FY 2001 ANNUAL REPORT OF ACCOMPLISHENTS AND RESULTS

West Virginia Agricultural and Forestry Experiment Station
College of Agriculture, Forestry and Consumer Sciences
West Virginia University

Plan of Work for 2000 – 2004

A. Planned Programs

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

Overview

A principle goal of research conducted in the West Virginia Agricultural and Forestry Experiment Station is to contribute to economic development of state industries of agriculture and forestry and to enhance the quality of life of state citizens. The focus of Station research is on economic activities for which West Virginia conditions provide some degree of competitive advantage. Examples of state resources which offer actual or potential advantage include an expanse of exceptional hardwood forests; a topography, soil and climate well suited to the production of forages and/or pasture-reared livestock; a rich history, scenic beauty, abundant wildlife and varied recreational opportunities which are highly attractive to tourists; extensive water resources well suited to the production of cool and cold water fish for food or recreation; and a proximity to large urban population centers for standard and/or niche marketing of agricultural or forest products.

West Virginia's forests and grasslands are among the state's most unique and valuable natural resources. Critical to effective management of the former are methods to accurately and efficiently inventory, classify and assess maturity of forest cover and to react appropriately to potentially extreme attacks by disease or insect pests. Recent research conducted in the West Virginia Agricultural and Forestry Experiment Station has developed a digital imaging system for species typing in Appalachian hardwood forests which is significantly more accurate than conventional aerial photography. Additional work has defined potentially effective treatments for Chestnut blight which may at least partially restore this species which once dominated Appalachian hardwood forests.

Hatch supported research to enhance profitability of low input, pasture-raised beef cattle and sheep has developed a genetically modified endophyte fungus which successfully colonizes fescue symbiotically but does not produce the ergopeptines toxic to livestock. Additional work has optimized supplemental concentrate feeding of grazing animals for maximum fiber intake and has documented the cost efficiency of pasture feeding and the benefits of rotational as opposed to continual grazing.

West Virginia's natural and human resources are ideal to support economically strong recreational and food aquaculture industries. Research supported by Hatch funding and by Special Research grants has developed strategies to market family vacation fishing packages through state resorts, hotels and parks and has addressed several production problems faced by producers of cold water species for human consumption. Among these are the use of impaired mine water sources for aquaculture, improved methods for managing fish waste, and the development of a new, light-weight raceway structure for raising trout and charr.

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 reducing costs of treatment for disease and insect pests and on assuring adequate pollination by natural populations of honey bees threatened by Varroa and tracheal mites.

Excellent progress has been made toward achieving the objective of Program 1 (National Goal 1). Efforts to establish a state-wide aquaculture industry and to enhance the low input production of pasture raised livestock for conventional and niche markets have been particularly successful.

Expenditures and SY for Program 1 (Goal 1)

Source	$ or SY
Formula	997,497
State Funding	**2,117,921**
SY's	**11.8**

Key Theme – Forest Management and Wood Products

a) Description – Research to enhance sustainable logging, value added wood product manufacture and tourism.
b) Impacts – High resolution digital imaging of forest cover was found to be considerably more accurate than analysis of conventional aerial photographs in identifying tree species. Digital imaging exceeded 70% accuracy and was particularly useful in identifying economically important species such as black cherry and oak. Resolution of approximately two meters was found to be most efficient with accuracy gained from higher resolutions insufficient to offset greater computational time. The ability to accurately and efficiently inventory hardwood forests is critical to profitable and sustainable forest management.

   Two hypoviruses have shown some ability to control blight in the American Chestnut. Reduced growth of blight cankers inoculated with hypovirus has occurred in successive years. The hypoviruses examined spread readily from inoculated to non-inoculated cankers on the same tree but less readily from tree to tree. The hypovirus more effective in controlling canker growth was most effective when

inoculations were made in Spring. Periodic removal of competing vegetation reduced tree mortality due to blight but only after practiced for extended periods.

c) Funding – Hatch, McIntire-Stennis, State
d) Scope of Impact – Multi-state Research
CT, MA, MD, NJ, NY-G, NY-I, PA

Key Theme – Utilization of Grasslands

a) Description – Employ extensive state grassland resources for sustainable, cost efficient production of forages and livestock
b) Impacts – Successful elimination of ergovaline content from endophyte fungus living symbiotically with grass fescue has eliminated animal toxicity by knockout gene techniques. Results showed no reduction in the ability of ergovaline deficient fungi to colonization fescue or to negatively impact fescue fitness. Genetic elimination of fescue toxicoses will yield a significantly more valuable forage for low cost livestock production.

Both forage intake and fiber digestion of grazing cattle supplemented with concentrate a showed significant interaction between time of supplement feeding (morning vs. evening) and pasture sward height, as well as a an interaction between duration of supplemental feeding (12 or 24 hour availability) and pasture sward height. Results allow improvement in animal production efficiency if timing of supplement feeding is adjusted for sward conditions and available grazing time.

Cost of gain for commercial calves reared on pasture-only was approximately one-half ($.44 vs. $81/kg) that for calves fed a combination of pasture and limited concentrate. Additionally, rotational grazing produced 17% more calf gain/ha/year than continuous grazing. Pasture is an efficient, low cost, stainable source of animal growth which can be enhanced with minimal pasture and grazing management.

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 – Aquaculture

a) Description – Assess potential and develop best aquaculture practices and provide support for the establishment of food and recreational fish production enterprises.
b) Impacts – Surveys of in-state and out-of-state recreation fishermen, as well as state fee fishing operators has demonstrated considerable opportunity for the establishment of fee fishing enterprises within West Virginia. Opportunities exist to serve customers with both primary and secondary interest in fishing. The latter (e.g., family vacation including but not exclusively focusing on fishing) will be developed with state motels, resorts and state parks.

Production costs for trout generally were less in raceway management systems than in tanks (sizes ranging from 2,500 to 100,000 lbs per year). Additionally, significant economies of scale were found to exist for raceways but not for tanks. Computer aided design was used to design and produce drawings of a light-weight, durable raceway constructed of a honeycomb fiber-reinforced polymer (HFRP). Topography appropriate to provide no-cost water flow (vs. pumping) afforded obvious but substantial cost advantage. Findings will contribute to the development of food and recreational fishing industries in West Virginia.

Preliminary results indicate trout can be successfully reared in treated acid mine waters and that there is no detectable accumulation of toxic metals (mercury, lead, cadmium, etc.) in the fish. Raising cool water fish represents a potential way to at least partially recoup cost of mandated remediation of water quality in previous mine sites.

Volume of waste from concentrated trout rearing facilities is influenced by several factors including amount and type (pelleted vs. extruded) of feed, how and when feed is delivered, etc. Filtration was the most cost effective of waste disposal options examined, adding approximately $.05 per pound to the cost of trout production. If left untreated, costs for downstream remediation were estimated to be $.22 per pound of trout produced.

A survey of health in West Virginia trout production facilities showed relatively low incidence of several fish diseases (identified on 0 to <10% of farms) but found producers should exercise most caution with respect to Whiling disease (25% of farms), bacterial kidney disease, and furunculosis (both approximately15% of farms).

c) Funding – Hatch, State and Special Research Grant.
d) Scope of Impact – Integrated research and extension

Key Theme – Agricultural and Forestry Profitability

a) Description – Support state economic development of agricultural and forest industries with focus on activities on activities offering competitive advantage to state producers.
b) Impacts – Susceptibility of 23 apple cultivars on two rootstocks (MARK and M.9 337) to 13 arthropod pests showed lowest susceptibility overall for Sansa and Pioneer Mac cultivars and greatest susceptibility for Shizuka and Cameo; susceptibility was lowest on MARK rootstock. Results provide producers with controls alternative to chemical use.

   A modified, four-part protocol was developed for treating honey bee colonies infested with Varroa and tracheal mites. The protocol was shown to maintain levels of infestation well below threshold injury levels without resorting to synthetic acaricides.
c) Funding – Hatch, State

d) Scope of Impact – Multi-state research
CT-NH, MA, ME, NH, NJ, NT-G, NI-I, PA, VT

Program 2 (National Goals 2 & 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 relationship between the goals and the relatively small sized of this program in West Virginia. The focus of research related to this goal is on food quality and safety, on concerns with potential accumulation of toxic substances in soils and water, with subsequent entry into the human food chain, and on the nutritional status of rural, low income families, especially pregnant women.

Abundant supplies of cool water of nearly constant year-round temperature, as well as easy access to large urban markets, offer West Virginia cool water aquaculture producers potential competitive advantage. Capitalizing on these advantages requires products of consistent high quality even though fish are among the most difficult to adequately preserve. Recent research in the West Virginia station has emphasized consistency of rearing environment, reducing fish stress at harvest, and effective cryopreservation, all of which have critical impact on product quality.

Additionally, important results have been obtained this past year regarding lead contamination in soils and the nutritional status of infants from rural West Virginia families participating in the Supplemental Nutrition program for Women, Infants, and Children.

Program 2 (National Goals 2 and 3) represents a limited research area in West Virginia. Additional faculty are being hired which will expand the level of research in food safety and quality in the future.

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

Source	$ or SY
Formula	455,263
State Funding	**345,010**
SY's	**1.8**

Key Theme – Food Safety and Quality

a) Description – Research to ensure food quality and safety for consumers.

b) Impacts – Sodium lactate and sucrose/sorbitol, alone or in combination with food-grade phosphates or $MgCl_2$ were found to be effective cryoprotectants, significantly improving the quality of trout fillets which are particularly susceptible to deterioration in quality with frozen storage.

The use of a commercial anesthetic (***Aqua-S***^{TM}) to enhance fish fillet quality by reducing stress at harvest, was not successful in improving quality even though the product did serve as an effective anesthetic.

Analysis of fish from eight producers growing the same strain of trout and using the same feed showed substantial variation in measures of product quality. Water characteristics are being examined as a possible cause.

Previously frozen trout fillets were brined at 8.7% and 17.4% using a sodium chloride solution for 30, 60, 90 or 120 minutes in an attempt to achieve the regulatory minimum of 3.5% water-phase salt content in refrigerated, vacuum packaged smoked fish. Five alternative brining protocols (combinations of direct salting, brining and tumbling) failed to reach the target 3.5%, but direct salting yielded a product closest (at 3.2%) to the target and with the greatest consistency of quality measures.

Survey of lead concentration in West Virginia forest soils found lower concentrations in younger, relative to older, organic soil horizons, suggesting lowered concentrations of lead from use of non-leaded gasoline. However, in many soil profiles, levels of lead were sufficient to predict leaching into water.

A cross-sectional analysis of infants from rural West Virginia families who were participating in the Supplemental Nutrition Program for Women, Infants, and Children (WIC) did not find iron deficiency to be a significant problem in this population. Blood lead levels were detectable but was not observed at toxic levels.

c) Funding – Hatch, State.

d) Scope of Impact – State specific.

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

Overview

West Virginia's economic future will depend in large measure on our success in preserving the rich natural resources of the state. Promoting a symbiotic coexistence between our farms, forests and natural environment, with policy decisions based on reliable, scientific information, is therefore a major focus of research conducted in the West Virginia Station.

Station research centers on developing environmentally friendly practices for managing farms and forests to protect state wildlife, water and soil for future generations. An

evaluation of the impact of gypsy moth infestations on cavity dwelling birds and effects on non-target organisms of attempts to control gypsy moths has produced meaningful results. Additional work has defined the parameters of impact on brook trout populations from logging and farming practices and has developed remediation programs.

Substantial resources are devoted to developing and evaluating holistic, organic methods of plant and animal production and toward defining economically viable methods of transitioning – wholly or partially – from conventional to organic production methods. The work has centered on managing disease and insect pests for a large variety of food crops with a minimum of, or no, chemical intervention.

Protection of soil and water is a national concern. Research from the West Virginia Station during the past year has defined phosphorus retention capacity of various soils, determined the ability of restored minesoils to regain native fertility under alternative management regimes, determined the effectiveness of coal ash and lime treatment for acid mine drainage, evaluated the ability of ectomycorrhizal fungi to restore metal contaminated soils, and measured radial oxygen loss from the root zones of various plants as a potential means to enhance organic pollutant remediation in constructed wetlands.

Progress toward achieving the objective of Program 3 (National Goal 4) is extremely encouraging. Of particular note are results defining both the impacts of human activities on natural populations and practical methods to mediate those which are negative, as well as findings which support conversion to more environmentally friendly, sustainable methods of agricultural production.

Expenditures and SY for Program 3 (Goal 4)

Source	$ or SY
Formula	684,560
State Funding	**673,097**
SY's	**7.0**

Key Themes – Wildlife Science and Management

a) Description – Research to identify and remediate as necessary negative impacts of agriculture and forestry on wildlife populations.

b) Impacts – The effect of Bacillus thuringiensis (Bt) on non-target Lepidoptera, their predators and parasitoids in central Appalachian hardwood forests was determined. None of the groups examined was found to be effected by Bt application to control gypsy mouth. The impact on cavity nesting bird populations of withholding all response to gypsy mouth infestations has been documented since 1984. Results show dramatic increases (>10x) in numbers of cavity nesting birds approximately two years following gypsy mouth defoliation

and concomitant tree mortality. However, populations decrease dramatically five to seven years later as trees begin to fall.

Mixed oak forests were found to support significantly more nest cavity trees than did Red Spruce/Yellow Birch or Black Cherry/Maple cover types. Red Spruce/ Yellow Birch had fewest cavities even though they were significantly older than either of the other types.

Very small (<.063 mm) sediment particles from land use practices (e.g., logging, road construction, etc.) was shown to have a significant negative impact on brook trout reproduction. Additionally, less than one percent sediment by weight will illicit the negative effect. Addition of woody debris may provide sediment storage areas and consequently improve fish reproduction.

c) Funding – McIntire-Stennis and State.

d) Scope of Impact – State specific.

Key Theme – Alternative Agricultural and Forestry Practices

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

b) Impacts – Research to evaluate alternative systems to transition from conventional to organic farming methods found only a kaolin-based particle film (Surround WP) among pepper extract and a plant fatty acid extract, to have any effect on foliar insect populations; none of the three affected populations of nematodes.

Tomatoes, pepper, green beans, peas, pumpkin, zucchini, lettuce, potatoes, wheat, forage soybeans, brussel sprouts and spinach were grown using organic farming methods and either low (green manure) or high (10 tons per acre composted dairy manure) input of organic matter. All yields except for soybean, zucchini, peas and tomatoes were significantly higher in the high input replicates. Most crops were relatively free of disease and pests but leafhoppers did cause extensive damage on potatoes and an outbreak of bacterial wilt damaged cucurbits. Plastic mulch generally was superior to straw as a weed suppression mulch.

The efficacy of systems to manage arthropod and disease pests of apples using organic methods (oils and pheromone mating disruption for insects; copper and sulfur fungicides for disease) were evaluated. Organic plots showed lower levels of aphids, leafhoppers and mites and increased numbers of arthropod predators, but significantly more injury to harvested fruit (from codling moth, oriental fruit moth, plum curculio and apple maggot). Organic methods resulted in increased pest damage to fruit and slightly higher production costs.

A direct comparison between sprayable or emulsion pheromones and conventional insecticide program showed mating disruption pheromones to provide insect control comparable to that of conventional insecticides.

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

Key Theme – Soil and Water Quality

a) Description – Research to evaluate soil quality, prevent soil contamination, and, where required, develop soil remediation programs.

b) Impacts – Considerable variation was found in P retention capacity of major soils in West Virginia with upland subsoil horizons appearing to have higher P fixing capacity than similar soil horizons in flood plains. For a given soil series (but not across series), there is a positive relationship between iron oxide content and P fixation capacity. Results indicate that the West Virginia soils examined are about 20-30% P saturated, rather than the 50% estimated previously for similar soils.

Results continue to indicate that minesoils will equate over time to adjacent native soils in terms of C, N, microbial biomass, microbial nitrogen, etc. Forest productivity was evaluated on 30-year old minesoil, half of which was planted in white pine, and half left to revegetate naturally. Soil development was better on the naturally revegetated site probably due to differences in ground cover. Forest productivity, including volunteer species, was much better on the planted site than on the naturally revegetated site. The value of treating minesoils was evaluated 10 years after establishment with combinations of three application rates of sewer sludge (0, 35, and 70 Mg/ha) and three of fly ash (0, 282, and 564 Mg/ha). Plant available concentrations of trace elements increased with application of sewer sludge and plant available Pb, Cr, Cu, Co and Zn were higher in soils treated with fly ash than in untreated soils.

Examples of ectomycorrhizal fungi taken from serpentine soils were genetically distinct from the fungi of the same species taken from non-serpentine soils. Differences in physiology between the types included two-fold greater acid phosphatase synthesis rates and a 35-fold increase in levels of malate exudation. Both may be associated with metal tolerances, making these genetic types potentially useful for restoring metal rich or contaminated soils.

Radial oxygen loss was measured from root zones of seven species of plants commonly used in constructed wetlands and Zea maize, used as a non-wetland control. Typha latifolia, often chosen for wetland plantings, exhibited oxygen gradients which were few and weak, probably indicating a difference between oxygen available for plant survival and released oxygen available for possible enhancement of pollutant remediation. Combined plantings of plants with high rates of radial oxygen loss and complimentary root architecture may be most effective for organic pollutant remediation.

The effectiveness of treatment for acid mine drainage using coal combustion by products and lime was examined. As amount of added lime increased, treated

water ranged from acidic with high iron content to pH of 7.5 with less than 1 mg/l of iron.

c) Funding – Hatch and State.

d) Scope of Impact – Multi-state research

CA-B, CA-D, CO, CT, GA. IA. MD. ME, MI. MN, MT, NH, NM, NV, NY-I, OH, OR, TN, VT

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

Overview

Declining per capita income and population outflow are chronic problems in West Virginia. Research to develop technologies and management systems which support economic development consequently represents a high priority in the West Virginia Station.

The extensive rural areas of West Virginia have dictated that Station research will focus on economic development in rural communities having agricultural or forest based economies. A study to evaluate the potential for niche marketing of eco-labeled wood products yielded disappointing but needed results. Enterprise budgets developed for pasture raised livestock and several aquaculture industries, as well as opportunities to develop community-based heritage tourism initiatives in West Virginia, were more encouraging particularly for producers having access to specific, state natural resources which tend to minimize risk and operating costs.

Results contributing to the objectives of Program 4 (National Goal 5) were limited by the minimal resources allocated to this program. We are well pleased, however, with results – and stakeholder interest in and application of those results – involving aquaculture, livestock grazing, and heritage tourism.

Expenditures and SY for Program 4 (Goal 5)

Source	$ or SY
Formula	361,013
State Funding	**352,665**
SY's	**4.6**

Key Theme – Community Economic Development

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

b) Impacts – Research to determine the feasibility of successfully marketing eco-labeled wood products has found limited enthusiasm among marketers. Most

firms are uncertain as to whether offering certified, "environmentally-friendly" wood products would benefit their business.

Studies have evaluated cost and returns for trout production, organic farming, pasture raised beef, production of hybrid striped bass, and selling of bait fish. All are generally profitable under typical West Virginia conditions; many can take advantage of existing land, climate, topography, natural surroundings, etc. to minimize startup and/or operating costs.

An analysis of liberalized international trade showed few if any negative impacts on the environment. In contrast, more often, countries have strengthened environmental regulations in order to trade with other nations, yielding a positive environmental impact.

Preliminary results indicate substantial interest in developing community-based heritage tourism initiatives in West Virginia. Existing initiatives have been inventoried and a state-wide strategic plan developed which will diversify West Virginia's economy while capitalizing on the state's natural, scenic beauty.

c) Source of Funding – Hatch and State

d) Scope of Impact – Multi-state research

AL, AR, FL, GA, KY, LA, MS, OR, TX, NC(A&T), ND

B. Stakeholder Input Process

Stakeholder input has been collected in conjunction with West Virginia Extension (which is administratively distinct from the College of Agriculture, Forestry and Consumer Sciences at West Virginia University) since we share the vast majority of our stakeholders. Previously, stakeholder input has been obtained at dedicated public meetings having no other purpose than to receive input. This procedure was augmented during the past year by collecting input at the annual meetings of major state associations of stakeholders including the West Virginia Farm Bureau, West Virginia Forestry Association, West Virginia Grasslands Steering Committee and the state Aquaculture Forum. Our intention is to continue using a combination of dedicated and annual association meetings to gather input.

Valuable input also is obtained from the West Virginia Agriculture and Forestry Advisory Board, which meets twice annually and deals mostly with research issues, and from our College Visiting Committee which considers academic as well as research programs. Both groups are intentionally balanced to represent the diversity of agricultural and forestry enterprises in West Virginia as well as consumers of products and services from those industries.

C. Program Review Process

There have been no changes in the merit review pro9cess from that indicated in the Plan of Work.

D. Evaluation of the Success of Multi and Joint Activities

Personnel from the West Virginia Station participated in six Northeastern, two Southern and one Western regional projects. Multi-state cooperation allows researchers to address numerous questions which could not be addressed by any state alone. Additionally, opportunities to share ideas, resources and expertise is especially beneficial to the West Virginia Station where resources are limited.

Northeast regional project, NE-185, represents a defining project for the West Virginia Station research effort due to its focus on economic development of local food systems. The rural and oftentimes isolated nature of many communities in the state, as well as their dependence on farm and forest economies, has made stakeholders in West Virginia extremely concerned with community economic development. Many of these stakeholders, additionally are from rural, low income families, typically underserved by governmental programs.

Results of research conducted by the participants in NE-185 have developed and refined protocols to study food systems of individual counties or regions within the participating states. Most importantly, results are demonstrating how the structures and viabilities of local food systems are heavily affected by public policy. Several states, including West Virginia, have used results to educate state agencies and local government officials and to assist them in making informed policy decisions.

Multi-state projects relevant to specific, economically important plant commodities in West Virginia include projects to evaluate new apple cultivars, to genetically enhance cold tolerance in horticultural plants, and to develop biologically based IPM systems for the management of plant parasitic nematodes 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 quality.

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 and the identification/introduction of pest predators, are ensuring more sustainable and environmental friendly crop production systems and reducing pesticide exposure risks.

Multi-state research projects involving pasture-based production systems for beef, sheep and dairy; as well as projects related to animal waste management and developing methods for more efficient reproduction in pasture maintained livestock, are of key

importance in enabling West Virginia producers to capitalize on the 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 two years. Integrated projects now 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 example being the aquaculture project discussed in Program 1. The aquaculture project is a multidisciplinary, multi-college, multi-institutional (with West Virginia State), integrated project to develop food fish and recreational fishing industries in the state. Its direction of focus is from the ultimate user to the technology delivery to the technology development, with needs of the first defining the structure of latter two. 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.

F. Integrated Research and Extension Activities

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

1. 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; improving animal marketing systems; and producing economic data, budgets and forecasts which enable profitable enterprises.

2. 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. A comprehensive, integrated effort to develop sustainable, profitable food fish and recreational fishing industries with focus on production, processing, marketing, value-added products, and use of abandoned mine water sources.

4. A state-wide, integrated effort to improve water quality actually or potentially compromised by acid mine drainage, improper animal waste management and poorly maintained septic systems.

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

Institution ____West Virginia University_____
State _____ West Virginia _____

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

Actual Expenditures

Title of Planned Program/Activity	FY 2000	FY 2001	FY 2002	FY 2003	FY 2004
1. Pasture Production of Livestock	280,135	325,127			
2. Competitive Poultry Industry	**279,656**	**140,078**			
3. Develop/Support Aquaculture	**160,762**	**244,047**			
4. Improved Water Quality	**169,940**	**162,058**			
Total	**890,493**	**871,310**			

_____ ____**2/26/02**___
Director **Date**

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