2013 West Virginia University Research Annual Report of Accomplishments and Results

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I. Report Overview

1. Executive Summary

The West Virginia Agricultural and Forestry Experiment Station is part of the Davis College of Agriculture, Natural Resources and Design. While the West Virginia Cooperative Extension Service is a separate administrative unit and not part of the College, research and extension are integrated through joint appointments, through coordination of activities and planning at the deans, directors and associate-directors levels, through integrated research, extension and education projects and programs funded by Hatch, Smith-Lever and McIntire-Stennis capacity funds and through competitive funding from NIFA and other sources. In 2013 we continued to coordinate efforts by the Experiment Station and Extension to encourage joint faculty efforts to go after competitive funding, particularly AFRI funding. The areas of focus for 2013 were nutrition and childhood obesity plus research and extension work on shale gas, an area of growing economic and environmental importance in our region. In 2013 the associate director of the WVU Agricultural and Forestry Experiment Station and a team of faculty from WVU served on a research advisory team for WV State. Such activities will help us to better coordinate our research and extension activities with those of WV State. In addition, starting in 2014 we will be submitting a coordinated plan of work constructed jointly among the WVU Agriculture and Forestry Experiment Station, WVU Extension, West Virginia State Extension and the WV State Experiment Station. Our annual report of accomplishments will remain separate until the 2015 report year.

The vision of the Davis College of Agriculture, Natural Resources and Design is to be a leader in learning, discovery, and engagement programs in natural, social and human resources aimed at improving the quality of life for the citizens of West Virginia and beyond. The mission of the Davis College is to enrich the lives of the citizens of West Virginia and beyond. This is accomplished by implementing programs designed to provide excellence in undergraduate and graduate education and research, train future leaders, collaboratively engage critical issues and promote stewardship of natural, renewable and human resources. The Greenhouse, Dairy, and Rumen Fermentation Laboratory provide additional opportunities for learning and study, and provide valuable community service. In addition, the College and Experiment Station utilize our 3,425 acres of farmland and 8,134 acres of forest for teaching, research and outreach activities.

The Davis College is currently undergoing a reorganization to streamline our administrative structure. Currently we have 5 divisions - Animal and Nutritional Sciences, Design and Merchandising, Plant and Soil Sciences, Forestry and Natural Resources and Resource Management - with varied programs of study and multiple degree options. After reorganization we will have three schools, one being a merger of Plant and Soil Sciences and Animal and Nutritional Sciences; the second being a merger of Design and Merchandizing with two programs that were formerly part of the Division of Resource Management (Landscape Architecture and Agricultural and Extension Education); and, the third being comprised by the former Division of Forestry and Natural Resources and the Agricultural and Resource Economics program (the remaining program from the Division of Resource Management). While the names of the new schools have not yet been set, the logic is to consolidate the programs of the College into three schools: those primarily focused on agriculture, those primarily focused on natural resources, and those primarily focused on design.

Faculty in the West Virginia Agricultural and Forestry Experiment Station conduct research in seven program areas: Economic Development and Quality of Life in Rural Communities; Climate Change, Environmental Quality and Stewardship; Global Food Security and Hunger: Fundamental Plant and Animal Systems; Global Food Security and Hunger: Production/Sustainable Agriculture; Childhood Obesity, Human Nutrition and Health; Production/Sustainable Forestry: Timber Management and Wood Products; and, Sustainable Energy. These program areas will be modified in 2015 to reflect the newly consolidated plan of work.

Needs of State citizens dictate that a large portion of the research projects in these programs is related to economic development in rural communities, improving human nutrition, health and quality of life in rural communities, and protecting and preserving state natural resources and the environment. Four centers and one organizational unit exist within the College to help focus and direct our efforts on economic development, natural resources and the environment. They also contribute to our ability to leverage Hatch and McIntire-Stennis capacity funding by attracting external competitive grants and other external sources of funding. The four centers are the Natural Resource Analysis Center (NRAC), the Environmental Research Center (ERC), the National Geospatial Development Center (NGDC) and the Appalachian Hardwood Center (AHC). The organizational unit is the West Virginia Cooperative Fish and Wildlife Unit.

The Natural Resource Analysis Center (NRAC) was formed in the early 1990s as a multi-disciplinary research and teaching facility in the Davis College of Agriculture, Natural Resources and Design at West Virginia University. Geographic Information Systems and Remote Sensing have been integral parts of the research and teaching programs of the Davis College for many years. The wide range of research and teaching activities at the Center have been designed to complement work within the College, and include environmental planning, environmental and natural resource economics, recreation, wildlife management, forest ecology, and land and water reclamation. Areas of expertise at NRAC include economic development and environmental sustainability, remote sensing, land cover mapping, landscape analyses, watershed-based analysis and applications, and GIS-based planning and decision making. Recent projects have included development of water resource GIS datasets for West Virginia and parcel prioritization methodology development for land conservation.

The goal of the Environmental Research Center (ERC) is to provide a center of excellence at West Virginia University that facilitates the integration of environmental research, outreach/education, and practitioner science. The ERC acts as an unbiased intermediary among groups and as a regional and national leader in integrated environmental and social research and outreach. The Center is housed in the Davis College of Agriculture, Natural Resources and Design, and is a collaborative venture involving faculty and staff from numerous programs and colleges throughout WVU as well as external collaborators from both the public and private sectors. The center's goal is to serve as the nucleus tying together various groups interested in interdisciplinary environmental research and education. As a college center, the ERC focuses on being a key driver behind large multi- and interdisciplinary research, teaching, and outreach efforts focused on environmental topics.

Funded by the Natural Resources Conservation Service (NRCS) and in partnership with West Virginia University, the National Geospatial Development Center (NGDC) was established to develop geospatial technologies that support the business mission of the NRCS. The Center operates collaboratively with university researchers, other NRCS Centers, as well as private and public partners to advance the integration and utilization of geospatial technologies in NRCS. The mission of the National Geospatial Development Center is to enhance NRCS capacity to produce, utilize, and apply soil and natural resources information through the innovative application of geospatial technologies in partnership with Cooperative Ecosystem Study Units, private industry, and other USDA technology centers.

Forest lands in West Virginia represent an enormous resource in the form of hardwood timber,

wildlife habitat, and areas for human recreation and restoration. Station research in timber management and wood utilization seeks enhanced profitability of timber production balanced against protection of wildlife habitats and recreational environments. Both are served by research projects which limit negative impacts of insects, disease and invasive species. Timber management research also is strongly influenced by the fact that a majority of state forest lands are in relatively small tracts, owned by many different individuals coexisting with several relatively large lumber producing companies. Research and outreach programs to serve both types of producers are supported. The Appalachian Hardwood Center (AHC) at West Virginia University is a jointly supported center of the WVU Extension Service and the WVU Davis College of Agriculture, Natural Resources and Design. The center was established in 1987 by the West Virginia Legislature to provide technical and research support for the state's growing wood products industry. The AHC is a center of excellence for outreach, extension and technology transfer, professional development, and applied research. The AHC serves sustainable, natural resource-based businesses and communities as well as private forest landowners and natural resource professionals in the Appalachian forest region.

The quantity and variety of wildlife in West Virginia are extremely important to the economy and character of the state. Research in this planned program is designed to better understand habitat requirements for wildlife in West Virginia, and to determine the impacts of human activity on wildlife habitat, particularly habitat for fish and song birds. A large majority of the research in this program represents cooperative research between West Virginia Station faculty and scientists with the West Virginia Division of Natural Resources, USGS, US Fish and Wildlife Service, and the Wildlife Management Institute, a group collectively known as the West Virginia Cooperative Fish and Wildlife Unit. While capacity funding provides infrastructure for this program, the majority of research in wildlife management is supported by external funds, another example of how capacity funds allow us to develop the infrastructure to attract external funding to deal with real-world problems.

This annual report provides an overview of the programs in the WV Agricultural and Forestry Experiment Station with selected accomplishments for 2013 highlighted in the narrative for each program area.

Total Actual Amount of professional FTEs/SYs for this State

Year: 2013	Extension		Research	
	1862	1890	1862	1890
Plan	0.0	0.0	40.9	0.0
Actual	0.0	0.0	40.8	0.0

II. Merit Review Process

1. The Merit Review Process that was Employed for this year

- Internal University Panel
- External Non-University Panel
- Expert Peer Review

2. Brief Explanation

A scientific merit and peer review process is used for all Hatch, McIntire Stennis and Animal and

Health and Disease Act research projects. Projects are reviewed internally by individuals with expertise in the fields of science addressed in each proposal are selected by the Division Director, Experiment Station Director or designee and asked to judge technical merit, likelihood of achieving stated objectives, and potential impacts for each proposed project. A minimum of three peer scientists (i.e., individuals qualified by their status in the same discipline, or a closely related field of science), are asked to read and provide written comments on the proposed activities. The terms of reference for the reviewers focus on questions of the quality of the proposed science, technical feasibility of the research, the validity of the scientific approach, and likelihood for completing the stated objectives. Additional comments may be requested on a project's relevance to the station's priorities, the degree of integration with extension (as appropriate), responsiveness to stakeholder needs, and the accuracy of any claims for multi-disciplinary and multi-state collaboration. Reviewers are asked to present their findings in writing, and records of the reviewers' comments are preserved for the life of the project, or for a period of three years in the event that a project is not initiated. Competitively awarded grants requiring peer review or contract research requiring grantor approval are exempt from this process. Programs of research are reviewed annually by the Station visiting committee and every five years through a College level strategic planning process.

III. Stakeholder Input

1. Actions taken to seek stakeholder input that encouraged their participation

- Targeted invitation to traditional stakeholder groups
- Targeted invitation to traditional stakeholder individuals
- Survey of traditional stakeholder groups
- Survey specifically with non-traditional groups

Brief explanation.

Much stakeholder input is collected in conjunction with West Virginia University Extension (administratively distinct from the College of Agriculture, Natural Resources and Design) since we share a 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, the West Virginia Farmer's Market Association, etc.) We find the new procedure more efficient and to represent a 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 and Natural Resources, etc.) as well as from advisory groups established at the College/Station level (Davis College Visiting Committee).

2(A). A brief statement of the process that was used by the recipient institution to identify individuals and groups stakeholders and to collect input from them

1. Method to identify individuals and groups

- Use Advisory Committees
- Use Internal Focus Groups
- Use External Focus Groups

Brief explanation.

The focus of the Service/Outreach agenda for the College is to continue to enhance our

communication and working relationship with our Extension partners, commodity and industry groups, state agencies and community organizations that represent our College disciplines within the State of West Virginia. The impact of these efforts by the College will continue to enhance our relationship with our academic partners and stakeholders and make our programs more relevant to needs of the State and be consistent with Goal 5 of the West Virginia University's 2020 Strategic Plan- "to enhance the well-being and the quality of life of the people of West Virginia. We truly believe that our success as a land grant College/Institution will be measured by how well we serve the citizens of West Virginia, then the nation and the world. Based on the initial strategies identified in 2010 to improve our Service and Outreach agenda, we have had good success in implementing these strategies and have realized some strong positive impacts for an improved image of the College within the University and our Service and Outreach agenda within the State and region.

Strategies to Enhance our Service/Outreach Agenda

1. Contact and communicate information to the various stakeholder groups offering our assistance and requesting their input to identify their priority needs.
2. To create an updated data base of stakeholder, community groups and industry partnerships relevant to the College.
3. Implement activities to enhance the communication, awareness and image of the College.
   a. Expand our presence and participation to stakeholder groups
   b. Continue a monthly College Newsletter and biannual research report for general audiences
   c. Annual open house
   d. Enhance the activities of the College Alumni Association
   e. Research Annual Reports

2(B). A brief statement of the process that was used by the recipient institution to identify individuals and groups who are stakeholders and to collect input from them

1. Methods for collecting Stakeholder Input

- Meeting with traditional Stakeholder groups
- Survey of traditional Stakeholder groups
- Meeting with traditional Stakeholder individuals
- Meeting specifically with non-traditional groups

Brief explanation.

Surveys are distributed at annual meetings for numerous organizations having interest in College program areas (related to agriculture, forestry, landscape architecture, interior design, human nutrition, etc,) to provide input. Division Directors, College faculty and advisory groups are queried regularly and routinely to identify industries, groups or subject matter areas needing representation in the College input stream and for specific individuals to fill these roles.

3. A statement of how the input will be considered

- In the Budget Process
- To Identify Emerging Issues
- Redirect Research Programs
- In the Staff Hiring Process
- In the Action Plans
- To Set Priorities

Brief explanation.

The Davis College of Agriculture, Natural Resources and Design continues to value our work with the stakeholders and partnerships within our State and need their continued input to improve and make more relevant these relationships in the future and continue to enhance the well-being and quality of life of citizens in West Virginia in disciplines germane to our College. New facilities such as a new greenhouse completed in 2012 and a designed new Agriculture Sciences building proposed for completion in 2014/15 will enhance the quality of our teaching and research activities and partnership potential with external partners. These new facilities as well as scheduled enovations of existing facilities will certainly improve morale of faculty, staff and students, enhance our image and afford enhanced opportunities for our service, outreach and engagement agenda.

Input from our stakeholders is used to help inform long term strategic planning and budgeting. As we are faced with a State budget cut this and next year, we work with our stakeholders to help determine where spending can be reduced without impinging on mission-critical programs.

Brief Explanation of what you learned from your Stakeholders

This year we experienced a cut in our State budget plus the loss in capacity funding due to the sequestration. We examined our spending on our research, teaching and outreach programs to see where we could reduce efforts to meet the budget reduction. We received strong feedback from our stakeholders that our outreach activities, including the bull test and bull sale at Wardensville, our Kiddie Days and Family Days activities at our animal science farm in Morgantown, and our organic field day at our horticulture farm in Morgantown, were highly valued and should be continued.

IV. Expenditure Summary

1. Total Actual Formula dollars Allocated (prepopulated from C-REEMS)			
Extension		Research	
Smith-Lever 3b & 3c	1890 Extension	Hatch	Evans-Allen
0	0	3003407	0

2. Totaled Actual dollars from Planned Programs Inputs				
	Extension		Research	
	Smith-Lever 3b & 3c	1890 Extension	Hatch	Evans-Allen
Actual Formula	0	0	2893206	0
Actual Matching	0	0	6508972	0
Actual All Other	0	0	3921697	0
Total Actual Expended	0	0	13323875	0

3. Amount of Above Actual Formula Dollars Expended which comes from Carryover funds from previous				
Carryover	0	0	2224852	0

V. Planned Program Table of Content

S. No.	PROGRAM NAME
1	Economic Development and Quality of Life in Rural Communities
2	Climate Change, Environmental Quality and Stewardship
3	Global Food Security and Hunger--Fundamental Plant and Animal Systems
4	Global Food Security and Hunger--Production/Sustainable Agriculture
5	Childhood Obesity, Human Nutrition and Health
6	Production/Sustainable Forestry - Timber Management and Wood Products
7	Sustainable Energy
8	Food Safety

V(A). Planned Program (Summary)

Program # 1

1. Name of the Planned Program

Economic Development and Quality of Life in Rural Communities

☑ Reporting on this Program

V(B). Program Knowledge Area(s)

1. Program Knowledge Areas and Percentage

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
131	Alternative Uses of Land			10%	
134	Outdoor Recreation			15%	
511	New and Improved Non-Food Products and Processes			15%	
604	Marketing and Distribution Practices			15%	
605	Natural Resource and Environmental Economics			10%	
608	Community Resource Planning and Development			20%	
724	Healthy Lifestyle			5%	
804	Human Environmental Issues Concerning Apparel, Textiles, and Residential and Commercial Structures			5%	
903	Communication, Education, and Information Delivery			5%	
	Total			100%	

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2013	Extension		Research	
	1862	1890	1862	1890
Plan	0.0	0.0	6.5	0.0
Actual Paid Professional	0.0	0.0	7.9	0.0
Actual Volunteer	0.0	0.0	0.0	0.0

2. Actual dollars expended in this Program (includes Carryover Funds from previous years)

Extension		Research	
Smith-Lever 3b & 3c	**1890 Extension**	**Hatch**	**Evans-Allen**
0	0	393108	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
0	0	930965	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
0	0	265976	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

West Virginia is considered to be a lagging region in terms of economic development and growth, a characteristic shared by many states in the Appalachian Region. While the region has abundant natural resources, particularly coal, natural gas, forests, water and recreational opportunities, unemployment is typically higher than in the rest of the Nation. Accordingly, the West Virginia Agricultural and Forestry Experiment Station has designated economic development and the quality of life in rural communities as one of our primary program areas. Work in this program area is divided into two categories: economic development and quality of life.

A significant part of rural employment growth nationwide has occurred in non-traditional economic activities including those capitalizing on natural resources and climate. A number of possible economic opportunities are currently being investigated in West Virginia, including pasture finished beef, cool water aquaculture, local food production and marketing, wood utilization, organic production of vegetables and animal products, and ecotourism. In the last two years cutbacks in Agricultural Research Service (ARS) budgets and the closing of the ARS facility in Beaver, WV, have led to a reduction in the research resources devoted to the pasture finished beef projects. The elimination of congressionally directed spending has also led to reduced activity in the aquaculture and wood utilization areas. These cutbacks increase the relative importance of federal capacity funding and AFRI competitive funding to the success of our research programs.

Improving the competitive position of small and mid-size enterprises (SMEs) that have declined over time as a result of reduced profitability and marketability of conventional products requires more efficient production processes, alternative products and marketing strategies. For example, production in intensive environments such as greenhouses could be more profitable and potentially less risky, particularly in areas where land, water, labor, and energy are scarce. The goal of one economic development project is to identify strategies for niche and value-added products that will improve SME business performance. This project is timely given that many niche products are more healthful, thereby improving health outcomes in areas such as Appalachia where one strategy to reverse declining economic growth and competitiveness could be to reverse growing obesity and health-related problems. In addition, focusing on SMEs could be an effective economic development strategy because most economic growth occurs at this level. The results of this study show that WV has the land base to produce enough special crops to meet local seasonal demand. In particular, markets for specific vegetables were shown to have potential for significant economic impacts and job creation. These results have sparked interest among farmers and Extension personnel that encourage entry or expansion into these niche markets.

2. Brief description of the target audience

The primary audience for our community and economic development activities is community managers, planners, policy makers, consultants and local development committees or groups. For aquacultural and agricultural product development and marketing, the audience includes producers, processors and distributors. Our work on the quality of life is used by local and State planners and policy makers, State citizens and community groups and educators.

3. How was eXtension used?

eXtension was not used in this program

V(E). Planned Program (Outputs)

1. Standard output measures

2013	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	0	0	0	0

2. Number of Patent Applications Submitted (Standard Research Output)

Patent Applications Submitted

Year: 2013

Actual: 0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2013	Extension	Research	Total
Actual	0	11	11

V(F). State Defined Outputs

Output Target

<u>Output #1</u>

Output Measure

- Presentations on research at professional meetings

Year	Actual
2013	12

Output #2

Output Measure

- Team consultations with, and reports to assist, community action groups focused on improving local economic development and quality of life.

Year	Actual
2013	2

Output #3

Output Measure

- Completed graduate degree programs

Year	Actual
2013	4

Output #4

Output Measure

- Popular press reports.

Year	Actual
2013	4

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Number of community specific plans developed and adopted in whole or in part to help enhance economic development and quality of life.
2	Number of business plans and successful start-ups in the State developed and implemented with assistance from the WVU Agricultural and Forestry Experiment Station.

Outcome #1

1. Outcome Measures

Number of community specific plans developed and adopted in whole or in part to help enhance economic development and quality of life.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Many communities in West Virginia are lagging economically and need assistance in developing plans to enhance their economic development, quality of life, and attractiveness to tourists. Our Community Design Team (CDT) has operated for 13 years to provide multidisciplinary University teams to help regional communities with economic development, tourism, flood control, transportation planning and design issues. The CDT is a joint venture of the Davis College and WVU Extension.

What has been done
In 2013 the Community Design Team was in the process of reorganizing to better address the needs of the State, so no new community visits occurred and no new plans were developed.

Results
None to report.

4. Associated Knowledge Areas

KA Code	Knowledge Area
131	Alternative Uses of Land
605	Natural Resource and Environmental Economics
608	Community Resource Planning and Development
804	Human Environmental Issues Concerning Apparel, Textiles, and Residential and Commercial Structures

Outcome #2

1. Outcome Measures

Number of business plans and successful start-ups in the State developed and implemented with assistance from the WVU Agricultural and Forestry Experiment Station.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	4

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The fastest growth in the U.S. economy is due to entrepreneurship and growth in small sole proprietorship businesses. The Appalachian region has lagged the nation in the growth of new small businesses.

What has been done
The Davis College has developed an entrepreneurship program that helps students develop business plans in conjunction with faculty and local business leaders. An annual statewide competition is held with the winners receiving funding for start-ups. Our students continue to dominate the winner's list of that program due to the quality of our entrepreneurship program and the abilities of our students.

Results
Business plans were successfully developed and implemented by WVU Davis College students, with assistance from the faculty and local business leaders in 2013 in the areas of artificial insemination of cattle, equestrian outfitting, hydroponics and agro-tourism. Davis College students are working on a patent for a device to instantly stop the flow of blood in the limbs of soldiers who have been severely injured by an explosive device.

4. Associated Knowledge Areas

KA Code	Knowledge Area
134	Outdoor Recreation
511	New and Improved Non-Food Products and Processes
608	Community Resource Planning and Development
903	Communication, Education, and Information Delivery

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Economy
- Appropriations changes

Brief Explanation

The sequestration in 2013 limited the funding we were able to use to conduct our research program in this area.

V(I). Planned Program (Evaluation Studies)

Evaluation Results

Experiment Station research program evaluation will take place at two levels and on two different time cycles. All programs will using these general criteria plus additional criteria tailored to each program as detailed in the Plan of Work under Outputs and State Defined Outputs and Outcomes.

Annual evaluation will continue as before, looking at productivity in terms of immediate impact:

- Referee journal articles and books
- Professional presentations
- General audience papers and news reports
- M.S. and PhD graduates
- Trends in terms of competitive funding

And in terms of longer-term impact:

- Citations in scientific journals
- Patents
- Successful technology transfer or start-ups based on research programs
- Awards based on continuing impact and research excellence

In addition, every five years we will have a full portfolio review of our research programs in terms of:

- Long term productivity
- Relevance to our constituent groups and the State and Region
- The allocation of research inputs among the programs
- Consideration of eliminating some research programs that are not productive or have diminished relevance given NIFA and State priorities
- Consideration of adding additional program areas given NIFA and State priorities

Our standard annual evaluation results are detailed in the state defined outputs and

state defined outcomes sections of this report. In addition, for this program we evaluated our programs that encourage researchers to pursue patents, licensing agreements and other forms of technology transfer in order to reduce barriers for faculty. We also, in conjunction with the university developed a system to help undergraduate students with business plans, start ups and patents. We found a number of areas that imposed barriers and attempted to improve our system. We also did a full evaluation of our Community Design Team program.

Key Items of Evaluation

Our changes in our entrepreneurship program and attempts to foster technology transfer have been successful. Business plans were successfully developed and implemented by WVU Davis College students, with assistance from the faculty and local business leaders in 2013 in the areas of artificial insemination of cattle, equestrian outfitting, hydroponics and agrotourism. Davis College students are working on a patent for a device to instantly stop the flow of blood in the limbs of soldiers who have been severely injured by an explosive device. In addition, two faculty members made progress in a licensing agreement with a food manufacturer to market a product they developed.

Our evaluation of our Community Design Team, a program conducted jointly with WVU Extension, led us to put the program on hold for an indefinite period, for budgetary purposes and to allow time for strategic planning to revitalize the program.

V(A). Planned Program (Summary)

Program # 2

1. Name of the Planned Program

Climate Change, Environmental Quality and Stewardship

☑ Reporting on this Program

V(B). Program Knowledge Area(s)

1. Program Knowledge Areas and Percentage

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
101	Appraisal of Soil Resources			15%	
102	Soil, Plant, Water, Nutrient Relationships			10%	
112	Watershed Protection and Management			15%	
132	Weather and Climate			10%	
133	Pollution Prevention and Mitigation			15%	
135	Aquatic and Terrestrial Wildlife			25%	
605	Natural Resource and Environmental Economics			10%	
	Total			100%	

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2013	Extension		Research	
	1862	1890	1862	1890
Plan	0.0	0.0	7.0	0.0
Actual Paid Professional	0.0	0.0	7.7	0.0
Actual Volunteer	0.0	0.0	0.0	0.0

2. Actual dollars expended in this Program (includes Carryover Funds from previous years)

Extension		Research	
Smith-Lever 3b & 3c	**1890 Extension**	**Hatch**	**Evans-Allen**
0	0	375204	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
0	0	980765	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
0	0	1157761	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

Research to assist in the preservation of West Virginia's soil, water, forest and wildlife resources is a high priority in the West Virginia Experiment Station particularly given the extra stresses and uncertainty imposed by a changing climate. The focus of Station research is on studying, protecting and restoring environmental quality while developing economically effective and environmentally sustainable management practices for agriculture, forestry, mining and rural communities and anticipating and adapting to climate change. Our primary environmental research areas involve mine land restoration, soil science, ecosystem resiliency to climate change and other environmental stressors, water quality, wetlands, and aquatic and terrestrial wildlife ecology.

Contamination of soil and water with acid mine drainage from abandoned surface and underground mines and restoration of the landscape from surface mining are important issues in West Virginia. Disturbed soils, such as those resulting from agriculture, erosion, deforestation, road building, urbanization, and surface mining require specialized treatments to make them suitable for subsequent use and management. Integrated research is being conducted to characterize the nature and scope of these problems and to develop cost effective remediation programs. Work is being conducted to evaluate properties of soil materials placed on the surface and determine their suitability for a variety of land uses such as agriculture, forestry, building site potential, recreation, and energy production. Relevant research projects include restoring surface mines to productive forestland or grassland (including switchgrass as a possible feedstock for biofuels), use of different types of soil amendments such as biochar and poultry litter on damaged soils to restore productivity, and restoring lost aquatic ecosystem functions on reclaimed mine sites and watersheds. Progress continues in assessing the ecological functions of restored and created wetlands.

One project titled, "Water Economics: Examining Economic and Social Incentives to Protect and Conserve Water Resources,"estimated the costs and benefits of using constructed wetlands versus best management practices (BMPs) to reduce nitrate runoff from agricultural land. The study found that while constructed wetlands were able to reduce ultimate runoff nitrates more cheaply than a small wastewater treatment system, in general they were not cost effective when compared to reduced application of nitrogen fertilizer (a BMP). The cost effectiveness differential between constructed wetlands and the BMP diminished as the projected life of the wetland increased.

Identification of critical fish habitat is paramount in the protection and restoration of stream habitat and stream fish populations. Brook trout (Salvelinus fontinalis) are the only native salmonid to the Appalachian Mountains and their populations and distributions have declined through habitat degradation and in some areas such as the Smoky Mountains, through possible competition with exotic salmonids. A

better understanding of critical habitat requirements of brook trout and a better understanding of brook trout population dynamics in relation to stream habitat is needed to improve management recommendations for both aquatic managers and land-use managers such as the timber industry. To gain this understanding requires long-term studies of the population responses of brook trout across a variety of streams under a range of environmental conditions and land use changes. One study builds upon earlier work by developing long-term study of the spatial and temporal variability of stream habitat and brook trout populations in the Central Appalachian Mountains of West Virginia. Such long-term studies are needed to identify limiting and controlling factors of brook trout in this region and the relative impacts of each upon overall population resilience. Knowledge of these factors within the context of land-use practices and determination of the habitat attributes controlling the abundance of all life stages of brook trout will enable better land-use and restoration guidelines to be established for the region. The result of these studies may be adjustments to Best Management Practices within streamside management zones that favor both forest yield and brook trout populations.

Another investigator continued research on the conservation genetics of fish and wildlife populations. This year's work examined the genetic effects of lake sturgeon stocking. The results of the study demonstrated that multiple years of stocking is necessary to adequately represent the genetic diversity of the source population. Also, the number of released offspring and family sizes need to be equalized across years in order to maximize the effective population size.

2. Brief description of the target audience

The activities in this area are used to contribute to the body of knowledge in the environmental and natural sciences, and to inform policy makers, planners, regulatory agencies and public interest and citizens groups.

3. How was eXtension used?

eXtension was not used in this program

V(E). Planned Program (Outputs)

1. Standard output measures

2013	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	0	0	0	0

2. Number of Patent Applications Submitted (Standard Research Output)

Patent Applications Submitted

Year:	2013
Actual:	0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2013	Extension	Research	Total
Actual	0	25	25

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Presentations on research at professional meetings

Year	Actual
2013	29

Output #2

Output Measure

- Popular press articles on research

Year	Actual
2013	7

Output #3

Output Measure

- Completed graduate degree programs

Year	Actual
2013	6

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Reduce percentage of state streams classified as impaired by agricultural and forestry activities (%).
2	Number of State landowners adopting reclamation and watershed protection practices in consultation with Experiment Station Faculty.

Outcome #1

1. Outcome Measures

Reduce percentage of state streams classified as impaired by agricultural and forestry activities (%).

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Recreational fishing is an important State industry. Unfortunately, many of the State's most valuable fisheries have been severely damaged by acid mine drainage from coal mining, from poorly constructed culverts, from acid precipitation and from deforestation. Upper Shavers Fork was a nationally known brook trout fishery, attracting recreational users from all over the country. The fishery was severely damaged by deforestation in the early 20th century and more recently, by acid precipitation.

What has been done
A ten-year ecological study of the watershed conducted by faculty in the Davis College determined the causes of the fisheries' decline: deforestation led to stream bank erosion and a widening of the river, making it shallower and subject to higher temperatures than Brook Trout can survive. Loss of tree canopy further added to the thermal problems. Acid precipitation and limited natural buffering in the watershed also stressed the Brook trout population. Finally, poorly designed railroad culverts prevented the fish from moving into cooler tributaries in the warmer seasons.

Results
The research led to a targeted restoration effort involving WVU, the WV Department of Natural Resources, the Federal government and private investors. Approximately 5 million dollars have been spent replanting trees, improving stream habitat, replacing culverts with fish friendly culverts, and liming the upper reaches to reduce acidity. Approximately 4 miles of Shavers Fork have been restored, and the watershed was recently featured as a success story on the "Fly Fishing Chronicles," a nationally syndicated television show. It is estimated that the fishery will now generate $300 - $500 million dollars in economic benefits over the next 20 years.

4. Associated Knowledge Areas

KA Code	Knowledge Area
133	Pollution Prevention and Mitigation
135	Aquatic and Terrestrial Wildlife
605	Natural Resource and Environmental Economics

Outcome #2

1. **Outcome Measures**

Number of State landowners adopting reclamation and watershed protection practices in consultation with Experiment Station Faculty.

Not Reporting on this Outcome Measure

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Economy
- Appropriations changes

Brief Explanation

Sequestration in 2013 limited the funds we were able to use to support research in this program area.

V(I). Planned Program (Evaluation Studies)

Evaluation Results

Experiment Station research program evaluation will take place at two levels and on two different time cycles. All programs will using these general criteria plus additional criteria tailored to each program as detailed in the Plan of Work under Outputs and State Defined Outputs and Outcomes.

Annual evaluation will continue as before, looking at productivity in terms of immediate impact:

- Referee journal articles and books
- Professional presentations
- General audience papers and news reports
- M.S. and PhD graduates
- Trends in terms of competitive funding

And in terms of longer-term impact:

- Citations in scientific journals
- Patents
- Successful technology transfer or start-ups based on research programs
- Awards based on continuing impact and research excellence

In addition, every five years we will have a full portfolio review of our research programs in terms of:

- Long term productivity
- Relevance to our constituent groups and the State and Region
- The allocation of research inputs among the programs
- Consideration of eliminating some research programs that are not productive or have diminished relevance given NIFA and State priorities
- Consideration of adding additional program areas given NIFA and State priorities

As reported last year, we began a three year review of our aquatic ecosystem and stream restoration efforts. The evaluation was to look at the ecological impacts of the restoration program and the economic consequences of the efforts in terms of recreational benefits and costs of implementation. Our initial findings have been extremely positive and the results of the evaluation are given below.

Key Items of Evaluation

Our evaluation of the first phase of our Shavers Fork project indicate that the benefits of restoration greatly exceed the costs. As such we plan to continue this project with the WV Department of Natural Resources and have applied both for State and competitive funding to assist in the restoration and to support further research. We have also decided that one of our College's greatest strengths is in remediation of damaged aquatic ecosystems and damaged and contaminated soils. Our College is leading a University wide effort to become a center of excellence in water research, and we plan to utilize this effort to further strengthen our programs in aquatic ecology and watershed remediation.

V(A). Planned Program (Summary)

Program # 3

1. Name of the Planned Program

Global Food Security and Hunger--Fundamental Plant and Animal Systems

☑ Reporting on this Program

V(B). Program Knowledge Area(s)

1. Program Knowledge Areas and Percentage

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
201	Plant Genome, Genetics, and Genetic Mechanisms			25%	
206	Basic Plant Biology			15%	
301	Reproductive Performance of Animals			25%	
302	Nutrient Utilization in Animals			15%	
304	Animal Genome			10%	
305	Animal Physiological Processes			10%	
	Total			100%	

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2013	Extension		Research	
	1862	1890	1862	1890
Plan	0.0	0.0	4.5	0.0
Actual Paid Professional	0.0	0.0	4.6	0.0
Actual Volunteer	0.0	0.0	0.0	0.0

2. Actual dollars expended in this Program (includes Carryover Funds from previous years)

Extension		Research	
Smith-Lever 3b & 3c	**1890 Extension**	**Hatch**	**Evans-Allen**
0	0	716596	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
0	0	949695	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
0	0	258013	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

Research involving fundamental plant and animal systems is designed to increase our basic scientific understanding of reproductive, nutritional and general physiological systems and processes. On the animal side, practical problems addressed include embryonic mortality in sheep and cattle, infertility in dairy cows, performance limiting amino acids in animal rations, and health and disease resistance in poultry. For plants, the program emphasis includes determining the molecular interactions during nitrogen fixation symbiosis between legumes and rhizobial bacteria, characterization of arbuscular mycorrhizal fungi, determining functions of ubiquitin and other polypeptide tags, understanding basic mechanisms of flower senescence and cold shock adaptation, combating the impacts of phytophthora and Chestnut blight and defining and eliminating negative effects on grazing animals of ergot alkaloids produced by fungi that are symbiotic with pasture grasses. While not much integrated research goes on in this area, due to the basic nature of the science, the Chestnut blight project combines both research and extension in a highly effective, award winning, multistate research project.

Dairy cow pregnancy rates have declined 30% in the last 50 years, and approximately 80% of the total loss occurs during the embryonic stage (before day 42). Throughout the United States, which has approximately 9 million dairy cows, the industry is losing almost a billion dollars each year due to high embryonic loss. Researchers have suggested that lower pregnancy rates result from low progesterone concentrations. Research at Davis College has shown that hepatocytes cultured in the presence of insulin exhibit reduced progesterone catabolism, which is a result of lowered hepatic cytochrome P450 activity. Currently, there is a paucity of information on nutritional regulation of cytochrome P450 activity, especially on mechanisms to reduce these catabolic enzymes. Therefore, a study designed to measure differences in the activity of cytochrome P450s and progesterone clearance, following alterations in diet would contribute substantially to understanding the influence of nutrition on peripheral progesterone concentrations.

The researchers were able to clearly demonstrate that progesterone clearance can be modified by hormones regulated by the composition of the diet. By altering the composition of the diet in a balanced way that still meets the needs of the cow and lactation, it is possible to dramatically reduce the catabolism of progesterone. If the hypothesis that excess progesterone catabolism is at least a part of the reason for particularly low fertility rates in dairy cattle, then feeding them a diet which shifts the volatile fatty acid production towards propionate should increase their fertility. Furthermore, by carefully selecting feedstuffs one can meet the demands for milk production while increasing propionate production.

2. Brief description of the target audience

The target audience for this area is composed of animal and plant scientists, biochemists, professional practitioners, dieticians, regulators and agribusiness firms.

3. How was eXtension used?

eXtension was not used in this program

V(E). Planned Program (Outputs)

1. Standard output measures

2013	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	0	0	0	0

2. Number of Patent Applications Submitted (Standard Research Output)

Patent Applications Submitted

Year: 2013

Actual: 0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2013	Extension	Research	Total
Actual	0	20	20

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Presentation on research at professional meetings

Year	Actual
2013	16

Output #2

Output Measure

- Completed graduate degree programs

Year	Actual
2013	3

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Gain understanding of the mechanisms that govern flower senescence
2	Develop ergot alkaloid deficient grasses at or near wild-type vigor - # new cultivars
3	Successfully develop and employ strategies using hypovirus as a biological control agent for Chestnut blight - # new strategies employed
4	Identify ovarian-specific gene expression affecting reproductive success - # new genes identified

Outcome #1

1. **Outcome Measures**

Gain understanding of the mechanisms that govern flower senescence

Not Reporting on this Outcome Measure

Outcome #2

1. **Outcome Measures**

Develop ergot alkaloid deficient grasses at or near wild-type vigor - # new cultivars

2. **Associated Institution Types**

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	2

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Many agriculturally important forage and turf grasses, including tall fescue and perennial ryegrass, are infected with symbiotic fungi from the genus Neotyphodium. These fungi grow internally in the plants, which show no external symptoms. The fungi benefit the plant by providing tolerance to biological or environmental stress. In many cases, these fungi produce bioactive chemicals including ergot alkaloids and lolines. Loline alkaloids, in general, are effective against insects, but the relative activities of different lolines need to be assessed. Certain ergot alkaloids provide protection against insects; however, many ergot alkaloids also are harmful to grazing animals, resulting in poor weight gain, poor health, and reduced reproduction.

What has been done
Davis College researchers have identified many of the genes required to produce ergot alkaloids and lolines. The goals of this current project are to eliminate, replace, or add specific genes to symbiotic fungi to alter the spectrum of ergot alkaloids and lolines produced in a controlled manner. The modified fungi will be reintroduced into their grass hosts (grown in containment), and the chemical profiles will be analyzed. Plants containing the modified fungi will be studied to determine the effects of specific chemicals on insect pests and parasitic nematodes (soil-dwelling round worms). This approach may produce fungi that provide enhanced bioprotective properties to their grass hosts. The alterations in ergot alkaloids also may reduce toxicity to grazing animals.

Results
Two independent lolE knockout mutants were generated from strain E2368 and one has been introduced into meadow fescue. The resulting symbiotum had no known loline alkaloid, but the possibility that this mutant produces a previously unknown intermediate in the loline alkaloid pathway is under investigation. Goals that have not yet been met include the completion of the engineering of certain strains (most of which are listed as in progress above), the chemical characterization of several engineered strains that have recently been introduced into plants, and the future provision of completely characterized strains to collaborators for assays of anti-insect and anti-nematode activities.

4. Associated Knowledge Areas

KA Code	Knowledge Area
201	Plant Genome, Genetics, and Genetic Mechanisms
206	Basic Plant Biology

Outcome #3

1. Outcome Measures

Successfully develop and employ strategies using hypovirus as a biological control agent for Chestnut blight - # new strategies employed

Not Reporting on this Outcome Measure

Outcome #4

1. Outcome Measures

Identify ovarian-specific gene expression affecting reproductive success - # new genes identified

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Dairy cow pregnancy rates have declined 30% in the last 50 years, and approximately 80% of the total loss occurs during the embryonic stage (before day 42). Throughout the United States, which has approximately 9 million dairy cows, the industry is losing almost a billion dollars each year due to high embryonic loss.

What has been done
Researchers have suggested that lower pregnancy rates result from low progesterone concentrations. Research at Davis College has shown that hepatocytes cultured in the presence of insulin exhibit reduced progesterone catabolism, which is a result of lowered hepatic cytochrome P450 activity. Currently, there is a paucity of information on nutritional regulation of cytochrome P450 activity, especially on mechanisms to reduce these catabolic enzymes. Therefore, a study designed to measure differences in the activity of cytochrome P450s and progesterone clearance, following alterations in diet would contribute substantially to understanding the influence of nutrition on peripheral progesterone concentrations.

Results
The researchers were able to clearly demonstrate that progesterone clearance can be modified by hormones regulated by the composition of the diet. By altering the composition of the diet in a balanced way that still meets the needs of the cow and lactation, it is possible to dramatically reduce the catabolism of progesterone. If the hypothesis that excess progesterone catabolism is at least a part of the reason for particularly low fertility rates in dairy cattle, then feeding them a diet which shifts the volatile fatty acid production towards propionate should increase their fertility. Furthermore, by carefully selecting feedstuffs one can meet the demands for milk production while increasing propionate production.

4. Associated Knowledge Areas

KA Code	Knowledge Area
301	Reproductive Performance of Animals
304	Animal Genome
305	Animal Physiological Processes

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Natural Disasters (drought, weather extremes, etc.)
- Appropriations changes
- Competing Public priorities

Brief Explanation

The sequestration in 2013 limited the funding we were able to use to conduct our research program in this area.

V(I). Planned Program (Evaluation Studies)

Evaluation Results

Experiment Station research program evaluation will take place at two levels and on two different time cycles. All programs will using these general criteria plus additional criteria tailored to each program as detailed in the Plan of Work under Outputs and State

Defined Outputs and Outcomes.

Annual evaluation will continue as before, looking at productivity in terms of immediate impact:

- Referee journal articles and books
- Professional presentations
- General audience papers and news reports
- M.S. and PhD graduates
- Trends in terms of competitive funding

And in terms of longer-term impact:

- Citations in scientific journals
- Patents
- Successful technology transfer or start-ups based on research programs
- Awards based on continuing impact and research excellence

In addition, every five years we will have a full portfolio review of our research programs in terms of:

- Long term productivity
- Relevance to our constituent groups and the State and Region
- The allocation of research inputs among the programs
- Consideration of eliminating some research programs that are not productive or have diminished relevance given NIFA and State priorities
- Consideration of adding additional program areas given NIFA and State priorities

This year we evaluated this program in terms of outputs (refereed journal articles, citations, graduate students graduated) and in terms of inputs (high quality competitive grants). Our highest levels of performance were in the molecular genetics and biochemistry areas. The results of this analysis are detailed below.

Key Items of Evaluation

We are in the process of hiring two more molecular geneticists in the Plant Sciences area, and are working with other Colleges on campus to develop a joint graduate program in Genetics and Biochemistry. We successfully merged our undergraduate program in biochemistry with the biology and chemistry departments and hope to do something similar at the graduate level with the addition of the College of Health Sciences to the inter-collegiate team.

V(A). Planned Program (Summary)

Program # 4

1. Name of the Planned Program

Global Food Security and Hunger--Production/Sustainable Agriculture

☑ Reporting on this Program

V(B). Program Knowledge Area(s)

1. Program Knowledge Areas and Percentage

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
133	Pollution Prevention and Mitigation			10%	
202	Plant Genetic Resources			5%	
205	Plant Management Systems			10%	
211	Insects, Mites, and Other Arthropods Affecting Plants			10%	
212	Pathogens and Nematodes Affecting Plants			10%	
216	Integrated Pest Management Systems			5%	
301	Reproductive Performance of Animals			15%	
302	Nutrient Utilization in Animals			15%	
303	Genetic Improvement of Animals			5%	
307	Animal Management Systems			10%	
313	Internal Parasites in Animals			5%	
	Total			100%	

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2013	Extension		Research	
	1862	1890	1862	1890
Plan	0.0	0.0	8.0	0.0
Actual Paid Professional	0.0	0.0	10.1	0.0
Actual Volunteer	0.0	0.0	0.0	0.0

2. Actual dollars expended in this Program (includes Carryover Funds from previous years)

Extension		Research	
Smith-Lever 3b & 3c	**1890 Extension**	**Hatch**	**Evans-Allen**
0	0	1019044	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
0	0	2026469	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
0	0	1335106	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

This program area involves applied research in plant and animal production systems. Projects are focused on increasing the productivity and sustainability of agriculture thereby contributing both to food security and alleviating world hunger.

West Virginia agriculture is dominated by high intensity poultry production and low intensity pasture-fed ruminant production with a declining amount of acreage in tree-fruit production. Much of the land in West Virginia is characterized by steep slopes and high rates of erosion that are suitable to pasture but not to intensive row-crop production. Most intensive crop production, including some fruits and vegetables, is limited to those regions of the state that have relatively flat terrain and favorable soil characteristics. To be competitive, West Virginia producers typically must become competitive either by increasing the value of what they produce or by reducing transportation and production costs by relying on locally-marketed products, by taking advantage of the State's proximity to major urban markets or by developing niche products. Some examples of successful enterprises include encouraging markets and consumer acceptance of pasture-raised and pasture-finished beef; cool water aquaculture; focusing on higher priced products such as those with ornamental or recreational use; increasing real or perceived product value in specialty or out-of-season markets such as lamb and organic products; and by diversifying product offerings. A number of projects at the Davis College involve long-term organic farming research involving plant systems, animal systems, integrated plant and animal systems and non-chemical control of parasites in sheep.

In the organic farming area, trials of different varieties continued. A three-year trial compared ten tomato cultivars in 2010, seven cultivars in 2011, and six cultivars in 2012, for susceptibility to early blight and Septoria leaf spot, and for damage and population density of Brown Marmorated Stink Bug (BMSB). Compost amendments significantly reduced early blight and promoted green leaf area duration, especially in indeterminate cultivars such as Brandywine, Big Beef or WV 63. Two numbered varieties, 99197 and 99199, had the least diseased foliage, while early season determinate cultivars such as Early Cascade, Celebrity and Paragon were most damaged by early blight and Septoria leaf spot. Tomato cultivars Gold Nugget, WV 63, Great White, Washington Red, Black Prince, Black Cherry, and White Cherry all showed injury to BMSB, although symptoms were most pronounced on darker cultivars. Yields were highest for Golden Nugget and Washington Cherry early in the season, but WV 63 and Great White were highest in the later part of the season. The compost effect was significant 4 of 5 harvest dates and the compost-by-cultivar interaction was statistically significant on 2 of 5 dates in 2011, but not in 2012. In almost all cases, yields were higher in plots with compost than in plots without, but there was a tendency for the low input plots to have higher yields very late in the growing season, suggesting that compost promotes early yields.

Understanding pest populations in time and space is necessary for effective pest management. In traditional pest management practice, a pest management decision (i.e. to control pests or not) is based on the evaluation of insect density or injury level within a management unit, which is usually an entire field. Control measures are applied only when the average pest density exceeds the economic threshold. However, many earlier studies showed that most pests are spatially aggregated, and thus control measures should be applied ideally only when and where needed within a field to maximize return from pest management. This new approach and its associated technologies are called spatially targeted pest management. Although the idea of spatially targeted pest management has long been recognized by farmers, the practical implementation of the idea in current industrial farming systems has not occurred mainly due to the lack of technology for spatially targeted application of control measures. In the past 20 years, new technology has become more accessible, which allows pest management practitioners to analyze spatial distribution of pests and incorporate spatial information into pest management. Such technology includes global positioning systems (GPS), geographic information systems (GIS), variable rate technology, and remote sensing. Researchers at WVU have developed a miniaturized autopilot system (only a weight of 3 oz.) which provides operating Unmanned Aerial Vehicles (UAVs) without a pilot or controller. Such UAV technology can be used for landscape-scale pest detection in a large geographic area, providing economical and effective landscape-scale pest detection. The system has been tested and found to be effective at altitudes above 60 feet and speeds up to 50 mph.

A sheep project titled, "Increased Efficiency of Sheep Production," examined the impacts of gonadotropic stimulation using PG 600 on the fertility o fall-born ewes and dry and lactating ewes bred out of season. A 15 percent increase in lambing rate was observed in dry ewes, while a more modest in lambing rate was observed in fall-born and lactating ewes. In another experiment lambs reared with ewes for 165 days gained 4 kgs more than lambs weaned at 75 days. Finally, pasture raised lambs that were given protein supplements during the growout period gained approximately 3 kgs more than lambs raised only on pasture. In 2013 over 100 farm visits were conducted, and over 200 attended 4 workshops related to profitability, marketing and parasite control.

2. Brief description of the target audience

The target audience for this program area includes producers, processors, distributors, extension specialists, agricultural consultants, regulators, policy makers and other researchers.

3. How was eXtension used?

eXtension was not used in this program

V(E). Planned Program (Outputs)

1. Standard output measures

2013	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	0	0	0	0

2. Number of Patent Applications Submitted (Standard Research Output)
Patent Applications Submitted

Year: 2013

Actual: 0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2013	Extension	Research	Total
Actual	0	12	12

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Presentation on research at professional meetings

Year	Actual
2013	20

Output #2

Output Measure

- Popular press articles on research

Year	Actual
2013	9

Output #3

Output Measure

- Completed graduate degree programs

Year	Actual
2013	8

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Growth in state sales of beef - % increase
2	Growth in state aquaculture industry - annual % increase in gross revenue
3	Growth in state broiler, egg and turkey sales- annual % increase

Outcome #1

1. Outcome Measures

Growth in state sales of beef - % increase

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	16

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Beef cattle and sheep production are important sectors of the WV agricultural economy, given the relative abundance of high quality pasture land and the relative shortage of prime farmland for intensive agricultural product production.

What has been done
We have a long-term integrated pasture-based beef program that has examined ways to increase the production quantity and quality of pasture grass and to enhance the market opportunities for pasture raised beef.

Results
Revenues in the State beef industry have continued to grow due to improved pasture and forage and favorable prices.

4. Associated Knowledge Areas

KA Code	Knowledge Area
205	Plant Management Systems
301	Reproductive Performance of Animals
302	Nutrient Utilization in Animals
303	Genetic Improvement of Animals
307	Animal Management Systems

Outcome #2

1. Outcome Measures

Growth in state aquaculture industry - annual % increase in gross revenue

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	6

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The State aquaculture industry takes advantage of one of West Virginia's best resources, cold fresh water. The aquaculture industry produces trout for stream stocking for recreational fishing and trout for restaurants and direct sale to consumers.

What has been done
We have been engaged in a long term project that combines research, demonstration projects and extension and outreach to try and support the aquacultural industry.

Results
Continued growth in the cold water aquaculture and aquaponics industries.

4. Associated Knowledge Areas

KA Code	Knowledge Area
133	Pollution Prevention and Mitigation
302	Nutrient Utilization in Animals
303	Genetic Improvement of Animals
307	Animal Management Systems

Outcome #3

1. Outcome Measures

Growth in state broiler, egg and turkey sales- annual % increase

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	20

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The poultry industry in WV (broilers, eggs and Turkeys) is the single largest agricultural industry in the State. There is considerable pressure on this industry due to increasing costs of production, regional competition and pressures to reduce phosphorus pollution in the Potomac Watershed.

What has been done
West Virginia University's Davis College has one of the most productive feed manufacture and animal nutrition research programs in the United States as evidenced by WVU's number of industry collaborations and publications, and by invitations to speak at national and international professional conferences. Current work in poultry feed pellet quality focuses on designing the feed in such a way that there is less breakage and waste when it is consumed. Other related work has focused on decreased potassium levels in feed to reduce water pollution from poultry litter.

Results
Continued growth in the industry and reduced water pollution due to feed reformulation and improves management practices.

4. Associated Knowledge Areas

KA Code	Knowledge Area
133	Pollution Prevention and Mitigation
211	Insects, Mites, and Other Arthropods Affecting Plants
307	Animal Management Systems

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Economy
- Appropriations changes
- Competing Public priorities

Brief Explanation

The sequestration in 2013 limited the funding we were able to use to conduct our research program in this area.

V(I). Planned Program (Evaluation Studies)

Evaluation Results

Experiment Station research program evaluation will take place at two levels and on two different time cycles. All programs will using these general criteria plus additional criteria tailored to each program as detailed in the Plan of Work under Outputs and State Defined Outputs and Outcomes.

Annual evaluation will continue as before, looking at productivity in terms of immediate impact:

- Referee journal articles and books
- Professional presentations
- General audience papers and news reports
- M.S. and PhD graduates
- Trends in terms of competitive funding

And in terms of longer-term impact:

- Citations in scientific journals
- Patents
- Successful technology transfer or start-ups based on research programs
- Awards based on continuing impact and research excellence

In addition, every five years we will have a full portfolio review of our research programs in terms of:

- Long term productivity
- Relevance to our constituent groups and the State and Region
- The allocation of research inputs among the programs
- Consideration of eliminating some research programs that are not productive or have diminished relevance given NIFA and State priorities
- Consideration of adding additional program areas given NIFA and State priorities

This year we continued to make progress based in our evaluations from 2012 that led to strengthening our Horticulture and Poultry programs. In addition, we did a financial evaluation of the operations of our farms and forests. The results are detailed below.

Key Items of Evaluation

We purchased several walk-in growth chambers to assist our horticulture researchers and are in the process of hiring a new plant pathologist and another professor of horticulture. We also hired (start in 2014) a new director of our Plant and Soil Sciences Division who is a strong researcher in the plant genetics and horticulture areas. The results of the evaluation of the farm financial situation led us to appoint a committee to come up with a plan to centralize finance and management of the farms in the Experiment Station. The results of that study should be finalized in 2014.

V(A). Planned Program (Summary)

Program # 5

1. Name of the Planned Program

Childhood Obesity, Human Nutrition and Health

☑ Reporting on this Program

V(B). Program Knowledge Area(s)

1. Program Knowledge Areas and Percentage

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
501	New and Improved Food Processing Technologies			15%	
502	New and Improved Food Products			15%	
702	Requirements and Function of Nutrients and Other Food Components			20%	
703	Nutrition Education and Behavior			30%	
724	Healthy Lifestyle			20%	
	Total			100%	

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2013	Extension		Research	
	1862	1890	1862	1890
Plan	0.0	0.0	3.5	0.0
Actual Paid Professional	0.0	0.0	2.7	0.0
Actual Volunteer	0.0	0.0	0.0	0.0

2. Actual dollars expended in this Program (includes Carryover Funds from previous years)

Extension		Research	
Smith-Lever 3b & 3c	**1890 Extension**	**Hatch**	**Evans-Allen**
0	0	351534	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
0	0	569425	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
0	0	301069	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

West Virginia citizens have the second highest level of obesity in the Nation (33.8%, Center for Disease Control, 2012). West Virginia is also above the national averages for incidence of diabetes, high blood pressure, and cardiovascular disease, as well as for osteopenia and osteoporosis. Station research in human nutrition and health is focused on determining the current and potential impacts of diet, nutritional education and dietary intervention on obesity and obesity related conditions (diabetes, elevated cholesterol and plasma lipids, heart attack, stroke and some cancers). The program also is testing the efficacy and safety of bioactive compounds in foods, including krill protein, and is developing omega-3 DHA enhanced diets and educational programs to support their adoption.

A number of projects continued to look at the effects of omega-3 DHA enhanced diets on various aspects of human health, either directly or through animal models. The general population is encouraged to increase omega-3 polyunsaturated fatty acid (n-3 PUFA) intake in order to optimize health for preventative health care. Consumers are typically unaware that different amounts, types, and structural forms of n-3 PUFA have different efficacy. Therefore, the objectives of one research project were to characterize different sources of n-3 PUFAs and to determine whether consumption of these oils influences renal fatty acid composition and renal health. Lipid classes and fatty acid profile of corn (CO), flaxseed (FO), menhaden (MO), salmon (SO), tuna (TO) or krill (KO) oils were determined by thin-layer and gas chromatography. The study results indicated that consumption of n-3 PUFAs influences renal health and the effects varied depending on the n-3 PUFA source consumed. The research so far has led to receipt of a Soybean Health Program Incentive Grant and the preparation and submission of a NIH R01 grant. The next phase of the study will look at the effects of diet on polycystic kidney disease progression.

Twenty-first century century consumers are fully aware of health benefits associated with omega-3 FA. Similarly to organic foods, the sales of nutraceutical food products have steadily increased over the past decade and it is expected that this trend will continue. The main goal of another research project is to develop nutritional foods that are high in omega-3 FA and would appeal to consumers. Development of foods containing higher concentrations of omega-3 FA are of interest because of their role in decreasing the risk of diseases such as cardiovascular disease, type 2 diabetes and obesity. The impact of this research could have positive effects on overall nutrition and health of consumers. Isoelectric solubilization and precipitation (ISP) processing is a protein recovery process where high or low pH conditions cause protein separation from insoluble fractions of the fish (i.e. bones, skin, scales, etc.) by solubilization. Using pH shifts, protein is recovered by precipitation and centrifugation. This process has been shown to provide efficient and favorable recovery rates when compared to other commercial processing techniques such as mechanical filleting or conventional methods involving separators and decanters (Taskaya et al., 2009). Traditionally, strong acids such as HCl are used in the process but organic acids have been shown to be more effective at reducing bacterial pathogens. The results of these studies showed that organic acids have the potential to recover protein and lipid from otherwise hard to process fish by ISP processing. The gels made from recovered carp protein show similar or improved functional, texture and color properties compared to Alaska Pollock surimi depending on the treatment and might be used for the development of restructured fish products and value-added for human consumption.

2. Brief description of the target audience

The target audience for this program area includes dieticians, nutritionists, policy makers, researchers, extension specialists, 4-H and other youth program developers, community leaders and State citizens.

3. How was eXtension used?

eXtension was not used in this program

V(E). Planned Program (Outputs)

1. Standard output measures

2013	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	0	0	0	0

2. Number of Patent Applications Submitted (Standard Research Output)

Patent Applications Submitted

Year: 2013

Actual: 0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2013	Extension	Research	Total
Actual	0	9	0

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Presentations on research at scientific meetings

Year	Actual
2013	10

Output #2

Output Measure

- Popular press articles on research

Year	Actual
2013	2

Output #3

Output Measure

- Completed graduate degree programs

Year	Actual
2013	3

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Annual reduction in state incidence of obesity -% reduction
2	Participants in nutition workshops will increase their knowledge of the relation between nutrition and health (% of participants reporting a gain in knowledge).
3	Participants in nutrition workshops will gain an understanding of how to make healthy food choices (% reporting a gain in understanding).
4	Development of inexpensive food sources of protein and omega 3 fatty acids.

Outcome #1

1. Outcome Measures

Annual reduction in state incidence of obesity -% reduction

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
West Virginia citizens have the second highest level of obesity in the Nation (33.2%, Center for Disease Control, 2012, an increase over last year's 32.4 %). West Virginia is also above the national averages for incidence of diabetes, high blood pressure, and cardiovascular disease, as well as for osteopenia and osteoporosis.

What has been done
Station research in human nutrition and health is focused on determining the current and potential impacts of diet, nutritional education and dietary intervention on obesity and obesity related conditions (diabetes, elevated cholesterol and plasma lipids, heart attack, stroke and some cancers).

Results
While the overall rate of obesity increased somewhat, preliminary data indicate a decline in the rate of childhood obesity. Since the target groups of our work have been children and adolescents, this finding,if proven to be statistically significant, is promising.

4. Associated Knowledge Areas

KA Code	Knowledge Area
702	Requirements and Function of Nutrients and Other Food Components
703	Nutrition Education and Behavior

Outcome #2

1. **Outcome Measures**

Participants in nutition workshops will increase their knowledge of the relation between nutrition and health (% of participants reporting a gain in knowledge).

Not Reporting on this Outcome Measure

Outcome #3

1. **Outcome Measures**

Participants in nutrition workshops will gain an understanding of how to make healthy food choices (% reporting a gain in understanding).

Not Reporting on this Outcome Measure

Outcome #4

1. **Outcome Measures**

Development of inexpensive food sources of protein and omega 3 fatty acids.

2. **Associated Institution Types**

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Omega-3 PUFA's are claimed to have positive effects on humans by reducing triglycerides and cholesterol. Research is needed on the relationship between different sources of omega-3 PUFA's and health and applied research is needed to develop consumer acceptable products that contain omega-3 PUFA's.

What has been done
Development of foods containing higher concentrations of omega-3
FA are of interest because of their role in decreasing the risk of diseases such as cardiovascular

disease, type 2 diabetes and obesity. The impact of this research could have positive effects on overall nutrition and health of consumers. Isoelectric solubilization and precipitation (ISP) processing is a protein recovery process where high or low pH conditions cause protein separation from insoluble fractions of the fish (i.e. bones, skin, scales, etc.) by solubilization. Using pH shifts, protein is recovered by precipitation and centrifugation.

Results
The process has been shown to provide efficient and favorable recovery rates when compared to other commercial processing techniques such as mechanical filleting or conventional methods involving separators and decanters. The gels made from recovered carp protein show similar or improved functional, texture and color properties compared to Alaska Pollock surimi depending on the treatment and might be used for the development of restructured fish products and value-added for human consumption.

4. Associated Knowledge Areas

KA Code	Knowledge Area
501	New and Improved Food Processing Technologies
502	New and Improved Food Products

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Economy
- Appropriations changes
- Competing Public priorities

Brief Explanation

The sequestration in 2013 limited the funding we were able to use to conduct our research program in this area.

V(I). Planned Program (Evaluation Studies)

Evaluation Results

Experiment Station research program evaluation will take place at two levels and on two different time cycles. All programs will using these general criteria plus additional criteria tailored to each program as detailed in the Plan of Work under Outputs and State Defined Outputs and Outcomes.

Annual evaluation will continue as before, looking at productivity in terms of immediate impact:

- Referee journal articles and books
- Professional presentations
- General audience papers and news reports
- M.S. and PhD graduates
- Trends in terms of competitive funding

And in terms of longer-term impact:

- Citations in scientific journals
- Patents
- Successful technology transfer or start-ups based on research programs
- Awards based on continuing impact and research excellence

In addition, every five years we will have a full portfolio review of our research programs in terms of:

- Long term productivity
- Relevance to our constituent groups and the State and Region
- The allocation of research inputs among the programs
- Consideration of eliminating some research programs that are not productive or have diminished relevance given NIFA and State priorities
- Consideration of adding additional program areas given NIFA and State priorities

We are still working to complete the results of the reviews we conducted in 2012. We are continuing to increase the amount of funded research we do jointly with Extension and are still working to improve our level of joint planning. In 2014 we will do our first consolidated Plan of Work with WVU Extension and WV State Research and Extension.

Key Items of Evaluation

V(A). Planned Program (Summary)

Program # 6

1. Name of the Planned Program

Production/Sustainable Forestry - Timber Management and Wood Products

☑ Reporting on this Program

V(B). Program Knowledge Area(s)

1. Program Knowledge Areas and Percentage

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
123	Management and Sustainability of Forest Resources			65%	
124	Urban Forestry			5%	
203	Plant Biological Efficiency and Abiotic Stresses Affecting Plants			10%	
511	New and Improved Non-Food Products and Processes			20%	
	Total			100%	

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2013	Extension		Research	
	1862	1890	1862	1890
Plan	0.0	0.0	7.0	0.0
Actual Paid Professional	0.0	0.0	6.5	0.0
Actual Volunteer	0.0	0.0	0.0	0.0

2. Actual dollars expended in this Program (includes Carryover Funds from previous years)

Extension		Research	
Smith-Lever 3b & 3c	**1890 Extension**	**Hatch**	**Evans-Allen**
0	0	8996	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
0	0	893907	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
0	0	502684	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

This program includes research to develop improved procedures for hardwood timber management and harvest, to increase the efficiency of wood utilization while developing new uses for hardwoods, and, increasingly, to devise new processes to efficiently utilize wood and timber resources in the production of renewable bio-energy and bio-products. Timber management research includes specifically the development of models to predict yields, systems to protect forest resources from insect pests, acid precipitation, fire, disease, and invasive species; harvest management protocols for optimum regeneration and re-growth; methods to use harvest and processing wastes to efficiently produce bio-energy; feedstock and bioproduct logistics; and, programs that respond to research needs and concerns of corporate and private owners and provide economic comparisons among alternative management and harvest methods.

A continuing study is looking at market potential and alternative-uses for abundant but under-utilized Appalachian hardwoods such as yellow poplar and especially red maple. One facet of this study is identification and manufacturing of new, value-added veneer-based products from these under-utilized species. The impact of the project during this project period was the development of alternative composite materials using hardwood biomass materials that went through a value-added conversion process. Specifically, in terms of the alternative composites, mixed hardwood biomass that was carbonized (i.e., biochar) was used as a reinforcement for a film material that could be used for a variety of applications. In additional to a reinforcement for film material, research was performed to look at using carbonized hardwoods to make sensors that could be used in a variety of applications such as humidity and temperature monitoring, gas emission monitoring, and general touch sensors. The use of carbonized hardwood has potential for being used for electrical sensing, energy storage, composite, and fuel cell applications. The research led to a better understanding of how carbonized wood acted in terms of reinforcing polymer films and improving the electrical conductivity of sensors. The project is expected to have a positive impact on converting low-value hardwoods into high-value materials with predictable properties that can be used in energy storage, sensor, and composite applications. Work is underway to investigate the electrical conductivity of these materials under dynamical mechanical thermal conditions. This work is expected to produce a unique type of touch sensor produced from carbonized hardwood as the electrical conductor. Through this work, we also realized a change in knowledge on the unique nature of carbon from woody biomass sources, as compared to other carbon sources. We think we can harness these unique properties in the development of unique bio-based electrical conducting materials.

A project titled, "Using Biomechanical Approaches to Understand How Branch Development Leads to Stable Crown Form," is looking at how urban tree branches grow and develop so arborists and urban foresters can better understand how to manage urban trees and minimize the risk of failure. Understanding development will help managers increase the resiliency of urban trees, hopefully leading to fewer power outages during storm events or reducing the duration of outages.

A forestry program has examined the role of peer-to-peer learning as a vehicle for outreach compared with more traditional technical assistance programs. Peer-to-peer learning involves sharing of knowledge or experiences among landowners either through formal or informal social networks. Empirical evidence in other states has shown that landowners tend to trust people like themselves and are therefore more likely to adopt new programs if they see their peers do so. Given the vast number of woodland owners in our state (estimated to be about 250,000), it is in the interest of the West Virginia Division of Forestry to promote networks of woodland owners that are self-sustaining and that provide an efficient way to enroll woodland owners and other stakeholders in landscape conservation efforts. The cornerstone of our promotion of peer-to-peer networks is the woodland tour. On these tours of private woodland properties, woodland owners and general nature enthusiasts come together to learn from one another. During the FY2013 period, we hosted nine field-based woodland tours. A total of 229 individuals attended

these tours. We maintained a list of addresses for the attendees and are currently developing a mail-based questionnaire to assess the impacts of the woodland tours. The questionnaire will be sent out in January 2014.

2. Brief description of the target audience

The target audience for this program includes professional foresters, the forest-product industry, small and large woodlot owners, extension specialists, consultants, regulators and policy makers.

3. How was eXtension used?

eXtension was not used in this program

V(E). Planned Program (Outputs)

1. Standard output measures

2013	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	0	0	0	0

2. Number of Patent Applications Submitted (Standard Research Output)

Patent Applications Submitted

Year: 2013

Actual: 0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2013	Extension	Research	Total
Actual	0	8	8

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Presentations on research at professional meetings

Year	Actual
2013	22

Output #2

Output Measure

- Popular press articles on research

Year	Actual
2013	2

Output #3

Output Measure

- Completed graduate degree programs

Year	Actual
2013	4

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Growth in state timber industry - % change
2	Growth in state wood products and furniture industry - % change
3	Program and workshop participants will gain information that will improve their forest operation management skills (% of participants who report a gain in knowledge).

Outcome #1

1. Outcome Measures

Growth in state timber industry - % change

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The WV State forest industry is larger than the agricultural sector in terms of its contribution to the State economy. The health of the forest sector is thus crucial to the health of the State economy. It is a renewable resource based industry and is thus sustainable if managed properly. One way of expanding the industry is to find markets for underutilized hardwood species.

What has been done
A continuing study is looking at market potential and alternative-uses for abundant but under-utilized Appalachian hardwoods such as yellow poplar and especially red maple. One facet of this study is identification and manufacturing of new, value-added veneer-based products from these under-utilized species.

Results
The impact of the project during this project period was the development of alternative composite materials using hardwood biomass materials that went through a value-added conversion process. Specifically, in terms of the alternative composites, mixed hardwood biomass that was carbonized (i.e., biochar) was used as a reinforcement for a film material that could be used for a variety of applications. In additional to a reinforcement for film material, research was performed to look at using carbonized hardwoods to make sensors that could be used in a variety of applications such as humidity and temperature monitoring, gas emission monitoring, and general touch sensors. The use of carbonized hardwood has potential for being used for electrical sensing, energy storage, composite, and fuel cell applications. The research led to a better understanding of how carbonized wood acted in terms of reinforcing polymer films and improving the electrical conductivity of sensors. The project is expected to have a positive impact on converting low-value hardwoods into high-value materials with predictable properties that can be used in energy storage, sensor, and composite applications.

4. Associated Knowledge Areas

KA Code	Knowledge Area
123	Management and Sustainability of Forest Resources

Outcome #2

1. Outcome Measures

Growth in state wood products and furniture industry - % change

Not Reporting on this Outcome Measure

Outcome #3

1. Outcome Measures

Program and workshop participants will gain information that will improve their forest operation management skills (% of participants who report a gain in knowledge).

Not Reporting on this Outcome Measure

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Economy
- Appropriations changes
- Public Policy changes
- Competing Public priorities

Brief Explanation

The sequestration in 2013 limited the funding we were able to use to conduct our research program in this area.

V(I). Planned Program (Evaluation Studies)

Evaluation Results

Experiment Station research program evaluation will take place at two levels and on two different time cycles. All programs will using these general criteria plus additional criteria tailored to each program as detailed in the Plan of Work under Outputs and State Defined Outputs and Outcomes.

Annual evaluation will continue as before, looking at productivity in terms of immediate impact:

- Referee journal articles and books
- Professional presentations
- General audience papers and news reports
- M.S. and PhD graduates

- Trends in terms of competitive funding

And in terms of longer-term impact:

- Citations in scientific journals
- Patents
- Successful technology transfer or start-ups based on research programs
- Awards based on continuing impact and research excellence

In addition, every five years we will have a full portfolio review of our research programs in terms of:

- Long term productivity
- Relevance to our constituent groups and the State and Region
- The allocation of research inputs among the programs
- Consideration of eliminating some research programs that are not productive or have diminished relevance given NIFA and State priorities
- Consideration of adding additional program areas given NIFA and State priorities

The Forestry/Natural Resources Program is evaluated annually by a board of advisors composed of university researchers, industry representatives and representatives of relevant government agencies.

Key Items of Evaluation

This year we continued to implement the results of last year's evaluation to upgrade the laboratories and facilities in our Forestry program. We were delayed due to budgetary issues, but the renovations are now in progress. We also had a joint evaluation of our research programs with the regional USDA Forest Service. The results of that review were extremely positive and will lead to more cooperative work with the Forest Service and may also lead to some joint hires in strategic areas.

V(A). Planned Program (Summary)

Program # 7

1. Name of the Planned Program

Sustainable Energy

☑ Reporting on this Program

V(B). Program Knowledge Area(s)

1. Program Knowledge Areas and Percentage

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
133	Pollution Prevention and Mitigation			10%	
403	Waste Disposal, Recycling, and Reuse			20%	
511	New and Improved Non-Food Products and Processes			40%	
605	Natural Resource and Environmental Economics			15%	
610	Domestic Policy Analysis			15%	
	Total			100%	

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2013	Extension		Research	
	1862	1890	1862	1890
Plan	0.0	0.0	2.5	0.0
Actual Paid Professional	0.0	0.0	1.3	0.0
Actual Volunteer	0.0	0.0	0.0	0.0

2. Actual dollars expended in this Program (includes Carryover Funds from previous years)

Extension		Research	
Smith-Lever 3b & 3c	**1890 Extension**	**Hatch**	**Evans-Allen**
0	0	28724	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
0	0	157746	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
0	0	101088	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

This program focuses on biofuel and bioenergy production. We have increased activity and funding of this area as indicated in the Plan of Work. The program so far is focused on examining different biomass feedstocks for the production of biofuels (ethanol, biodiesel, syngas) and biomaterials, nondestructive methods for characterizing the physical and chemical properties of lingo-cellulosic biomass, and syngas production from co-firing coal and biomass. The feedstocks examined so far include algae, switchgrass and mixed grasses, and residual woody biomass from forestry operations.

A continuing project focuses on production of biofuels and bioproducts from biomass. Biomass gasification technology has been proven at small-scale. The biomass gasification process requires large amounts of feedstock supply, is an expensive process and has some operational problems. The main problems are: tar formation and subsequent clogging of pipe lines due to tar accumulation and low melting point of ash present in woody biomass leading to agglomeration which cause de-fluidization of fluidized bed gasifiers. Hence, economics and operational problems limit biomass gasification technology at commercial scale. While biomass gasification technology matures, coal-biomass gasification with some modifications in coal fed gasifiers seems promising as an option for commercial scale syngas production. Co-gasification of biomass and coal produces a synergistic effect to gain environmental and technical advantages over biomass or coal gasification alone. In 2013 use of coal-hardwood pellet mixtures was evaluated to produce syngas using an air as well as air-mist mixture as gasifying agents in a downdraft gasifer. Results showed that coal agglomeration adversely affected the gasification process when mixtures with 80% or more coal were fed. Use of 20% of coal and 80% biomass in a down-draft gasfier helps to increase carbon conversion efficiency without any significant decrease in the hydrogen concentration of the syngas.

As prices of oil continue to remain high and predicted known oil reserves remain finite, the need to find alternate sources of energy and chemicals has become more urgent than ever. Lignocellulosic biomass, a renewable non-edible resource represents such an "alternate source." As non-renewable energy sources such as whale oil and petroleum oil were the primary energy sources for the 19th and 20th centuries respectively, lignocellulosic biomass, may be the energy and biochemical source for the 21st century. Tremendous amounts of wood residues are generated by various forest products operations in West Virginia. This presents a potential opportunity for economic development for the state. One of the goals of this project is to develop new methods of extracting lipids from Camelina sativa and producing biodiesel, a goal that was attained in 2013.

2. Brief description of the target audience

The target audience for this program area includes the bio-fuels and materials industries, the electricity generating industry, researchers, regulators, policy makers, and foresters.

3. How was eXtension used?

eXtension was not used in this program

V(E). Planned Program (Outputs)

1. Standard output measures

2013	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	0	0	0	0

2. Number of Patent Applications Submitted (Standard Research Output)

Patent Applications Submitted

Year: 2013

Actual: 0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2013	Extension	Research	Total
Actual	0	16	16

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Presentations on research at professional meetings

Year	Actual
2013	30

Output #2

Output Measure

- Energy policy papers

Year	Actual
2013	3

Output #3

Output Measure

- Completed graduate degree programs

Year	Actual

2013 3

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Work with the electrical generation industry to increase the percentage of renewable sources of biomass co-fired with coal (% increase per year)
2	Develop new processes for converting lignocellulose to usable sources of energy (number of new processes).
3	Percentage of participants in workshops held in the State on sustainable energy production and use who gain an understanding of the issue (% who report gains in knowledge).

Outcome #1

1. Outcome Measures

Work with the electrical generation industry to increase the percentage of renewable sources of biomass co-fired with coal (% increase per year)

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The economy of WV is heavily dependent on the coal and natural gas industries, both exhaustible fossil fuels. There is a need to diversify both the State economy and our portfolio of energy sources. Increasing the amount of renewable energy production will help diversify the State economy, reduce our dependence as a country on imports of fossil fuels, and lead to a more sustainable energy supply. One way to do this is combining coal with renewable sources of biomass to produce energy products.

What has been done
A continuing integrated project focuses on production of biofuels and bioproducts from biomass. Biomass gasification technology has been proven at small-scale. The biomass gasification process requires large amounts of feedstock supply, is an expensive process and has some operational problems. The main problems are: tar formation and subsequent clogging of pipe lines due to tar accumulation and low melting point of ash present in woody biomass leading to agglomeration which cause de-fluidization of fluidized bed gasifiers. Hence, economics and operational problems limit biomass gasification technology at commercial scale.

Results
While biomass gasification technology matures, coal-biomass gasification with some modifications in coal fed gasifiers seems promising as an option for commercial scale syngas production. Co-gasification of biomass and coal produces a synergistic effect to gain environmental and technical advantages over biomass or coal gasification alone. In 2013 use of coal-hardwood pellet mixtures was evaluated to produce syngas using an air as well as air-mist mixture as gasifying agents in a downdraft gasifer.

4. Associated Knowledge Areas

KA Code	Knowledge Area
133	Pollution Prevention and Mitigation
403	Waste Disposal, Recycling, and Reuse
511	New and Improved Non-Food Products and Processes

Outcome #2

1. Outcome Measures

Develop new processes for converting lignocellulose to usable sources of energy (number of new processes).

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
As prices of oil continue to remain high and predicted known oil reserves remain finite, the need to find alternate sources of energy and chemicals has become more urgent than ever. Lignocellulosic biomass, a renewable non-edible resource represents such an "alternate source."

What has been done
One of the goals of a Davis College project is to develop new methods of extracting lipids from Camelina sativa and producing biodiesel.

Results
Biodiesel was produced from Camelina in 2013.

4. Associated Knowledge Areas

KA Code	Knowledge Area
511	New and Improved Non-Food Products and Processes

Outcome #3

1. **Outcome Measures**

Percentage of participants in workshops held in the State on sustainable energy production and use who gain an understanding of the issue (% who report gains in knowledge).

Not Reporting on this Outcome Measure

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Economy
- Appropriations changes

Brief Explanation

The sequestration in 2013 limited the funding we were able to use to conduct our research program in this area.

V(I). Planned Program (Evaluation Studies)

Evaluation Results

Experiment Station research program evaluation will take place at two levels and on two different time cycles. All programs will using these general criteria plus additional criteria tailored to each program as detailed in the Plan of Work under Outputs and State Defined Outputs and Outcomes.

Annual evaluation will continue as before, looking at productivity in terms of immediate impact:

- Referee journal articles and books
- Professional presentations
- General audience papers and news reports
- M.S. and PhD graduates
- Trends in terms of competitive funding

And in terms of longer-term impact:

- Citations in scientific journals
- Patents
- Successful technology transfer or start-ups based on research programs
- Awards based on continuing impact and research excellence

In addition, every five years we will have a full portfolio review of our research programs in terms of:

- Long term productivity

- Relevance to our constituent groups and the State and Region
- The allocation of research inputs among the programs
- Consideration of eliminating some research programs that are not productive or have diminished relevance given NIFA and State priorities
- Consideration of adding additional program areas given NIFA and State priorities

As discussed last year this program is still relatively new. It is progressing well and has attracted high quality competitive funding from AFRI and DOE as well as increasing its visibility in the region (as measured by competitively funded AFRI research projects with Penn State, Rutgers and Cornell).

Key Items of Evaluation

One area we did evaluate this year was our commitment to bioenergy research given the rapidly changing energy markets due to the increasing production from unconventional oil and gas extraction. We decided to keep our focus on bioenergy because of its future potential, the availability of biomass in this region for conversion, and the expected pressures from global climate change on fossil fuel use in the near future. We also decided to strengthen our faculty resources in the water area and to work jointly with the College of Engineering to help investigate the environmental impacts of shale gas extraction.

V(A). Planned Program (Summary)

Program # 8

1. Name of the Planned Program

Food Safety

☐ Reporting on this Program

Reason for not reporting

This goal area has been merged into the Global Food Security and Hunger: Production/Sustainable Agriculture goal area. It will be revived in 2015 after our new combined Plan of Work with WVU Extension and WV State University takes effect.

V(B). Program Knowledge Area(s)

1. Program Knowledge Areas and Percentage

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2013	Extension		Research	
	1862	1890	1862	1890
Plan	0.0	0.0	1.0	0.0
Actual Paid Professional	{NO DATA ENTERED}	{NO DATA ENTERED}	{NO DATA ENTERED}	{NO DATA ENTERED}
Actual Volunteer	{NO DATA ENTERED}	{NO DATA ENTERED}	{NO DATA ENTERED}	{NO DATA ENTERED}

2. Actual dollars expended in this Program (includes Carryover Funds from previous years)

Extension		Research	
Smith-Lever 3b & 3c	**1890 Extension**	**Hatch**	**Evans-Allen**
{NO DATA ENTERED}	{NO DATA ENTERED}	{NO DATA ENTERED}	{NO DATA ENTERED}
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
{NO DATA ENTERED}	{NO DATA ENTERED}	{NO DATA ENTERED}	{NO DATA ENTERED}
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
{NO DATA ENTERED}	{NO DATA ENTERED}	{NO DATA ENTERED}	{NO DATA ENTERED}

V(D). Planned Program (Activity)

1. Brief description of the Activity

The primary activities in this program area involve food safety issues in management of processed fish and fish fillets from cold-water aquaculture operations and developing procedures for testing and for

eradicating newly emerging water-borne bacteria that may enter the food supply. Research findings will be communicated to the public, the food processing industry and policy makers in conjunction with the outreach efforts of WVU Extension.

2. Brief description of the target audience

The target audience for this program area includes the food processing industry, the aquacultural producers and marketers, food processors, regulators and policy makers.

3. How was eXtension used?

{No Data Entered}

V(E). Planned Program (Outputs)

1. Standard output measures

2013	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	0	0	0	0

2. Number of Patent Applications Submitted (Standard Research Output)

Patent Applications Submitted

Year: 2013

Actual: {No Data Entered}

Patents listed

{No Data Entered}

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2013	Extension	Research	Total
Actual	0	1	0

V(F). State Defined Outputs

Output Target

<u>Output #1</u>

Output Measure

- Presentations at Professional Meetings

Year **Actual**

2013	0

Output #2

Output Measure

- Articles for the general public

Year	Actual
2013	0

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Participants attending food safety workshops will gain information that improves their ability to manage food safety issues (% reporting gain in knowledge).

Outcome #1

1. Outcome Measures

Participants attending food safety workshops will gain information that improves their ability to manage food safety issues (% reporting gain in knowledge).

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
{No Data Entered}

What has been done
{No Data Entered}

Results
{No Data Entered}

4. Associated Knowledge Areas

KA Code	Knowledge Area
{No Data}	null

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Economy
- Public Policy changes
- Government Regulations

Brief Explanation

{No Data Entered}

V(I). Planned Program (Evaluation Studies)

Evaluation Results

{No Data Entered}

Key Items of Evaluation

{No Data Entered}