a component of the annual bull test and will be used in a similar ram testing program in the coming year.

West Virginia's fresh fruit industry (primarily apple and peach) has struggled in recent years with low commodity prices relative to costs of production. Recent research in the West Virginia Station has focused on developing systems for prevention and remediation of disease and insect problems which are less costly to producers, less intrusive to the environment and more acceptable to consumers.

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 Clemson University. 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 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	**1,552,508**
State Funding	**3,303,835**
SY's (FTE)	**17.8**

Key Theme 1.1 – Organic Production for Economics and the Environment

a) Description: Compare alternative systems of converting from conventional to organic production of vegetables, field crops and livestock; determine management practices and plant varieties sustainable and economically efficient during periods of transition, early certification, and production.

b) Impacts:
Low-input organic farming systems using green manure and cover crops were compared to high-input systems that include 10 T/acre dairy manure compost amendments from off-farm sources. Systems were assessed in a market garden vegetable trial and a field crop/livestock trial at the WVU Horticultural Research Farm which has been certified organic since 2003. The field crop trial included with- and without-livestock (sheep) treatments, arranged in a factorial randomized block design with the 2 compost (High vs Low-input) treatments. Soil and plant samples were analyzed and pests were monitored and controlled uniformly on all treatments 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 potato, pumpkin, 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 and produced more total gain per acre. Compost application resulted in significantly higher soil organic matter content, as well as higher levels of phosphorus, potassium, calcium and magnesium, than in low-input plots. Pest management trials evaluated ten treatments for suppression of seed rots and damping off in spinach, pea, beans and sweet corn. Planting seed in a compost layer in furrows resulted in the best emergence and highest yields. Applications of acetic acid or use of weeder geese resulted in unsatisfactory weed control in potato. Use of weekly spray applications of MilStop, Serenade, or milk did not significantly enhance yield or suppress powdery mildew of pumpkin, although Milstop did delay the onset of the powdery mildew epidemic. A trial to evaluate season extension compared floating row cover and high tunnels, with and without water bags as solar heat collectors, with conventional plantings and indicated that yields were significantly increased by the coverings. The use of water bags also significantly increased yields of tomato. #

Organic standards restrict use of chemical nematocides requiring alternative methods of nematode control such as crop rotation and/or the use of organic soil amendments. Common nematodes found during our study included Pratylenchus crenatus, Xiphinema rivesi, Helicotylenchus spp., Tylenchorhynchus spp. Meloidogyne hapla, and Clarkus papillatus (predator). Population densities remained low for all plant parasites throughout the seven years of this experiment and few differences among compost treatments or among crops were statistically significant. Increases over the growing season were not observed, suggesting the presence of suppressive soils. Bacterial feeding nematodes tended to increase over the four years of the trial, but differences among compost treatments were not significant at any date examined. This experiment will continue through 2009.

Preference of a bacterial-feeding nematode, C. brevicauda, for various bacteria was evaluated in paired trials. C. brevicauda reproduction was greatest on a soil bacterium, tentatively identified as Bacillus mycoides. Reproduction was low on E. coli, and lowest on a nematode-associated bacterium, related to Flexibacter sancti. C. brevicauda was attracted toward E. coli at significantly higher levels than toward B. thuringiensis, B. pumilus, three soil bacteria, and one nematode-associated bacterium. C. brevicauda tended to be attracted to bacteria with smaller cell size, and tended to prefer Gram negative to Gram positive bacteria. An experiment evaluated thyme oil preparations for root knot nematode management in greenhouse tomato beds. ProMax (3.5 % thyme oil) significantly reduced populations of Meloidogyne compared to untreated plots. However, population densities of lesion, spiral and dagger nematodes tended to be higher in treated plots. Results of Nematode Biocontrol Activity assays were inconclusive, as survival and infectivity of Meloidogyne incognita was significantly greater in sterilized thyme-treated soil than in non-treated controls. #

Varroa mites are a serious and growing threat to US populations of honey bees which represent a source of substantial farm income and, additionally are extremely important for the adequate fertilization of many crops. In 2006 faculty from the West Virginia Station conducted research, supported by a $50,000 grant from the Florida Dept of Agriculture, on controlling a severe infestation of varroa mites in that state. We treated 31 colonies with the 50% formic acid fumigator (and Honey-B-Healthy to prevent queen loss). The resultant mite mortality in capped drone cells was: 1) 99.2% on 3 April (T 84 F, ~50% RH, 9:15am; 85ml 50% FA + 15 ml HBH; 2-deep, a single hive demonstration; 200 cells were opened); DPI Church Bee Yard, Alachua Co., FL. 2) 92.6% on 15 August (T 94 F, 58,7% RH; 1:30pm; 90ml 50% FA +15 ml HBH; 10, 2-deep colonies (100 cells per colony; Mr. Hope's property, Cocoa, FL), and 3) 93.7% on 23 October (T 81.8 F, RH 41.2%; 5pm; 110 ml 50% FA + 15 ml HBH, 5PM; 20, 2-deep colonies;100 cells per colony; Duda Ranch, Melbourne, FL). Our overall treatment mortality of varroa mites removed from 100 capped drone cells in 31 colonies was 93.54%. Control mortality averaged 2%. We noticed a significant influx of adult bees from collapsing colonies, causing our alcohol washes to have unusually high numbers of varroa mites despite high mortality in capped brood cells. We believe that a passing cold front on 23 October stimulated workers and drones from weak and collapsing colonies in the region to seek queenright colonies. #

Evaluation of potato varieties for their adaptation to organic farming situations will be useful to those who produce and market organically grown potatoes. Seventeen potato cultivars were evaluated for yield, maturity, skin and flesh color, and pest resistance at the WVU Organic Research Farm during 2004 and 2005. On April 24, 2004 potatoes were planted in a trial with three replicate plots of 10 hills each. Plots were managed organically with 10 tons per acre of dairy manure compost for fertility. No pest management treatments were applied. Plots were hilled and hand-weeded as needed. The trial was repeated as a demonstration in 2005, and the results of the trials were summarized in 2006. Early white and gold varieties included Onaway, Norgold (russet), and Keuka Gold. Early red varieties were Reddale, Red Gold, and Dark Red Norland. Midseason red and gold cultivars were Cranberry Red, Rose Gold, and Yukon Gold. Blue or purple cultivars included All Blue, Caribe, and Purple Viking. Mid- to full-season varieties were Kennebec, Butte (russet), Elba, Green Mountain, and Katahdin, and all had white flesh. Highest yields were from Green Mountain, Keuka Gold, Butte, Reddale and Onaway, while All Blue and Dark Red Norland had the lowest yields. Disease levels were low in all varieties. Keuka Gold, though advertised as an early season potato, retained green vines and was harvested with the full season varieties. Full season varieties, except Elba, tended to have higher incidence of scab than early season varieties, and Green Mountain was especially susceptible, resulting in a high percentage of blemished tubers graded as unmarketable. Reddale produced significantly higher yields than Dark Red Norland, but it tended to have many large-sized tubers that are less attractive for the "red" market. Both have red skin and white flesh. Cranberry red has red skin and deep red flesh. Red gold and Rose Gold have red skins and yellow flesh. Butte distinguished itself as a very attractive russet variety with many "baker-sized" tubers and relatively few "knobby" tubers which are a common problem for Northeastern US growing conditions. Among the blue/purple varieties, Purple Viking and Caribe tended to produce "knobby" tubers. All Blue produced low yields and small tubers with tough skins. A desirable blue potato has not yet been identified. #

c) Funding: Hatch, State

d) Scope of impact: Integrated research and extension

Key Theme 1.2 – Food and Sport Fish Aquaculture

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

b) Impacts:
A heat tolerant strain of rainbow trout performed well with hybrid striped bass in a system using mine water in a year round operation. Growth rates, feed conversion and mortality levels were acceptable. Mortality levels for hybrid bluegill were unsatisfactory. Both largemouth bass and hybrid bluegill grew poorly in the study. #

Raceway design and simulation software (RDSS) has been written as an event-based tool to assist with the design of new raceway rearing systems or to evaluate the operation of existing systems. Users enter information regarding fish movement within the raceway at any time during the simulation. RDSS simulates the growth, optimal feeding rate, oxygen consumption, nitrogen production, oxygen replenishment via weirs and/or other oxygenation technologies, and economic parameters such as the cost of feed and fingerlings and the revenue from fish sales, are combined to determine information about cash flow. The software includes a comprehensive set of on-line help/warning messages to guide the user when entering data and a user's manual has been developed to aid producers. #

Production and metabolic variables were measured on individuals from 4 families of rainbow trout, representing two strains from which high feed efficiency and low feed efficiency families were identified. Fish were or were not put under a metabolic/nutritional stress and response in lysine metabolism was measured. Families within strains that were most efficient at one point in their growth curve were not necessarily more efficient through out their growth curves. Results also suggested that the regulation of lysine catabolism occurred post-translationally. #

An assessment was made of the impact of the state legal/institutional framework on the development of an aquaculture industry in West Virginia. Statutes, regulations and judicial cases, of both federal and state origin, relative to aquaculture in West Virginia were reviewed. Investigators also participated in various forums, interviewed fish growers and communicated with state agencies to discern how the current laws are applied. The research is substantially complete although there remain issues that continue to surface. Investigators have concluded that the current state regulatory and statutory scheme is a significant deterrent to development of the industry in general. The statutes and regulations are either poorly or vaguely written, dispersed among and between statutory and regulatory bodies of law or, often by default (absence of specific statute), contain provisions that are both unfair and illogical and are generally, difficult for both the lay person and even legal professionals to clearly understand and apply. #

c) Funding: Hatch, State and special grant research

e) Scope of Impact: Integrated research and extension.

Key Theme 1.3 – Pasture Raised and Finished Beef

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

b) Impacts:

Microbial communities in pasture soils are altered by cattle manure and by the feeding activities of earthworms. We are examining the effect of these factors on pasture soil fertility and quality. We have determined that the lime requirement (LR) method used by the West Virginia University Soil Test Laboratory, the Mehlich Buffer pH method, does a good job predicting LR for alfisols and inceptisols, but a very poor job of prediction for ultisols. For ultisols, LR was over predicted when little lime was needed and severely under predicted when high lime applications were needed. Significant improvements in lime recommendations for ultisols could be made by adopting an altered equation to predict lime requirement. #

Year 2 of the winter-stocking program was initiated 12/6/05 and completed 3/31/06. The goal of this experiment is for animals to gain 0.45 kg per day and be finished on pasture in the following growing season. Steers in the four winter forage-feedings-systems designated as naturalized grassland, orchardgrass hay, orchardgrass haylage and tall fescue averaged 0.45, 0.45, 0.59 and 0.59 kg per hd per day. The orchardgrass hay treatment required the most external feed inputs while the fescue and orchargrass haylage required the least. #

In-store evaluations of willingness to pay (WTP) for pasture-raised beef (PRB) were conducted in which grocery store shoppers were allowed to bid (in a vickrey second-price experimental auction set-up) for PRB products. The protocol for the market assessment contained mechanisms for eliciting true WTP through actual monetary consequences for bidding behavior and allowed the researcher to determine marginal WTP for specific product attributes such as production protocol, region or origin, and antibiotic/hormone free status. Further, since WTP experiment participants provide sensory ratings for PRB samples, these responses can be compared to trained taste panel ratings of samples from the same animal so that the relationship between taste panel and consumer preferences can be better understood. A PRB risk assessment was made based on primary production data and secondary price data. Using a decision tree approach, a spreadsheet program has been created containing specific cost, revenue, and production information, and referencing various sub-regions breeding program types. #

Ergot alkaloids are a complex family of indole-derived mycotoxins that adversely affect grazing animals, as well as bacteria, insects, and humans. They are produced by several species of fungi including Neotyphodium/Epichloe spp., which are important endophytes of grasses, Claviceps spp. pathogens of grasses, and Aspergillus fumigatus, a common saprophyte and opportunistic human pathogen. Ergot alkaloid producers typically accumulate complex profiles that include the pathway end product, one or more accumulating intermediates, and some products of pathway spurs. We previously identified genes for two pathway steps (the initial prenyltransferase reaction, and lysergyl peptide synthetase), and knocked them out in an endophyte of perennial ryegrass. Our studies with these knock-out endophytes and their effects on rabbits and insects indicate that accumulating intermediates or spur products provide benefits to the producing fungus that differ from those conferred by

the pathway end product. Thus a thorough understanding of the pathway and the consequences of its truncation at different points is of basic and agricultural importance.

One objective of this NRI-funded project is to characterize the ergot alkaloid synthesis (EAS) genes from endophytic fungi and compare them to characterized clusters of EAS genes from C. purpurea (with 13 hypothesized EAS genes in a cluster) and Aspergillus fumigatus (whose EAS cluster has 7 homologs of the C. purpurea EAS genes and several apparently species-specific genes). Among the endophytes, homologs of 11 of the C. purpurea EAS genes were identified among 5 contigs of the E. festucae genome, and 5 of these EAS genes were found between two fosmid clones from N. coenophialum. Some microsynteny characterizes E. festucae, C. purpurea and A. fumigatus EAS clusters, whereas the N. coenophialum EAS genes located to date show rather distinct gene order and orientation. The pathways in these various species appear to share common early steps and then diverge beyond the intermediate chanoclavine to yield different end products. Additional objectives of this project involve further elucidation of the EAS pathways and gene functions by disruption and complementation tests. Gene disruptions in A. fumigatus established requirements for two additional genes in early, shared steps in the pathway. Disruption of easC, predicted to encode a catalase-related protein, eliminated all ergot alkaloids that accumulate in A. fumigatus (chanoclavine, festuclavine and fumigaclavines A, B, and C). Complementation with a wild-type allele or supplementation of the easC mutant with chanoclavine restored production of festuclavine and the fumigaclavines. Disruption of easF, postulated to encode a methyltransferase for the second pathway step, resulted in the loss of chanoclavine and all ergot alkaloids derived from chanoclavine. Compounds corresponding to novel peaks in HPLC chromatograms of the easC and easF mutants are being characterized to identify the pathway steps to which they contribute. #

Ergot alkaloid-producing endophytes of grasses typically accumulate complex profiles that include: ergovaline, the pathway end product; one or more clavine intermediates that accumulate to high levels; and, some clavine or lysergic acid-derived products of pathway spurs. We hypothesize that the apparent inefficiency in the pathway has been selected for because accumulating intermediates or spur products may provide some benefit to the producing fungus that differs from that conferred by the pathway end product. A set of four types of perennial ryegrass plants that differ in endophyte status is being investigated to determine the contribution of different ergot alkaloids to traits associated with the bioprotective endophyte Neotyphodium lolii x Epichloe typhina isolate Lp1. All plants are of the same cultivar and have the following endophyte and ergot alkaloid states: e-free, endophyte-free plants containing no ergot alkaloids; dmaW ko, containing endophyte in which dmaW (controlling the first pathway step) has been disrupted to eliminate all ergot alkaloids; lpsA ko, containing endophyte in which lpsA (controlling a late pathway step) has been mutated to eliminate products of the later portion of the ergot pathway, including ergine and ergovaline, but has retained high concentration of certain clavine intermediates and lysergic acid; and, wild type, containing the wild-type endophyte,

which produces a full complement of ergot alkaloids including clavine intermediates, lysergic acid, ergine, and ergovaline.

In feeding preference studies conducted collaboratively with Dr. Daniel Potter (University of Kentucky), black cutworm (Agrotis ipsilon) strongly preferred endophyte-free perennial ryegrass compared to perennial ryegrass containing wild-type endophyte. Insects also preferred both the dmaW ko-infected grasses and lpsA ko-infected grasses compared to wild-type endophyte-infected grasses, demonstrating that lysergic acid derivatives such as ergine and ergovaline deter feeding of this insect. There was no significant difference in the amount of lpsA ko consumed versus dmaW ko consumed, indicating that clavine alkaloids and lysergic acid do not contribute to feeding deterrence of this insect herbivore. Together these comparisons show that ergine and/ ergovaline - ergot alkaloids that are present in the wild-type endophyte but missing from both the dmaW ko and lpsA ko - contribute significantly to the deterrence of feeding by black cutworm. This finding is in contrast to data we collected on rabbit feeding preference, which showed that clavine alkaloids were sufficient to reduce the appeal of endophyte-infected grasses and that ergovaline increased satiety. Together these studies show differences in the benefits conferred by accumulating intermediates (clavines) and pathway end products (ergine and ergovaline), supporting the hypothesis that inefficiency in the ergot alkaloid pathway has been selected for because it is beneficial to the alkaloid-producing fungus. #

Comparisons of species diversity of beneficial arbuscular mycorrhizal fungi (AMF) over a range of grassland sites across the U.S. is being used to provide clues about how disturbance affects fungal community composition and activity. To date, 100 samples from three sites have been established in parallel trap cultures using sudangrass as host plant at WVU and using native plants as hosts at Indiana University. Infectivity assays have been conducted on all samples to measure baseline fungal activity in soils. Of 40 examined to date, infectivity was less than half the level we consider optimal (> 25% colonization by 21 days). With such low levels, we plan at least two culture cycles to induce adequate sporulation to establish pure cultures of each native AMF species.

Another goal was to develop a robust phylogeny from a 720-780 base pair 5' region of the 25S ribosomal RNA-encoding gene. Sequence data from 82 species indicates some conflict with morphology at higher taxonomic levels (family and above), but surprisingly, shows remarkable congruence with morphology at the species level. Therefore, these sequences are being used to complement morphological criteria in identifying AMF species composition of sampled plant communities. There are some problems with amplification of sequences of contaminant saprobic fungi from field-collected spores of unknown identity. Design of more AMF-specific primers is being explored, but at the same time one of two genes encoding for beta-tubulin is being sequenced in a range of taxa to supplement 28S rDNA data. Primers also are being designed to amplify a region of the DNA polymerase II gene. Multiple gene sequences will help to resolve conflicts between molecular and morphological data when reconstructing a phylogeny of AMF species. A collaboration with the

University of Guelph seeks to use the mitochondrial cytochrome oxidase I gene for AMF species diagnosis. #

c) Source of Funding: Hatch, State.

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 1.4 – Agricultural and Forest Profitability

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

b) Impacts:
A state-wide project to support development of a profitable sheep and goat industry in West Virginia has as a major research focus, the reduction of embryo and fetal mortality. Data from 11 flocks (1375 ewes) revealed that reproductive wastage is high, at 43.3 percent from breeding to lambing, 28 percent complete pregnancy failure prior to day 25 and 15.3 percent late embryonic and fetal loss from day 25 to term. Contributing factors identified in this study were breed type (black-faced ewes had the most loss) and progesterone concentration at day 25 (high values were beneficial). A follow-up study in collaboration with USDA- US Sheep Experiment Station to assess the impact of age of follicle ovulated (young vs. old) on embryonic/fetal loss has been conducted. Data are being analyzed. Data collected from 7 flocks on the project to evaluate the effect of repeated ultrasonography on embryonic loss revealed that this procedure is safe and does not cause embryonic loss. #

Late embryonic or early fetal deaths in lactating dairy cows lengthen calving intervals. Experiments were done to determine if luteal function and/or steroid metabolism differed for cows with low or high circulating concentrations of progesterone (P4) on d 30 of gestation. Cows with P4 ≥4.0 ng/ml or ≤2.5 ng/ml were lutectomized. Luteal tissue was analyzed for P4 and mRNA for preproendothelins 1 and 3, endothelin converting enzyme, endothelin receptors A and B, cyclooxygenase-2, aldoketoreductase 1B5, 15-hydroxyprostaglandin dehydrogenase, and prostaglandin E synthase. Cows were injected s.c. with 150 mg P4 every 12 h beginning at lutectomy (h 0); jugular blood was sampled every 4 h until 48 h and assayed for P4. Luteal P4 content and mRNA for any gene investigated were not correlated with h 0 serum P4. Post-lutectomy serum P4 displayed a time by treatment interaction ($P < 0.0001$), being lower for the "Low" group during periods when values were elevated. Likewise, area under the curve was less ($P < 0.05$) for cows with Low (49.6 plus or minus 6.2) vs. High (83.6 plus or minus 12.5) P4 at h 0. Therefore, metabolic clearance is a more important factor in peripheral concentration of P4 than luteal production. Management practices that decrease metabolic clearance rate of P4 might be beneficial in decreasing late embryonic or early fetal mortality. Further

statistical analyses of the data and interpretation are underway with support from Hatch Project 421. #

Others have shown that abnormal growth of the allantois and timing of its fusion with the chorion preceded high rates of late embryonic / early fetal loss of manipulated embryos. Allantoic development was characterized in dairy cows and heifers to determine whether timing of detection of the allantois and diameter of the allantoic lumen might be used to investigate late embryonic / early fetal loss. Reproductive tracts of dairy heifers (n = 29) and lactating dairy cows (n = 33) were examined daily, via transrectal ultrasonography (Aloka 900), beginning on d 21 post-insemination (PI). Variables included: first day of detection of the allantois, diameter of the allantoic lumen and length of the embryo at first detection of the allantois. Range and mean of first day of detection of the allantois (d 21 to 26, mean 23, after insemination) agreed with previous reports. The allantois was detected earlier ($P < 0.05$) in heifers (22.4 plus or minus 0.18 d) than in cows (23.5 plus or minus 0.25 d). Diameter of the allantoic lumen at first detection (4.6 plus or minus 0.03 mm) did not differ with day of detection and was not affected by age of dam. In contrast, logistic regression showed that length of embryo (range 2.6 to 7.9 mm) varied with day of first detection of the allantois ($P < 0.05$), but not with age of dam. Differences in day of first ultrasonographic detection of placental membranes, between heifers and cows, might reflect differing developmental rates and, based on present data, there might be an asynchrony in development of the embryo and the placental membranes. Therefore, the first day of detection of the allantois might be useful for predicting pregnancy loss during placentation. #

In addition to a difference in birth weight previously reported, we have found that lambs born to ewes treated with growth hormone at breeding, to alter the environment to which the embryo is exposed, have an improved development of the cardiovascular system and an altered response from their brain-liver endocrine axis. These data are quite exciting as they indicate that the environment to which an early embryo is exposed can have long term consequences for the growth and health of the individual. We have also recently initiated studies to investigate what might be different about the development of the very early embryo in response to the treatment with growth hormone. In a limited number of animals, we find that embryos from ewes treated with growth hormone have a 33 percent increase in the ratio of trophectoderm to inner cell mass. We think that these data will ultimately lead to alterations in the way we feed and manage animals around the time of breeding to improve growth and health in the offspring. Furthermore, these data may translate to interventions applicable to pregnant humans to improve the health and well-being of generations to come. #

We recently have completed two replicates of an experiment in which we supplement ewes' rations with two different fatty acids in an isocaloric manner. This supplementation results in very different patterns of insulin secretion following feeding. Specifically, when ewes are supplemented with propionate (a gluconeogenic substrate) there is a dramatic rise in insulin following feeding. Coincident with the

increase in insulin following propionate supplementation, there is a dramatic reduction (by one-half) in the activity of the two enzymes that catabolize progesterone and not surprisingly a marked reduction in the metabolic clearance rate of progesterone. This sort of nutritional approach to decreasing progesterone catabolism has the potential to have a tremendous impact on the dairy industry where pregnancy wastage is an enormous economic burden. #

Analysis of a direct comparison microarray experiment using a bovine oligo array revealed up regulation of 272 genes (M-value ≥ 0.9, $q \leq 0.05$) and down regulation of 203 genes (M-value ≤ -0.9, $q \leq 0.05$) in granulosal cells from persistent follicles (aged cells) in comparison to growing follicles (young cells). Messenger RNA for NPM2, an oocyte-specific nuclear protein, was highly expressed in GV and MII stage oocytes; expression decreased in embryos at 2-, 4-, and 8-cell stages, but was still detectable at very low level in 16-cell embryos and barely detectable in morulae and blastocysts. Bovine NPM2 may be important in chromatin decondensation and reorganization in early bovine embryos. #

Effect on fertility of cauterization of largest follicle(s) on d 11, which increases ovulation of younger follicles, was tested in 154 Polypay ewes at the US Sheep Experiment Station in Dubois, Idaho. Proportions of ewes pregnant at d 45 and lambing and lambs born per ewe lambing did not differ between treated (93.6%, 88.9% and 2.12, respectively) and control (87.9, 83.7% and 2.38 respectively). Fertility was not greater for oocytes from only the ultimate follicular wave than for oocytes from both penultimate and ultimate follicular waves. To test whether protein kinase C epsilon (PKCE) might mediate the prostaglandin F2 alpha (PGF)-stimulated rise in intracellular calcium, and low PKCE might allow resistance of early CL (d 4) to PGF, siRNA was used to reduce expression of PKCE in bovine luteal steroidogenic cells. When PKCE expression was ablated by 75%, the inhibitory effect of PGF on LH-stimulated accumulation of progesterone was only 29%, in contrast, to 75% in controls ($P < 0.05$). Elevated intracellular calcium inhibited LH-stimulated progesterone in d-4 and d-10 cells. Thus differential expression of PKCE and its effect on calcium are important for acquisition of luteolytic response to PGF. Early direct inhibitory actions of PGF on secretion of progesterone were not reversed by the ET-A receptor antagonist, and late inhibitory effects were reversed by the ET-A antagonist. Thus, PGF has anti-steroidogenic actions both dependent upon, and independent of, ET-1 mediation. In beef cows, fertility was not affected by the numbers of antral follicles ≥ 4 mm in diameter in a single follicular wave during the estrous cycle before insemination. Conception rates to artificial insemination in dairy cattle have decreased since 1960. During preparation of semen for artificial insemination, seminal plasma is highly diluted. One component of seminal plasma, transforming growth factor-beta1, has immuno-regulatory actions in the female reproductive tract. Beef cows were treated with either seminal plasma, TGF-beta1 or bovine serum albumin (control) at insemination. Effects on conception rate varied with a combination of factors, including age and body condition of cattle. #

A long-term research goal in the West Virginia Station is to develop a model of oxidative stress in poultry and determine the efficacy of elevated plasma uric acid concentrations to function as a protectant against oxidative stress and thus limit tissue damage caused by oxidants. Raising plasma uric acid levels through feed manipulation can lead to increased resistance to oxidative stress and increased animal well-being. Studies in our laboratory have demonstrated the role of hemin as a model for generating oxidative stress. The addition of inosine, a precursor of uric acid, to the diet of birds injected daily with hemin was found to dramatically reduced oxidative stress. Further, pretreatment of birds with inosine prior to hemin injection prevented the resultant increase in measurements of oxidative stress.

One of the products of oxidative stress in the tissues of animals is the advanced glycation endproduct pentosidine (Ps). Recent studies suggest that a linear correlation exists between the age of individual birds and the accumulation of Ps in their tissues. Current studies are investigating Ps concentrations in skin samples of black vultures. Biopsy punches of 4, 6 and 8mm size were obtained from birds at the time of collection and assayed for Ps concentration. Results from this study suggest that precise measurements of Ps concentration can be determined at each fragment size. However, skin samples of 6mm in size were found to be more accurate for the determination of Ps concetration. Current studies are comparing measurements of Ps in skin samples from the patagium versus breast. The patagium may represent a potentially less invasive source of skin sample for biologists interested in sampling live birds. Accurate age information could aid species recovery programs and provide insights into longevity now understood entirely from banding programs and captive birds. #

Increasing the efficiency of lysine use for protein synthesis will decrease livestock production costs especially in the swine industry. Moreover, increasing the efficiency of lysine use for protein synthesis has the potential to decrease the environmental impact of agricultural enterprises. It has been determined that the extra-hepatic tissues have the capacity to make a significant contribution to whole body lysine oxidation. This finding is based on the activity of the initial enzyme of saccharopine-dependent lysine degradation, lysine alpha-ketoglutarate reductase (LKR), being widely dispersed throughout the body of the chicken. Consistent with the activity being widely dispersed throughout the body, the messenger RNA was found in every tissue studied. Moreover, the in vitro oxidation of both uniformly and 1- radio-labeled lysine showed that the lysine oxidative capacity was also widely distributed. Although there was a good correlation between lysine oxidative capacity and LKR activity, several tissues clearly did not fit the regression. This lack of correlation suggested that alternative pathways of lysine oxidation likely contribute to whole body lysine oxidative capacity. In the chicken, the lysine alpha-oxidase pathway (L-amino acid oxidase) has the capacity to use lysine as a substrate and thus has the potential to contribute to whole body lysine catabolism. Additionally, the lysyl oxidase pathway contributes to whole body lysine catabolism by using lysine as a substrate. In all tissues tested the LKR activity seemed to be predominantly associated with the mitochondrial fraction as is the case in other species. When

chickens were fed diets differing in lysine content there was a tendency for dietary lysine and LKR activity to be correlated but no differences in LKR mRNA or protein abundance was detected. In mice, increasing dietary protein increased LKR mRNA but not LKR protein abundance suggesting post-translational modifications may be responsible for regulating LKR activity. In rainbow trout, starvation induced an increase in LKR activity but this was associated with a decreased LKR mRNA again consistent with post-translational regulation as the mode regulating LKR activity. #

Understanding flower senescence at a molecular level will help future efforts to increase the economic value and productivity of agricultural crops through genetic engineering. Significant progress has been made in an effort to elucidate the mechanism that triggers flower senescence in economically important crops. Our research during this reporting period supports the hypothesis that senescence-related (SR) genes, including those responsible for triggering ethylene biosynthesis (necessary to sustain the senescence process), are regulated by the interaction of two transcription factors, CEBP and DC-EIL3 in flower petals. The two transcription factors seem to compete for the same regulatory element in SR genes as both have been independently shown to interact, in vitro, with this regulatory element (pERE). The level of transcripts of CEBP, classified as a nuclear-encoded chlorplast RNA binding protein, are high during the growth and development of petals and negatively correlated with DC-EIL3 transcript during the same stage of development. DC-EIL3 transcript levels on the other hand are low during growth and development and increase as CEBP transcripts decrease during senescence. Ethylene treatment results in the similar patterns of mRNA abundance. We have now shown that CEBP can be located to the nucleus as a protein with GFP constructs (not just the chlorplast as previously thought, hence the original the name nuclear encoded chlorplast RNA binding protein). This is exciting news because it demonstrates that CEBP can act as a functional transcription factor and therefore compete with DC-EIL3 for the same regulatory element. Our working hypothesis that CEBP occupies pERE during petal growth and development (restricting transcription) and slowly decreases in abudance during development while DC-EIL3 abundance increases during the later stages of development, allowing the transcription of SR genes, is therefore partially supported. This type of regulation in ethylene signaling has not been described before and therefore has the possibility of opening up new avenues in genetic engineering. Work is ongoing in further support of our hypothesis. #

Switchgrass cultivars have been categorized as either lowland or upland ecotypes based upon their morphology, relative maturity, and area of adaptation. Data from a 10-year multi-state-study designed to examine the effects of nitrogen fertilizer rates and cutting schedules on two lowland cultivars (Alamo and Kanlow) and two upland cultivars (Cave-in-Rock and Shelter) were summarized and published as two journal articles. Across eight sites the lowland cultivars yielded more than the upland cultivars (15.8 vs. 12.6 Mg per hectare). In plots near Morgantown, West Virginia, highest biomass yields were obtained when lowland cultivars were cut once per year after the first killing frost. Upland cultivars yielded 10 percent more when cut twice rather than once per year. Stand counts were greatest when a low N rate was used (50

kg per hectare in spring for the one-cut management or 50 kg per hectare in spring and 50 kg per hectare after the first cut for the two-cut management). Stands thinned when they were cut once per year and fertilized with 100 kilograms of N per hectare. When lowland cultivars vs. upland cultivars were cut twice per year, a smaller percentage of the total seasonal yield was harvested in the first cutting, and the total seasonal yield of lowland cultivars was reduced, primarily because lowland cultivars mature later than upland cultivars. Lowland plots cut once per year averaged 20 percent more biomass than plots cut twice per year. Excellent stand persistence and high biomass yields (16 Mg per hectare) were obtained when lowland cultivars received 50 kg of N per hectare in spring and were cut once per year in late October or early November after frost. #

Two branch-mounted and three canopy-suspended trap treatments were evaluated for monitoring stink bugs in 2006. Branch-mounted treatments consisted of yellow plastic pyramids of 0.6 m and 0.3 m in height topped with plastic jars of 3.8 L and 1.9 L, respectively. Canopy-suspended treatments consisted of yellow plastic pyramids of 0.6 m, 0.3 m, and 0.3 m in height topped with plastic jars of 3.8 L, 3.8 L, and 1.9 L, respectively. Both branch-mounted and canopy-suspended traps were deployed so the plastic jar was at 1.8 - 2 m above ground. Four replications of the five trap treatments were installed in border rows next to a woods in a 1.2 ha, 17-yr-old Rome apple orchard and a 3.2 ha, 18-yr-old Newhaven peach orchard. Traps were installed in both orchards on May 17 and all insects were removed and stink bugs identified weekly until August 24 (peach) or October 12 (apple). All traps were baited with lures containing 200 mg of methyl (2E, 4Z)-decadienoate from Advanced Pheromone Technologies (now APTIV, Inc.), and provisioned with 1/4 piece of insecticide ear tag containing 10% permethrin. Both lures and ear tags were replaced every 4 weeks.

In the apple orchard, captures of adult brown and green stink bugs, nymphs, and total stink bugs did not differ significantly among trap sizes and deployment methods. Dusky stink bugs, which were fewest in number, were captured less frequently in suspended traps with the smaller size pyramid. In the peach orchard, there were no significant differences in capture among trap treatments for adult dusky and green stink bugs, and nymphs. Captures of brown stink bugs and total stink bugs were significantly lower in the smallest trap, but only when suspended. For branch-mounted traps, reducing the size of the pyramid (0.6 m to 0.3 m) and jar (3.8 L to 1.9 L) did not effect stink bug capture. For suspended traps, captures were similar among pyramid and jar sizes, except for fewer brown stink bugs with the smaller pyramid and jar in peach, and fewer dusky stink bugs with the smaller pyramid in apple. Total stink bug capture was similar with branch-mounted and suspended traps. For the various trap treatments deployed in apple, brown stink bug accounted for the majority of capture (41-54%), followed by nymphs (21-32%, mostly green stink bug), green stink bug (13-21%), and dusky stink bug (8-12%). In peach, brown stink bug represented an even higher percentage of the total capture (65-76%), followed by dusky stink bug (23-32%), nymphs (0-5%), and green stink bug (0-2%). Cost of materials per trap (excluding shipping, lure and ear tag) was estimated at $10.00 for a 0.6 m pyramid - 3.8 L jar, $6.50 for a 0.3 m pyramid - 3.8 L jar, and $5.75 for a 0.3 m

pyramid - 1.9 L jar. Reducing the pyramid and jar size in half reduced trap costs by 43%, without sacrificing trap capture efficiency.

In a second experiment, various insecticide treatments were evaluated for stink bug control in a peach orchard. Four applications (two at beginning of season and two at end of season) of Danitol (not registered) or Warrior, with four applications of Imidan in between resulted in the lowest incidence of fruit injury from stink bugs. #

An updated and comprehensive survey of private timber landowners in the State is needed to have a better understanding of West Virginia's timberland resource base. Such information will be useful in evaluating implications of private landowners' forest management decisions and activities in the production and utilization of hardwood resources in the State. . Preliminary results of the survey indicate that aesthetic enjoyment and place of residence were the two most important reasons for forest land ownership. Most landowners are not actively managing their forest land. Less than 13% of the respondents have conducted any type of forest management activity; 21% have harvested timber in the last 5 years; and 12% have a written management plan. Landowner participation in educational and forestry assistance programs has been minimal with only 3% attending educational programs; less than 20% were aware of the forestry assistance/incentive programs, and only 25% of those aware had ever used any of the programs. Further analysis on the relationship between landowner characteristics and their management decisions is underway. #

c) Funding: Hatch and State

Scope of Impact: Integrated research and extension

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 who were replaced only recently. Research in the areas of human and animal nutrition, food quality and safety, and nutritional biochemistry has a more prominent role in the 2007-11 Plan of Work prepared for USDA-CSREES. For example, faculty have this year initiated projects to evaluate the efficacy of dietary isoflavones and voluntary physical exercise in preventing estrogen deficiency induced osteopenia and adiposity and to develop and assess intervention strategies to increase consumption of docosashexaenoic acid in the general population.

Research in Program 2 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..

West Virginia is one of the most overweight of US states with both adults and youth impacted. Knowledge regarding relationships among familial factors, dietary patterns and body mass index of young children, will allow us to better address the serious and growing problem of childhood obesity in West Virginia. On-going research is providing information about these relationships in rural, Appalachian children that will allow us to design culturally sensitive, effective outreach and education programs.

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	**253,639**
State Funding	**320,283**
SY's (FTE)	**1.9**

Key Theme 2.1 – Enhancing Food Safety and Quality

a) Description: Research to improve quality and safety of foods especially focused on beef, poultry and aquaculture industries.

b) Impacts:
Inactivation kinetics of Escherichia coli and acid-resistant Salmonella ssp. Montevideo subjected to e-beam has been investigated. The D10-value is a decimal reduction of microbial population expressed as e-beam dose required to inactivate 1-log of the initial microbial population. Fresh meat products such as ground beef, chicken meat, and fish fillets usually do not use a pasteurization step to inactivate microorganisms such as E. coli O157:H7. Recent outbreaks of E. coli in spinach and lettuce as well as Salmonella in tomatoes indicate a need for microbial inactivation in these fresh ready-to-eat (RTE) foods in a non-thermal manner. Electron beam (e-beam) inactivates microorganisms without heat, instead generating electron beam radiation from electrical energy. Therefore, e-beam could be applied to fresh meat products as well as RTE products including fresh leafy vegetables. D10-values ranged from 0.22 to 0.35 kGy for E. coli in trout at 4C and chicken at -20C, respectively. Regardless of temperature, chicken had highest D10-value followed by beef and trout. D10-values of frozen samples were higher than D10-values of samples irradiated at 4 and 22C regardless of species. These data indicate that microbial

inactivation depends on the temperature of the food during irradiation; the lower the temperature, the less efficient microbial inactivation.

Water activity (Aw; the amount of water in food available for microbial growth, chemical reaction, etc.) of ground beef, chicken breast meat, and trout fillets was adjusted to 1.00 (control), 0.98, and 0.96 by partial vacuum drying. Water activity (Aw) is D10-values from e-beam treatment ranged from 0.22 to 0.35 kGy for E. coli in trout (Aw=1.00) and chicken (Aw=0.96), respectively. D10-values for samples with Aw=1.00, 0.98, and 0.96 were 0.254, 0.317, and 0.319, respectively. These data indicate that microbial resistance increases as the amount of available water in food decreases. Acid-resistant Salmonella was inoculated in tomato and pH was adjusted to 4.4 and 4.9. D10-values were 1.07 and 1.50 kGy for Salmonella in tomato at pH = 4.4 and 4.9, respectively. These values are relatively high likely due to resistance that Salmonella developed to acid.

Collaboration with Tokyo Institute of Technology Department of Energy Sciences has been initiated. Our collaborators have developed a compact e-beam device that utilizes a secondary emission electron gun (SEEG) for surface decontamination. Some experiments have been conducted to inactivate E. coli with SEEG e-beam. A visiting scientist has come to our laboratory to initiate our collaborative study. Due to its compact and innovative design, the SEEG e-beam can be developed into a household device and likely may be combined with an existing appliance such as a microwave oven. This is our mutual goal and focus of our research collaboration. This household device could work in two modes: microwave - whenever heat is needed and e-beam - whenever non-thermal microbial inactivation is desired. Non-thermal inactivation of food-borne pathogens by the SEEG e-beam could be used for RTE foods such as fresh leafy vegetables. #

Production environment and management practices may impact fish fillet quality attributes, including storage stability. Effects of carbon dioxide level, strain, water velocity, and feeding frequency on fillet yield and quality attributes were evaluated. In addition, effect of production system on psychrotrophic bacteria count and presence or absence of Aeromonas was studied. From day 28 to day 89 of the trial, cook yield and Kramer shear increased. Moisture content decreased after 28 d, fat increased after 28 d, and protein content increased after 56 d. Water velocity or CO2 level did not affect ($P>0.05$) Kramer shear in this study. Fish from the low CO2 treatment were heavier than fish from the high CO2 treatment (568.2 v. 517.3 g). In a second trial, muscle tissue contained more ($P<0.05$) fat when fish were fed 3 times per day compared to once a day (6.55 v. 5.42%). Also, fish were larger ($P<0.05$) when fed 3 times per day (954.0 v. 730.7 g). Higher CO2 level did not change ($P>0.05$) muscle moisture or fat content; however, it decreased ($P<0.05$) whole weights (912.9 v. 771.8 g). Fillet yield was not affected ($P>0.05$) by CO2 level, feeding regimen, or strain.

Rainbow trout and water samples were collected from flow-through, 80% water reuse, and 95% water reuse systems for Aeromonas isolation. Three fish from each

system were rinsed in Buffered Peptone Buffer (BPB). Three additional fish per system were filleted, divided into right and left halves, and halves were randomly assigned to d 1 or d 7 evaluations. Aeromona spp. were isolated according to accepted procedures and presumptive positives were speciated with API 20NE. Psychrotrophic plate count was determined for cores initially and after refrigeration at 4 + or - 2 degrees C for 7 d using plate count agar (PCA) and incubation at 26 + or - 2 degrees C for 48 h. Frequency of Aeromonas spp. detection and psychrotrophic counts were affected by sampling period, and they did not appear to be affected by water reuse. Aeromonas hydrophila and A. sobria were identified with the predominant organism as A. hydrophila. #

Recovery of protein and lipids from seafood by-products will allow development of value added products from what previously was a waste with significant disposal costs. A small lab-scale protein and lipid recovery system was designed and tested. In batch mode, precipitation of myofibrillar and sarcoplasmic proteins was highest at pH = 5.5. Protein recovery yields at acidic pH range approached 90% and at basic pH was generally above 80%. Fatty acid profile (FAP) of trout muscle and the trout lipids recovered at pH = 2, 2.5, 3, 12, 12.5, and 13 was analyzed to determine quality of FA. Trout muscle proteins recovered in the laboratory process were used to develop protein gels. The gels obtained from trout exhibited superior gel strength. The continuous pH adjustment at the pilot scale is feasible, but protein separation following adjustment of pH to 5.5 to precipitate functional muscle proteins is slow due to small protein size. The size of protein particles may be increased by flocculants making protein separation in an industrial decanter-centrifuge more efficient.

We tested protein flocculants for their applicability in the isoelectric solubilization/precipitation recovery system using trout processing by-products. Six commercially available flocculants with different charge characteristics and molecular weights were tested at different concentrations. A high Mw anionic flocculant at 65 ppm resulted in excellent protein separation after 10 min reaction in the jar tester. This flocculant could be injected into the bio-reactor during the continuous adjustment of pH to 5.5, resulting in increased size of proteins, and therefore, more efficient separation during subsequent centrifugation in a decanter-centrifuge. The effluent water from the decanter-centrifuge could be re-used in the homogenization step. #

A commercial trout diet was supplemented with 0 (control), 8.5 or 15% (w/w) of flaxseed oil (FO). Trout were harvested on days 0, 30, 60, 90, and 120. While the total fat levels of fillets were not affected by FO supplementation, the FAP was. The lowest proportion of saturated fatty acids was obtained for 15%, followed by 8.5% FO group, and the control group. Results suggest that the omega-3-enhanced cultivated trout can be raised by supplementing basal diets with 15% FO. #

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:

Due to the chronic nature of osteoporosis, we are using an animal model to evaluate a dietary and moderate exercise treatment regimen that if successful may be applied to a human population. Determination of a safe and effective therapy to alleviate obesity and osteoporosis will have a significant health impact because over 65% of the US population is obese and 77.5% of all postmenopausal women suffer from osteopenia or osteoporosis. Moreover, West Virginia ranks among the highest in the nation for the prevalence of obesity and osteoporosis. Zucker obese (fa/fa) rats (n=10/group) were trained to run on a treadmill for 15 minutes daily. Following treadmill running for 9 weeks, we collected both the tibiae and femur. Femoral and tibial biomechanical strength were assessed using a TA.HDi Texture Analyzer (Texture Technologies Corp, NY) outfitted with a three-point bending apparatus. Following bone biomechanical strength analysis, the whole femur and tibia were ashed at in a muffle furnace to determined total bone mineral content (BMC). Study results indicated that treadmill running for 9 weeks successfully reduced body mass by 10%. Although a weight reduction of 10% is recommended to reduce the co-morbidities associated with obesity, this has also been reported to result in a 1-2% bone loss. Our results showed no significant difference in the BMC ($p=0.02$) or any bone strength parameters ($p<0.05$) measured between the exercise and non-exercised obese rats. We are currently measuring biochemical bone turnover markers and we have developed collaborations with Dr. Marybeth Brown at University of Columbia-Missouri to perform DEXA. DEXA will provide additional insight by allowing us to measure bone mineral density and mineralization of the different regions of bone. The results indicate that treadmill running, although involuntary, is a feasible alternative to voluntary wheel running. However, it appears that exercise by itself fails to have any significant effect on bone. Thus, our next objective will be to investigate the combination of exercising and diet (i.e. soy isoflavones) to develop a successful regimen that will promote weight loss while preventing bone loss in aging women. #

National surveys have indicated that the percentage of overweight children doubles between the ages of three and five years. Early childhood is an ideal time to prevent the development of obesity and foster the development of lifestyle patterns that promote optimal health. Preschool aged children were recruited from Head Start programs, preschools, churches and community groups. Recruitment and data collection were carried out by Extension personnel in the counties. Children were weighed on an electronic scale to the nearest half pound and were measured on a portable stadiometer to the nearest half inch. BMI was calculated using the Centers

for Disease Control and Prevention BMI calculator and BMI percentiles were determined using published growth charts. Children were categorized into three groups, healthy weight, at risk for overweight, and overweight based on BMI percentiles on CDC growth charts. Two-hundred one preschool children from two rural counties were enrolled in this project. They ranged in age from 25.5 months to 71.8 months. About 11 percent of the children were African American with the remainder Caucasian. Thirty-eight (19%) of the children were overweight and another 30 (15%) were at risk for overweight. There were no differences in age or ethnicity among children in each group. Boys were more likely to be overweight compared to girls, while girls were more likely to be at risk for overweight compared to boys. Mother's BMI was significantly related to boys and girls BMI percentile ($p<0.05$), while dad's BMI was related only to the girls BMI percentile. Dad's educational level was significantly related to boys' BMI percentile ($p<0.05$), but not to girls'. There were no other familial factors that were significantly related to BMI percentile in this group of preschool children. Future analysis will look at mother's attitudes about her weight and her child's weight. Data from this study will be used by the Extension Service to inform their on-going nutrition education activities. It will be used to design one or more culturally competent interventions that can be tested for their impact on weight and weight change. It will be used by local schools, community organizations, and policy makers to define the scope of the obesity problem among preschool aged children in this area of West Virginia. #

An on-going project is expected to produce valid, reliable methods for measuring physiological and behavioral components of food intake and physical activity that can be used to systematically explore issues that affect body weight. It will inform the development of culturally sensitive outreach and education programs. Objectives are: 1. To determine valid, reliable measurements of physiological and behavioral factors related to obesity. 2. To examine salient behavioral and physiological factors associated with obesity in the context of related understandings, attitudes, beliefs and perceptions. 3. To develop and pilot test culturally competent interventions for obesity prevention. There are few valid and reliable methods for measuring body composition, physical activity, and dietary intake in children. To address objective #1, we will conduct a thorough review of the literature to identify methods that are valid, reliable, sensitive to change, and feasible. Those methods will be pilot tested in groups of rural Appalachian children. The methods and protocols for examining behavioral and physiological factors associated with obesity (objective #2) will be developed based on the findings from objective #1. In the final year of the project, we will develop culturally competent interventions for obesity prevention among rural Appalachian children based on the findings from objectives #1 and #2. Childhood obesity often tracks into adulthood, increasing the risk for chronic diseases at a younger age. Current interventions have not been effective in treating or preventing obesity. The purpose of this project is to learn more about the biological, behavioral, and environmental factors that contribute to obesity so that we can design effective interventions. #

The positive health benefits of DHA in the diet are widely known, however, it is believed that current consumption levels do not reflect adequate intake. A graduate student has been hired to validate a food survey instrument to be administered at public events later in the year. In addition, methods to produce DHA in laboratory are being tested. One method is by cultivation of a marine alga capable of producing edible oil with a high fraction of DHA. Preliminary growth studies have been conducted at the bench-top level. Data analysis is being conducted currently. #

c) Funding Source: Hatch, State

d) Scope of Impact: Integrated research and extension

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 a 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, forestry and other points of interaction of man and environment. 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 include 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) has been good. 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	557,951
State Funding	501,719
SY's (FTE)	4.7

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 effective remediation programs.

b) Impacts:

An on-going study is using emerging digital soil mapping techniques to represent soil-forming factors for the purpose of quantitatively modeling the distribution of soil properties and classes. The spatial distribution of soil properties (soil depth, drainage class, presence/absence of fragipans) and soil series is being modeled across an 82,500 acre watershed using multivariate statistical analyses. The most successfully predicted soil physical properties are percent rock fragments on the surface and in the profile. The digital soil maps generated by these methods suggest a greater range in variation across these mountain hillslopes than is depicted by published soil survey maps. This research also examines how effects of the scale of analysis influences terrain attributes calculated from digital elevation models and resulting soil-landscape relationships. Results indicate that as lag distance increases, calculated slope gradients decrease (become less steep) and curvatures approach zero (become flatter), with statistically significant differences in terrain attribute distributions in all cases. Correlation coefficients between terrain attributes and selected soil properties are also sensitive to the scale of calculation. Slope gradient is most correlated with selected soil properties at shorter lag distances. Slope curvature is always most correlated with selected soil properties at lag distances greater than 10 m.

A second project is being conducted to better understand the complex mosaic of soil moisture and temperature conditions in West Virginia. A terrain regression modeling approach was coupled with the Newhall Simulation Model to generate surfaces of soil temperature and moisture regimes, soil biological windows, and agroclimatic parameters (growing degree-days, frost-free period, and temperature minima). Results indicate that cryic temperature regimes and perudic moisture regimes are present in West Virginia, particularly at the highest elevations in the state. More extensive areas of frigid temperatures are also present.

A third project examines the roles of geospatial technology to investigate and define complex soil-landscape-climate relationships as part of soil survey updates. Geospatial tools, databases, and expert knowledge are being used to build geomorphometric rule structures that will guide investigation and mapping of two soil series--Nolo and Germania, in the process of updating an older soil survey in Potter County, PA. The application of this research has great potential for advancing soil survey activities and knowledge of quantitative soil-landscape relationships, primarily through the development of strategies for incorporating quantitative spatial procedures into soil survey methods. In the next generation of soil survey updates for West Virginia, the availability of digital elevation models, particularly those at fine resolutions, provides the base to apply terrain regressions that describe the functional relationships of terrain characteristics (e.g., elevation, slope gradient, slope aspect, slope curvature) to soil physical and chemical properties, soil classes, and soil climate characteristics. In particular, the methodologies used are able to successfully identify soil-landscape relationships at the watershed scale using a relatively small number of samples. However, when developing multivariate statistical soil-landscape models, our results indicate that including terrain attributes calculated at different scales can improve the quality of statistical models. #

Work has continued on three hydropedology-related projects. The first ("Hydrologic and Morphologic Characterization of Seasonally-Saturated Soils for Improved Land Use Evaluation") is a traditional water table monitoring study in cooperation with the USDA Natural Resource Conservation Service (NRCS) and the USDA Forest Service, looking at multiple soils of local importance in West Virginia where soil morphology and observed or inferred hydrology do not agree, thus presenting problems for classification or interpretation. We have installed 21 specially-designed monitoring wells (maximum water table recording devices, or MWTRD) in 12 different soils at 11 different sites around West Virginia. Specific sites include: (i) soils with perched water tables above fragipans, (ii) high-elevation soils in the frigid soil temperature regime, (iii) soils with perched water tables above slowly permeable clay layers, and (iv) soils with perched water tables above shallow bedrock.

The second project ("Phosphorus Sorption Capacity of West Virginia Soils: Spatial Assessment and in situ Leachability") investigates the occurrence (or lack thereof) of deep leaching and preferential flow of phosphorus into and through the subsoil of benchmark West Virginia soils. A field study is being conducted in cooperation with the NRCS to assess the role of natural structure and preferential flow on the movement of phosphorus through undisturbed soil profiles. To date, five plots (with two replicates each), representing two benchmark soils have been analyzed through the application of dye to the soil surface. Preliminary results indicate that all plots exhibit preferential flow, with the percent area stained by dye decreasing with depth. Extractable P levels are higher in the stained soil in four of five plots, but only significantly higher in one plot.

A third project ("Seasonal Infiltration and Subsurface Water Dynamics across Benchmark Soil Catenas of Eastern West Virginia") involves studies of infiltration and saturated hydraulic conductivity on benchmark soils that represent regional soil conditions and land use practices. This watershed-scale study in cooperation with the NRCS assesses soil hydrology across major landforms within a single watershed. A watershed in Hardy County, WV, has been selected for study and potential field sites have been identified. Information generated from the water table monitoring and water dynamics studies will be used to document the depth and duration of seasonally-high water tables and improve our understanding of water redistribution across typical landscapes in West Virginia. Results will be used to support forest management planning, revise soil use interpretations, and otherwise characterize water table dynamics for interpreting the presence of redoximorphic features. Data from the phosphorus leaching study will assist in making more accurate decisions on land applications of high phosphorus wastes, such as poultry litter, thus reducing environmental hazards. #

A continuing study of mineral cycling is focused on the element calcium. We are utilizing the small watershed approach whereby two contrasting watersheds with hardwood forest cover are being studied. Calcium is both more abundant and more mobile in watershed I, which is a north-facing watershed with mesophytic hardwood cover type. In watershed II, the forest cover is primarily oak and the amount of calcium measured in soil, and stream water is lower than in WSI. We have determined that the lower mobility of Calcium in WSII is associated with the litter decomposition and cycling rates, which are incomplete on an annual basis, compared to more rapid and complete decomposition in WSI. #

The sorption and transport of three non-crop herbicides (bromacil, hexazinone and imazapyr) were determined in saturated column studies using limestone as the sorbent. These compounds passed through the column with the water front; there was no discernible interaction between these herbicides and the limestone surface. There is a need to develop technologies to treat chloride from deep mine drainages. We evaluated one proposed technology- sorption to precipitating acid mine drainage solids for the WV Water Resources Institute. #

Surface mining in West Virginia has disturbed large tracts of forested land. In the 1930 to 1960s, reclamation generally involved replanting of trees on mined sites, but revegetation practices gradually evolved into seeding of forages for erosion control as federal and state laws were enacted in the 1970s. Reforestation of mined lands has recently become an important issue and both federal and state regulatory agencies are returning to forestry as a preferred post-mining land use. This study evaluated tree species recruitment and growth on three, 20-year-old, surface mined areas that were not transplanted with trees. Three transects of 150 m at each site extended across three positions: 1) the flat top after coal removal, 2) the outslope down from the flat top where soil and weathered rock materials had been pushed down the hill, and 3) the undisturbed forest. Tree canopy cover and herbaceous cover were determined at 1.5-m intervals along the transect line, and tree density and diameter at breast height

were measured for each species located in a plot 2.3 m wide along the line. Soil samples were taken to a depth of 25 cm at 15-m intervals along transects. Soils in all positions generally had loam textures, and soil pH ranged from 4.6 to 6.0 on undisturbed and outslope positions to 6.1 to 6.6 on flat tops. Soils were noticeably thinner and denser on flat tops than in other positions. Undisturbed forests averaged 85% canopy cover and were dominated by tuliptree (Liriodendron tulipifera L.), red maple (Acer rubrum L.), and sugar maple (Acer saccharum Marsh.), with minor contributions from red oak (Quercus rubrum L.), black gum (Nyssa sylvatica Marsh.), sourwood (Oxydendron arboretum (L) DC), sassafras (Sassafras variifolium (Nutt. Nees), and hickory (Carya spp.). Outslopes had primarily red maple, black birch, tuliptree, sourwood, and black locust (Robinia pseudo-acacia L.). Flat areas were dominated by herbaceous cover with red maple and black locust being the dominant trees. Areas seeded with herbaceous plants showed low numbers and cover by trees, while areas not seeded with herbaceous plants were almost as heavily covered by trees as undisturbed areas. New guidelines are being developed to aid survival and growth of mid to late-successional trees on newly-reclaimed sites. These include less compaction of soil materials and seeding less aggressive forage species where trees will be planted. #

In the spring of 2001, a research study was initiated in northern West Virginia to examine the establishment and growth of commercial hardwood trees on a reclaimed surface mined site. Fluidized bed combustion fly ash was placed on the surface and topsoil was spread over the layer of fly ash. We used ripping to break up the hardened layer of ash under the topsoil. We planted seeds and 1-0 seedlings of five hardwood species [red oak (Quercus rubra L.), black cherry (Prunus serotina Ehrh.), black walnut (Juglans nigra L.), white ash (Fraxinus americana L.), and yellow-poplar (Liriodendron tulipifera L.)] into north- and south-facing aspects, ripped and unripped minesoils, and mowed and unmowed groundcover. First and second year results showed extremely high survival of planted seedlings (>95% for all species) and seedling establishment from seeds was about 16% for black walnut and <5% for the other species. By the fifth year, black cherry survival averaged 37% for seedlings and 4% for seeds across plots, red oak was 46% and 2%, yellow poplar was 66% and 0%, black walnut was 81% and 36%, and white ash was 99% and 1%. Average height of trees was greatest with white ash (89 cm), followed by black walnut (65 cm) and yellow poplar (67 cm), then by red oak (45 cm) and black cherry (40 cm). In general, seedling and seed survival was best on north, ripped, and unmowed plots. This study confirms that trees can grow on sites where FBC fly ash has been applied and therefore we do not have to dispose of this fly ash material into land fills or other places where it may effect surface and ground water quality. #

The ecology and etiology of the opportunistic pathogen Enterobacter sakazakii is not well understood. In this regard, we have initiated efforts to determine the possible presence, distribution, and survival of E. sakazakii in aquatic environments. Preliminary in vitro survival studies conducted with laboratory microcosms suggest prolonged persistence during exposure to groundwater held at 10, 20, and 25 degrees C (approximate two-log reduction in survivors after three months). Viable cells

continued to be detected after more than 12 months at the 25 degree C temperature. Enterobacter sakazakii was more sensitive to a colder water temperature of 4 degrees C as reflected by a four-log reduction in survivors after three months of exposure. In addition, we evaluated the effectiveness of a presumptive differential/selective culture medium for the detection of E. sakazakii from surface water streams. Although the medium permitted successful isolation of the bacterium, further studies are required to improve the sensitivity and selectivity of the medium. We are currently identifying several antagonistic bacteria that gave false-positive results on the growth medium. Identification of antagonists could assist in the development of a new medium with increased inhibition of interfering false-positive bacteria.

In a related study, we are evaluating the effectiveness of a substrate utilization profile testing system (BIOLOG) as a potential assay for the physiological response of bacteria to environmental stress. Following thermal stress of E. sakazakii at 52 degrees C, substrate growth patterns were significantly different from control cells not exposed to heat. In particular, an increased uptake of the substrates glycogen, D-galactose, and lactulose with a corresponding decrease in uptake of alpha-keto valeric acid and i-erythritol was observed for thermally stressed cells compared to control cells. We intend to use these findings to design a culture medium with enhanced sensitivity and selectivity for the detection of E. sakazakii following a variety of environmental stresses. #

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 Practices of Agriculture and Forestry

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

b) Impacts:
Bird populations and forest vegetation were monitored before (1984-86), during (1987-88) and after (1989-1999) a gypsy moth (Lymantria dispar) outbreak. Subsequent sporadic increases in gypsy moth abundance have occurred since then. The study site location was the Sleepy Creek Wildlife Management Area in Morgan and Berkeley counties, West Virginia. The cumulative result of insect damage has been the breaking up of a fairly contiguous stand of mixed hardwood forest formerly occupying the ridge, mid-level, and riparian zones of Sleepy Creek Mountain and adjacent Third Hill Mountain. This has left a mosaic of habitat types ranging in structure from unbroken canopy stands to high tree mortality areas that exhibited immediate understory release of light tolerant densely spaced plant species. The main purpose of this study was to document changes in bird populations as they related to change in vegetation structure. In addition, nesting data were collected for four focal bird species, Acadian Flycatcher (Empidonax virescens), Indigo Bunting (Passerina

cyanea), Eastern Towhee (Pipilo erythrophthalmus) and Wood Thrush (Hylocichla mustelina) in order to document, among other things, the level of nest parasitism by Brown-headed Cowbirds (Molothrus ater) and the possible role of vegetation structure in nesting success. Summarizing the results- 1.) populations of 21 species of birds (ground or shrub nesting species) increased over the study period, 2.) 12 species showed no significant change in population levels, 3.) while 5 species declined, 4.) despite > 40% reduction in overall density of large overstory trees, bird species associated with this habitat type [e.g. Cerulean Warbler (Dendroica cerulea) and Scarlet Tanager (Piranga olivacea)] did not decrease, 5.) Indigo Bunting nests suffered higher brood parasitism rates in areas that were defoliated, while Wood Thrush nests were more successful in areas with high foliage cover, 6.) Nest patches of all four species differed in vegetation characteristics from random plots in similar habitat, indicating that birds may seek key features for nest placement within a generally suitable habitat type, 7.) the combined abundance of 11 snag/cavity nesting species [e.g. Pileated Woodpecker (Dryocopus pileatus) and Red-bellied Woodpecker (Melanerpes carolinensis)] increased greatly over the first 10 years, corresponding to an increase in dead standing trees, while these populations declined at the end of the study as the dead trees fell over and became unusable. #

Organic livestock production restricts the amendment of feed with antimicrobials and dictates that organic animals must be fed only certified organic grains. USDA organic livestock standards include requirements for pasture and access to the outdoors suitable to the natural nutritional and behavioral needs of the animal. Organic farming methods often include rotational grazing to reduce the presence of pathogens in the grazing areas. It is unknown whether this rotational grazing allows adequate time for pathogen reduction in the soil. We have performed preliminary work to assess antibiotic resistance analysis (ARA) and rep-PCR fingerprint patterns using bacterial isolates of Escherichia coli and Enterococcus sp. obtained from poultry and sheep raised using both organic and conventional production methods. We expect that there will be significant differences in the ARA and rep-PCR fingerprints of E. coli and Enterococcus under organic versus conventional production methods. We will analyze the persistence of E.coli and Enterococcus in the soil of the WVU Organic Farm rotational grazing areas for poultry. The working hypothesis is that E.coli and Enterococcus will not persist in grazed areas for longer than the alloted "off" periods. Genotypic and phenotypic profiles of the soil bacterial isolates are expected to be be similar to those obtained from the source animals. #

Experiments have been conducted to evaluate the growth and nutrient removal characteristics of cool and warm season plants grown in aquaculture effluent. Initial experiments, conducted in a building enclosing the fish raceways, determined that a simple paper towel support was the best culture medium. However, the light environment was insufficient in the raceway building to grow marketable plants. An abbreviated set of experiments were conducted in a newly constructed greenhouse located adjacent to the raceway building. Experiments were conducted in the winter and spring to evaluate growth and nutrient removal at varying water velocities and plant densities. Watercress and lettuce were chosen as the cool season and basil and

dill as the warm season plants. Experiments were conducted in the winter, spring, and summer. In the winter experiment, watercress grew well, lettuce grew poorly and basil failed to germinate. In the spring and summer experiments, watercress and lettuce grew well however the basil grew poorly. Dill failed to germinate in all experiments. Plant growth was monitored, and plant nutrient and water quality samples were collected throughout each experiment. Data are currently being analyzed. #

The objective of this research is to determine habitat components governing brook trout population dynamics in the central Appalachians at both large spatial and temporal scales. Large spatial scales (i.e. many streams) allow greater statistical power in analyzing typically highly variable stream habitat data and large temporal scales (i.e. several years of study) will allow incorporation of habitat-independent factors affecting brook trout population dynamics. Also, a long-term study could show the interaction between stream habitat and population recovery from extreme environmental conditions (drought and flood). Coupled within this long-term framework, manipulative studies may further elucidate relations between fish and streamside management. Within the major research objective, we also want to focus on fish habitat relationships at the individual level. These aspects include determination of adult brook trout habitat use versus availability and how this influences brook trout movement; and to examine food availability and hence production potential for brook trout in streams of differing riparian community structure and stand dynamics. As a by-product of this research we will also determine the range of stream conditions available in the region and begin to understand the sustainability of such systems over the long run.

Fish collections have taken place on all streams during fall to assess both adult use and young-of-year recruitment from the previous year. Collections were made using electrofishing and removal sampling. Fish samples were completed in fall 2003, 2004, 2005, and 2006. Habitat measures were collected during summer base flow conditions. During 2003 8 streams were sampled for habitat and during 2004 the remaining 17 streams were completed. In 2005 we began the second round of habitat sampling with 12 streams measured. The remaining 13 streams were assessed for habitat in summer 2006. Spawning substrate samples were collected from all study streams each fall during fish surveys. All samples from 2003-2006 have been dried and processed through a series of Wentworth sieves to evaluate the levels of fine sediments in each stream. These data presently are being related to subsequent recruitment of young-of-year brook trout from 2003 (assessed in 2004), 2004 (assessed in 2005), and 2005 (assessed in 2006). Short-term studies have also been conducted as part of this project. In 2006 field collections for a study was completed that examined size structure and age and growth of brook trout from across the 25 streams and watersheds included in the long-term studies. Growth rates differ among the streams and these differences are currently being explored with respect to geology, habitat and other variables. #

In 2006, we completed the second and final field season of data collection for the development of a state wide wetland Index of Biotic Integrity (IBI). To complement the 68 sites surveyed in 2005, we added an additional 83 sites distributed across the spectrum of human impairment within a mixture of public and private domain. This brings the total number of sites for two years of field work to 151. Data analysis is in progress. There were 682 species of plants, 119 species of birds, and 13 species of anurans identified throughout the study. In addition to this, over 350 specimens of dragonflies were captured for inclusion in the West Virginia Odonate survey. Preliminary results indicate that the metrics we have chosen are sensitive to environmental disturbance. Moreover, these indices appear to be affected by landscape-level land use. Our results can be used to increase the success of restored and created wetlands in West Virginia. Our work also can be used to implement a monitoring system to evaluate the changes in wetland function over time. Our research will result in enhanced wetlands function and an increase in wetland ecosystem integrity. #

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 for many rural West Virginia communities. 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	**448,440**
State Funding	**632,116**
SY's (FTE)	**6.7**

Key Theme 4.1 – Enhancing Economic Development in Rural Communities

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

b) Impacts:

We conducted an assessment of 32 communities and 10 counties within a ten mile buffer of the Monongahela National Forest. The purpose of the assessment was to characterize the social and economic environment of the Monongahela National Forest by showing the relationship and linkages between National Forest System land and communities through development of a social weather map. Of interest were two "hot spots" of social change identified on the map. First, the population in Hillsboro, WV is up 30% since 1990, and the median household income is the highest of any of the communities in the study extent. Second-home growth in the area is the highest in the state of West Virginia, and Snowshoe Mountain resort appears to be the driving factor behind this growth. Second, the recreational development of Deep Creek, Maryland (also considered as a popular recreation destination) is slowly migrating southwest and into the northern communities of the Monongahela National Forest and near the Spruce Knob/Seneca Rocks National Recreation Area. #

To help create a Forest-wide trail management plan for the Monongahela National Forest, we conducted a series of reviews, public meetings and associated research projects. The first phase of this planning process, an analysis of existing conditions, has been completed. Preliminary findings indicate that most observed trail erosion (measured as maximum trail incision) occurred on Mandy soils (53%) and in Coves (31%). Pottsville geology also accounted for 64% of all eroded trail segments. Large portions of erosion were also found in areas of human disturbance (power lines, roads and strip mines) and areas with open canopies. #

Hybrid striped bass were stocked at three pay fishing sites as a part of different recreation program formats to evaluate the impact of customer satisfaction and consequent business success. On-site observations and questionnaires were used to measure success of the stocking venture which added hybrid stripped bass to ponds already containing hybrid bluegill. Hybrid stripped bass were hard hitting and aggressive when first stocked but later became hook shy. The average respondend to questionnaires caught one bass per hour. Over 80% of participants were willing to pay $10 per child to experience this fishing experience. #

Knowledge of the extent to which and ways in which local governments provide local services – including the extent to which they work to pool productive resources – is vital for fiscal sustainability. To investigate the impacts of spatial spillover effects in the determination of local public spending, a spatial autoregressive model with spatial autoregressive disturbance was developed. The model was estimated by Generalized Spatial Two-Stage Least Squares estimation using county-level data from Appalachia for the 2002 fiscal year. The conventional (non spatial) model of local public expenditure determination was also estimated by Ordinary Least Squares estimation and the spatial lag, as well as the spatial error models by Maximum-Likelihood estimator. On the basis of the Ordinary Least Squares estimates, test statistics were developed to test for the existence of spatial lag or spatial error dependences in local public expenditure determination. Moran's I test statistic indicated the existence of spatial dependence in our data. The Lagrange Multiplier test statistics further indicated that the spatial error model was more appropriate than Moran's I test statistic. Given the finite date set, it was difficult to consistently estimate this model by maximum likelihood estimator because the basic assumption upon which the maximum likelihood estimation is based, normally distributed error terms, was not fulfilled as indicated by the Jarque-Bera test statistic. Since the Generalized Spatial Two-Stage Least Squares estimator does not require a normal distribution on the error terms, it is more efficient under this circumstance. Thus, analysis was based on the Generalized Spatial Two-Stage Least Squares coefficients.

It was found that counties in the study area were not engaged in strategic interaction in the determination of local public expenditures. The coefficient for the spatial lag dependent variable was negative but insignificant, indicating the copy-cat effect was not important. This result also indicated that the political agency yardstick competition model was not relevant in explaining the spatial interactions among local governments in Appalachia during the study period. The coefficient for the spatial error variable was, however, positive and highly significant. This shows the positive interdependences in local public expenditures through spatial error process, which could simply be because the local governments at the county-level in Appalachia are hit by a common shock. Population density had positive and significant effect on local public expenditure per capita and there was a positive and significant effect of per capita income taxes on per capita local public expenditure. The effects of demographic variables and long-term government debt were, however, found to be insignificant. #

Poverty and food insecurity are challenging socio-economic problems that policy makers have attempted to address for a long time. Among other things, providing financial and in-kind assistance are some of the initiatives taken to improve food security for low income households. The Food Stamp Program (FSP) is an important assistance program that serves to meet this goal. The objective of this study was to examine the implication of economic and policy variables on food stamp participation in West Virginia. To understand the current and lagged impact of economic variables on current food stamp participation, static and dynamic econometric models were used. These models were estimated using panel data of West Virginia counties.

Results indicated that county poverty levels affect the degree of county dependence on FSP with an increase in county poverty resulting in an increase in FSP participation. Likewise an increase in current and lagged county unemployment rate increased the degree of dependence on food stamp programs. In contrast, lagged employment growth tended to decrease FS dependence. However, both lagged and current county income growth did not seem to deter participation in the FSP. Cost of living in general affected participation in county welfare programs and specifically, increases in the lagged consumer price index, were associated with increasing FSP participation. Welfare program policies can have impacts in terms of flow of county welfare participants. PRWORA policy aims at limiting food stamp benefits to certain beneficiary groups. Based on the dynamic model result, this policy is associated with reduced food stamp participants in West Virginia. Unlike the findings from previous studies, the result of the dynamic model indicates that the degree of FSP participation decreased during the Democrat governors' period. A region specific participation comparison indicates that significant regional differences in the degree of FSP participation in West Virginia. #

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

b) Description: Research focused on use of state resources to improve quality of life for state citizens

c) Impacts:
Outdoor recreation can afford restorative experiences such as opportunities to reduce stress, promote more positive moods and feelings, and facilitate recovery from illness. As health benefits associated with recreation become increasingly more important in our society, it is helpful to understand whether and how trail design and resource impacts of recreational areas influence the quantity and quality of restorative experiences recreation managers provide. The purpose of this study was to identify predictors of restorative character on trails and to recommend management actions that enhance restorative experiences. Over 30% of study responses indicated that walking through mud, walking over/maneuvering around trees across trails, leaving park-like stands of trees, walking on eroded trails, walking on undefined or wide trails are associated with low restorative character. These types of negative events significantly ($p<.05$) reduced the overall quality of the simulated hiking experience. #

Public perception of forest health is often based on first impressions of an environment's appearance, and changes when forest users gain experience and appreciation of ecosystem processes that are maintained by sustainable forest management. This development of perceptual skill was documented in the final chapter of Leopold's (1981) Sand County Almanac. Leopold argued for a conservation esthetic where the perception of scenic beauty is tied to an

understanding of the natural processes of forests. The purpose of this pilot study was to test if perception of scenic beauty is related to pre-experience education. We supported the hypothesis that students who have undergone educational programs related to forest ecosystems have a more positive perception of the forest as displayed in video clips of forest settings. Results of this project will guide us in developing forest-based educational tours and evaluating the effectiveness of woodland workshop techniques. #

This project is designed to determine attitudes and behavior regarding historic preservation in order to better maintain historic landscapes in rural West Virginia and assess potential opportunities for economic development by promoting historical tourism. A West Virginia case study of a proposal to move a historic mill from its original location to one more convenient for tourism is being used as the context in which to examine historic preservation issues. While historians believe that preserving a historic building in its original location is important to maintain its historic integrity, the general public's opinion is unknown. To examine the importance the general public places on historic authenticity a questionnaire was mailed to 1000 households within the region of the mill that might be moved.

Survey responses showed that individuals were aware of historic resources in their counties and believe that preserving historic places in their area is very important. Reasons given for preserving historic places were for the benefit of future generations, for educational purposes, and for tourism. Very few had heard of a historic building being relocated and most believe that it was important to preserve a historic building at its original location, although it is acceptable to relocate a historic building in order to protect it. In order to determine if individuals are willing to pay for historic integrity and to place a value on historic authenticity in this case, households were asked if they would make a donation to preserve this particular historic mill at its original location. Less than a majority were willing to donate to preserve the historic integrity of the mill. We found that household income, importance placed on historic preservation, familiarity with the mill, a belief that non-profit groups should be in charge of preserving historic buildings, and intention to visit the mill in the future all had a positive impact on willingness to pay for historic integrity. Those that believed it is acceptable to move a historic building for visiting convenience would not pay to maintain the mill in its original inconvenient location. It is not clear that the economic value placed on historic integrity in this case would be sufficient to protect this rural historic resource. #

White-tailed deer, bear, and beaver populations have exceeded sociological and biological carrying capacity in many areas of the United States and are causing nuisance problems. The result of this overabundance has been a decline in ecosystem function and conflicts with man. Black bears are increasingly causing nuisance problems for people as black bear populations thrive and people continue to encroach upon black bear habitat. During 2003, 11 males and 1 female black bear were captured and fitted with radio collars. Individuals were randomly assigned to receive either treatment (n = 6) or control (n = 6). Upon release, treatment individuals

received a conditional regimen comprised of rubber buckshot to the flank and a succession of shell crackers. During the first 2 hours following release, bears became sessile and remained stationary for 24 hours. Four days after treatment all bears appeared to resume normal movements. Based on direct observations all control and treatment bears resumed nuisance activity within 2 weeks of release. The physical and auditory conditioning techniques we used did not appear to be an effective means of reducing repeat nuisance behavior. Controlling food availability may be the best way to limit nuisance behavior. #

A study was conducted to determine returns from the investment of public funds to provide recreational opportunities for citizens. The objective was to assist policy makers make informed decisions on public expenditures for the construction of recreational facilities and outdoor recreational projects such as the construction of hiking and biking trails. Results showed a significant positive relationship between access to recreational opportunities and voluntary exercise by citizens and a negative relationship between access to recreational opportunities and health related expenditures for cardio-vascular diseases. #

A newly instituted study will assist recreational managers in understanding why some racial/ethnic minorities participate in outdoor recreation activities while others do not. This will be an important consideration for natural resource managers in the upcoming decade. Many outdoor recreation areas were designed for traditional US recreationists, often consisting of Caucasian families and friends. It has been well-documented in the recreation literature that non-traditional users (ethnic/racial minorities, persons with disabilities, etc.) may be overlooked by managers without a concerted effort to pursue these potential recreationists. If the National Forests are to remain relevant to these potential recreation users, the motivations, constraints, and negotiation strategies of these users, or potential users must be understood. In particular, what constraints do non-traditional users perceive and experience in recreating in National Forests and how are they different from traditional users? What is their motivation level with regards to outdoor recreation participation, and what negotiation strategies do they use that enables their participation? The purpose of this study is to examine the motivations, perceived constraints, negotiation strategies, and the visitor experiences of non-traditional users in forest recreation settings, and potential forest users who do not currently recreate in these settings. #

d) Source of Funding: Hatch, State

e) Scope of Impact: Integrated research and extension

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 Consumer Sciences) since we share a large majority of stakeholders. We discontinued special meetings which had as their sole purpose, the gathering of stakeholder input and instead, have more recently relied upon 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 has been acted upon, is to develop and distribute cost-of-production and income budgets for individual vegetables in addition to those for the entire "market garden" as had been the previous 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 usually broadens to include many academic and outreach concerns which are linked to research. A suggestion from the Advisory Board which has been adopted, strongly encouraged Davis College administration to work more effectively with their counterparts in 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 during 2006 participated in 10 Northeastern regional research projects, five projects from the Southern region, and one project in each of the Western and Northcentral regions. Subject matter of the research ranged from breeding improved forage crops (for feed and/or biomass), to developing TMDL assessment tools, to management of wildlife damage, to developing obesity assessment, prevention and intervention programs.

West Virginia scientists participate in a Southern regional project 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-1016 is investigating the impacts of international trade agreements and domestic policy on regional agricultural businesses. 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 Attachment D 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 0economic 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. ***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.
4. ***Transition to Organic Production*** evaluates alternative methods of transitioning from traditional to organic methods of producing vegetables and small animal products measuring costs and returns from alternative methods of fertilization and pest control.
5. ***Improve Reproduction in Livestock*** develop and support integrated management systems which contribute to increased reproductive efficiency for beef and sheep producers.

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

Fiscal Year:__2006__

Select One: ☐ **Interim** **X Final** Final
Institution: West Virginia University
State: West Virginia

	Integrated Activities (Hatch)		**Multistate Extension Activities (Smith-Lever)**		**Integrated Activities (Smith-Lever)**
Established Target %	25%	**%**		**%**	
This FY Allocation (from 1088)	$ 2,404,641				
This FY Target Amount	601,160				
Title of Planned Program Activity					
Pasture Livestock Production	$147,428				
Competitive Poultry Industry	134,553				
Improve Water Quality	151,793				
Transition to Organic Production	104,748				
Improve Reproduction in Livestock	308,551				
Total	$847,073				
Carryover					

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

Director **Date**