

2014 West Virginia University Research Annual Report of Accomplishments and Results

Status: Accepted

Date Accepted: 06/05/2015

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 2014 we continued to coordinate efforts by the Experiment Station and Extension to encourage joint faculty efforts to go after competitive funding. In 2013 and 2014 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, the associate director of the WVU Experiment Station and selected WVU faculty and the directors of the McIntire Stennis program met with directors and faculty from WV State to review our joint research efforts and to identify new areas for joint research. In addition, starting in 2014 we submitted 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 reporting 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 recently completed a reorganization to streamline our administrative structure. Previously we had 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 have three schools, the School of Agriculture and Food (a merger of Plant and Soil Sciences and Animal and Nutritional Sciences); the School of Design and Community Development (a merger of Design and Merchandising with two programs that were formerly part of the Division of Resource Management--Landscape Architecture and Agricultural and Extension Education); and, the School of Natural Resources (comprised by the former Division of Forestry and Natural Resources and the Agricultural and Resource Economics program). The logic of the reorganization 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 2014 highlighted in the narrative for each program area.

Total Actual Amount of professional FTEs/SYs for this State

Year: 2014	Extension		Research	
	1862	1890	1862	1890
Plan	0.0	0.0	42.0	0.0
Actual	0.0	0.0	39.5	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.

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.

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.

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 construction of a new 240,000 square foot 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. The new building will have over 50 wet labs as well as a state of the art meat lab. These new facilities as well as scheduled renovations 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, as well as a cut in the operating budgets for our farms, 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 another cut in our State budget plus the loss of direct State support for our farms and some programs. We are examining 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 Organic Farm Field Day and our Kiddie Days and Family Days activities at our animal science farm in Morgantown, our soil test service lab and our organic field day at our horticulture farm in Morgantown, were highly valued and should be continued. Unfortunately the loss in operating funds may force us to cut some of these activities.

More specific stakeholder input and our reactions to that input are given in the evaluation sections of each of the the planned programs.

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	3320978	0

2. Totaled Actual dollars from Planned Programs Inputs				
	Extension		Research	
	Smith-Lever 3b & 3c	1890 Extension	Hatch	Evans-Allen
Actual Formula	0	0	3017213	0
Actual Matching	0	0	6414312	0
Actual All Other	0	0	3542608	0
Total Actual Expended	0	0	12974133	0

3. Amount of Above Actual Formula Dollars Expended which comes from Carryover funds from previous				
Carryover	0	0	2335055	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	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
7	Sustainable Energy

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			15%	
608	Community Resource Planning and Development			15%	
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: 2014	Extension		Research	
	1862	1890	1862	1890
Plan	0.0	0.0	6.5	0.0
Actual Paid	0.0	0.0	7.4	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	456125	0
1862 Matching	1890 Matching	1862 Matching	1890 Matching
0	0	799690	0
1862 All Other	1890 All Other	1862 All Other	1890 All Other
0	0	241914	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 three 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.

One area that is experiencing growth involves local food supply chains (LFSC). The United States has seen considerable growth in farmer's markets, community supported agriculture, and the use of roadside markets. Fueling the growth in these contemporary supply chains are consumer demand for high quality, fresh food products, reduction in food miles, and the use of environmentally friendly production practices. The development of LFSC is increasingly being viewed as an "alternative" to the "traditional" agribusiness supply chains. One project is designed to analyze the characteristics and performance of LFSC in the Appalachian region. The study examines the vertical and horizontal coordination, technology innovation, and competitive strategies utilized by LFSC to respond to changing consumer preferences and gain sustained competitive advantage and market share. A second project is engaged in outreach to low income households to promote their Community Food Hub that sells local foods. A third project has been educating urban farmers about how to grow and market their produce locally. And the fourth project conducted a pilot project with food pantry clients where they were provided with education and half of a CSA (Community Supported Agriculture) share for the season with plans for fundraising among the families and community partners to expand the CSA partnership with low income households next year.

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 aquaculture 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

2014	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: 2014
 Actual: 0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2014	Extension	Research	Total
Actual	0	9	0

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Presentations on research at professional meetings

Year Actual

2014 33

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
2014	2

Output #3

Output Measure

- Completed graduate degree programs

Year	Actual
2014	12

Output #4

Output Measure

- Popular press reports.

Year	Actual
2014	10

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.
3	Projects designed to stimulate local food production and markets

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.

Not Reporting on this Outcome Measure

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
2014	2

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

WV is a lagging state in terms of economic performance. The labor pool, especially skilled labor, is shrinking as people leave the state in search of better jobs.

What has been done

The fastest growing sector of the U.S. is the small business sector. We have strengthened our entrepreneurship programs and assistance in processing patents and licensing agreements to help new small businesses start up.

Results

We are negotiating a licensing agreement with a major food company to use a process for recovering fish protein and producing healthy fish sticks. This should lead to the creation of jobs as well as revenues for the State. Second, we are working with a major hog producer to move one of their hog producing and processing operations to WV to develop a production plan that not only produces processed pork but utilizes a WVU patented process for converting swine manure to biodiesel.

4. Associated Knowledge Areas

KA Code	Knowledge Area
131	Alternative Uses of Land
511	New and Improved Non-Food Products and Processes
604	Marketing and Distribution Practices
608	Community Resource Planning and Development
724	Healthy Lifestyle
903	Communication, Education, and Information Delivery

Outcome #3

1. Outcome Measures

Projects designed to stimulate local food production and markets

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

One area that is experiencing growth nationwide involves local food supply chains (LFSC). The United States has seen considerable growth in farmer's markets, community supported agriculture, and the use of roadside markets. Fueling the growth in these contemporary supply chains are consumer demand for high quality, fresh food products, reduction in food miles, and the use of environmentally friendly production practices. The development of LFSC is increasingly being viewed as an "alternative" to "traditional" agribusiness supply chains. We have four projects designed to increase production and consumption of locally produced food in WV.

What has been done

One project is designed to analyze the characteristics and performance of LFSC in the Appalachian region. The study examines the vertical and horizontal coordination, technology innovation, and competitive strategies utilized by LFSC to respond to changing consumer preferences and gain sustained competitive advantage and market share. A second project is engaged in outreach to low income households to promote their Community Food Hub that sells local foods. A third project has been educating urban farmers about how to grow and market their produce locally. And the fourth project conducted a pilot project with food pantry clients where they were provided with education and half of a CSA (Community Supported Agriculture) share

for the season with plans for fundraising among the families and community partners to expand the CSA partnership with low income households next year.

Results

Results so far have been modest, as our efforts are relatively new. We have received a lot of interest from local communities to help link local food producers with food hubs and local K-12 schools. We expect to see concrete results in the upcoming year.

4. Associated Knowledge Areas

KA Code	Knowledge Area
604	Marketing and Distribution Practices
608	Community Resource Planning and Development
724	Healthy Lifestyle
903	Communication, Education, and Information Delivery

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Economy
- Appropriations changes

Brief Explanation

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 use 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. We have heard from our stakeholders (citizens of the state and State Legislators, in particular) that we need to train our students so that they are job ready when they graduate and to prepare them for jobs that exist within the State. Too many of our "best and brightest" have to leave the State to find employment, which reduces the human capital of WV.

In response, we have developed two new academic programs that are designed to produce students at the undergraduate level that are job ready. The first is called E-Quad, which stands for Energy, Economics, Entrepreneurship and Environment. It is a multidisciplinary program that draws on what we call the traditional STEM disciplines--Science, Technology, Engineering and Math, plus coursework in economics, business, and law. Upon graduation these students will be prepared for jobs in the energy sector that can range from energy companies to state and federal regulatory agencies.

The second program is called Energy Land Management. The focus of this program is on giving students skills in land management and energy development. There is a growing need for professionals in the energy land management area due to the rapid growth in shale gas and petroleum industries. Our program is one of only a few programs to be accredited by the American Association of Professional Landmen.

Key Items of Evaluation

We have heard from our stakeholders (citizens of the state and State Legislators, in particular) that we need to train our students so that they are job ready when they graduate and to prepare them for jobs that exist within the State. Too many of our "best and brightest" have to leave the State to find employment, which reduces the human capital of WV.

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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: 2014	Extension		Research	
	1862	1890	1862	1890
Plan	0.0	0.0	8.0	0.0
Actual Paid	0.0	0.0	8.2	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	423845	0
1862 Matching	1890 Matching	1862 Matching	1890 Matching
0	0	1116157	0
1862 All Other	1890 All Other	1862 All Other	1890 All Other
0	0	969429	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 coal mines and natural gas fields 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. 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.

Once introduced into soils and waters, metals and metalloids are difficult to remove. Lead and zinc are common soil contaminants. They are often found together in soils, but have very different biogeochemical properties. Zinc is a plant and animal essential element that can be toxic at elevated concentrations; lead has no known function in plants or animals, and causes adverse effects in animals, even at very low concentrations. Selenium is an essential element for animals but tends to bio-accumulate in aquatic organisms. The ecosystem services provided by reclaimed mine soils, including surface water quality is directly related to the quantity and stability of the soil organic matter. One project examined the impacts of augmenting damaged soils with different forms of biochar. In particular, the researchers compared the impacts of poultry litter biochar with poultry litter as a soil amendment. Poultry litter biochar was more effective at removing potential metals of concern from a contaminated soil than was poultry litter applied at the same rate.

Quantifying the effects of natural resource management on hydrology and water quality has remained a central research interest during the past several decades. Land-change science has received scientific attention due to the potential consequences of land-use/land-cover changes on hydrological, ecological,

and socioeconomic systems worldwide. Specifically, changes in land-use and land-cover from natural resources management can lead to major changes in hydrology, water quality, and biogeochemical cycling. In the Central Appalachian Mountains region of the United States, forest harvesting, surface mining, and reclamation were dominant drivers of land-use/land-cover change in the latter quarter of the twentieth century. The relationship between forest harvesting and peak flow, storm flow, and water yield is well documented throughout the Appalachian region and elsewhere. Less understood are the effects of wide-scale disturbances on landscapes and ecosystem processes such as nutrient, sediment, and biogeochemical cycling, stream flow generation, catchment mean residence time (MRT), and the relationship between catchment attributes and hydrologic responses. As the demand for natural resources is expected to increase, there remains a critical need to quantify process-level hydrologic changes following disturbances. Process-level understanding across scales is required to more appropriately manage West Virginia's natural resources in order to meet growing energy and materials needs and maintain healthy aquatic and terrestrial ecosystems.

One study is seeking to develop statistical and modeling methods capable of detecting and discerning changes in hydrologic and water quality records following historical, present-day, and future disturbances. It will be able to evaluate changes and response thresholds in runoff generation mechanisms and biogeochemical cycling that potentially have deleterious consequences to downstream communities. So far this project has established the first multi-scale hydrology study on the impacts of mountaintop removal mining on water quantity; developed change detection models to assess the impacts of contemporary forest harvesting practices on water quantity and quality; and initiated the first longitudinal study to assess the impacts of unconventional gas development on shallow groundwater used by the US Forest Service in the Monongahela National Forest, WV. The results of this study, which are currently being disseminated, will lead to more informed policymaking regarding the rapidly expanding non-conventional petroleum and gas industries.

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. For 15 years WVU researchers have been working with the WV Department of Natural Resources to restore a wild brook trout fishery to the upper Shavers Fork on Cheat Mountain in Randolph and Pocahontas Counties. At one time, this section of Shavers Fork was considered to be one of the best native trout fisheries in the Eastern U.S. In the early 20th century, logging and railroad construction degraded the fish habitat by warming the water due to the loss of the forest canopy and because of culverts that limited access of the fish to cooler water for spawning. Beginning in 2000, Davis College researchers began studying the problems with this fishery. The results of this research led to the Shavers Fork Stream Restoration Program that has included habitat enhancement along 4 miles of main stem channel and removal or replacement of railroad culverts. The ultimate goal of this WVDNR - WVU collaboration is to turn a marginal trout stream back into a high value wild recreational fishery promoting economic development for the region. The research will also inform future stream restoration decisions in the State. Fishery restoration on Shavers Fork has been a major factor in expanding an existing private tourist railroad based in Elkins. This 90-mile loop, which includes Cass Scenic Railroad, is expected to generate approximately \$500 million in recreation and tourism related economic development to the region over the next 30 years.

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

2014	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: 2014

Actual: 0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2014	Extension	Research	Total
Actual	0	34	0

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Presentations on research at professional meetings

Year	Actual
2014	16

Output #2

Output Measure

- Popular press articles on research

Year	Actual
2014	6

Output #3

Output Measure

- Completed graduate degree programs

Year	Actual
2014	23

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Reduce the number 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.
3	Increase our understanding of the environmental impacts of mountaintop-removal coal mining and unconventional natural gas production

Outcome #1

1. Outcome Measures

Reduce the number 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
2014	1

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

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.

What has been done

For 15 years WVU researchers have been working with the WV Department of Natural Resources to restore a wild brook trout fishery to the upper Shavers Fork on Cheat Mountain in Randolph and Pocahontas Counties. At one time, this section of Shavers Fork was considered to be one of the best native trout fisheries in the Eastern U.S. In the early 20th century, logging and railroad construction degraded the fish habitat by warming the water due to the loss of the forest canopy and because of culverts that limited access of the fish to cooler water for spawning. Beginning in 2000, Davis College researchers began studying the problems with this fishery.

Results

The results of this research led to the Shavers Fork Stream Restoration Program that has included habitat enhancement along 4 miles of main stem channel and removal or replacement of railroad culverts. The ultimate goal of this WVDNR/WVU collaboration is to turn a marginal trout stream back into a high value wild recreational fishery promoting economic development for the region. The research will also inform future stream restoration decisions in the State. Fishery restoration on Shavers Fork has been a major factor in expanding an existing private tourist railroad based in Elkins. This 90-mile loop, which includes Cass Scenic Railroad, is expected to generate approximately \$500 million in recreation and tourism related economic development to the region over the next 30 years.

4. Associated Knowledge Areas

KA Code	Knowledge Area
112	Watershed Protection and Management
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

Outcome #3

1. Outcome Measures

Increase our understanding of the environmental impacts of mountaintop-removal coal mining and unconventional natural gas production

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Mountaintop mining is a widely used but controversial method of extracting coal in the Appalachian Region. The method is controversial because there is much disagreement as to the long-term environmental impacts of the practice.

What has been done

One study is seeking to develop statistical and modeling methods capable of detecting and discerning changes in hydrologic and water quality records following historical, present-day, and future disturbances. It will be able to evaluate changes and response thresholds in runoff

generation mechanisms and bio-geochemical cycling that potentially have deleterious consequences to downstream communities.

Results

So far this project has established the first multi-scale hydrology study on the impacts of mountaintop removal mining on water quantity; developed change detection models to assess the impacts of contemporary forest harvesting practices on water quantity and quality; and initiated the first longitudinal study to assess the impacts of unconventional gas development on shallow groundwater used by the US Forest Service in the Monongahela National Forest, WV. The results of this study, which are currently being disseminated, will lead to more informed policymaking regarding the rapidly expanding non-conventional petroleum and gas industries.

4. Associated Knowledge Areas

KA Code	Knowledge Area
112	Watershed Protection and Management
133	Pollution Prevention and Mitigation
605	Natural Resource and Environmental Economics

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Economy
- Appropriations changes

Brief Explanation

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 use 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. This program area has received very positive support from our constituents. Our legislators, federal and state, are impressed by how closely we cooperate with state and federal agencies. At the state level we have strong applied research agreements with the Division of Natural Resources, the Department of Forestry, the State Agricultural Commissioner and the Department of Agriculture and the Department of Environmental Protection. At the federal level we cooperate with the Department of Energy, the Environmental Protection Agency, the Department of the Interior, the US Department of Agriculture and the Department of the Interior.

We house a U.S. Fish and Wildlife Service Cooperative Unit and every year we invite a review team to evaluate that program. We were told this year that we were considered to be one of the strongest Units in the Nation and that USFWS will consider locating personnel at our Unit and increasing the research funding to the Unit. We have already experienced a large increase in funding for our fisheries and wildlife research.

Key Items of Evaluation

This program area has received very positive support from our constituents. Our legislators, federal and state, are impressed by how closely we cooperate with state and federal agencies. At the state level we have strong applied research agreements with the Division of Natural Resources, the Department of Forestry, the State Agricultural Commissioner and the Department of Agriculture and the Department of Environmental Protection. At the federal level we cooperate with the Department of Energy, the Environmental Protection Agency, the Department of the Interior, the US Department of Agriculture and the Department of Health and Human Services.

We house a U.S. Fish and Wildlife Service Cooperative Unit and every year we invite a review team to evaluate that program. We were told this year that we were considered to be one of the strongest Units in the Nation and that USFWS will consider locating personnel at our Unit and increasing the research funding to the Unit. We have already experienced a large increase in funding for our fisheries and wildlife research.

V(A). Planned Program (Summary)

Program # 3

1. Name of the Planned Program

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: 2014	Extension		Research	
	1862	1890	1862	1890
Plan	0.0	0.0	5.0	0.0
Actual Paid	0.0	0.0	5.5	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	687520	0
1862 Matching	1890 Matching	1862 Matching	1890 Matching
0	0	1227101	0
1862 All Other	1890 All Other	1862 All Other	1890 All Other
0	0	418712	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.

Progress was made in 2014 on limiting the negative effects on cattle from ergot alkaloids present in pasture grasses. In the previous report we indicated that several genes for grass, tall fescue, pose a threat to livestock productivity and health. The production of complex, toxic, lysergic acid-derived ergot alkaloids were eliminated from a strain of *E. coenophiala* that is well characterized as conferring beneficial effects on the grass. The resulting strain lacks transgenes, which should lessen public concerns and regulatory requirements compared to transgenic strains, when such strains are incorporated into tall fescue cultivars. Over the past year, tall fescue plants bearing this engineered endophyte have been increased in the greenhouse, in preparation for a larger seed increase in the field, planned for late 2014 to 2016.

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

2014	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: 2014

Actual: 0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2014	Extension	Research	Total
Actual	0	19	0

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Presentation on research at professional meetings

Year	Actual
2014	8

Output #2

Output Measure

- Completed graduate degree programs

Year	Actual
2014	14

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
2014	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Ergot alkaloids in pasture grasses are toxic to cattle but also serve as a defense mechanism for the grasses to protect against pests.

What has been done

One research project has worked to determine which types of ergot alkaloids are toxic to cattle in order to breed grasses that are deficient in the toxic alkaloids but still contain the alkaloids that are used in the plants' defense mechanisms.

Results

Progress was made in 2014 on limiting the negative effects on cattle from ergot alkaloids present in pasture grasses. In the previous report we indicated that several genes for grass, tall fescue, pose a threat to livestock productivity and health. The production of complex, toxic, lysergic acid-derived ergot alkaloids were eliminated from a strain of *E. coenophiala* that is well characterized as conferring beneficial effects on the grass. The resulting strain lacks transgenes, which should lessen public concerns and regulatory requirements compared to transgenic strains, when such strains are incorporated into tall fescue cultivars. Over the past year, tall fescue plants bearing this engineered endophyte have been increased in the greenhouse, in preparation for a larger seed increase in the field, planned for late 2014 to 2016.

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

Not Reporting on this Outcome Measure

V(H). Planned Program (External Factors)

External factors which affected outcomes

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

Brief Explanation

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 use 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. As mentioned last year, we have engaged in strategic planning for our basic sciences programs. We received feedback from constituents (industry, academia and government). Based on that feedback we have decided to strengthen our research programs in molecular genetics, microbiology and biochemistry. In addition to the two new faculty we reported last year, this year we intend to hire four more, two in genetics, one in microbiology and one analytical chemist. This investment should make us more competitive for AFRI, NSF and NIH funding.

Key Items of Evaluation

As mentioned last year, we have engaged in strategic planning for our basic sciences programs. We received feedback from constituents (industry, academia and government). Based on that feedback we have decided to strengthen our research programs in molecular genetics, microbiology and biochemistry. In addition to the two new faculty we reported last year, this year we intend to hire four more, two in genetics, one in microbiology and one analytical chemist. This investment should make us more competitive for AFRI, NSF and NIH funding.

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	Diseases 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: 2014	Extension		Research	
	1862	1890	1862	1890
Plan	0.0	0.0	9.0	0.0
Actual Paid	0.0	0.0	7.6	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	1041022	0
1862 Matching	1890 Matching	1862 Matching	1890 Matching
0	0	1660006	0
1862 All Other	1890 All Other	1862 All Other	1890 All Other
0	0	987047	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.

A long-term Hatch project ended in 2014. The project's goals were to develop marketing and production technologies to enhance the economic status of the West Virginia sheep industry. The long term goal of this project was to utilize a systems-based approach to revitalize and expand the sheep industry in the Appalachian region, thereby improving the competitive position and income of independent, small livestock producers and enhancing growth and development of rural communities. Specific objectives were: 1) to shift lambing date in test flocks from the current pattern of March and April to November and December, 2) to implement specific changes in production of pasture and harvested feed, reproductive management, breeding and selection, flock health programs, predator control measures and utilization of marketing alternatives to enable efficiency and profitability from the shift in lambing date, 3) to increase utilization of sheep as an enterprise, with attendant increases in (a) quality and productivity of pastures currently used mainly for cattle, (b) diversity and amount of farm income, and (c) contribution of small, independent livestock producers to the rural community, and 4) to evaluate the economic effects of the altered season of lambing compared to spring lambing. Over the period from 1998 through 2014, this project has contributed to stabilization of the sheep industry in West Virginia. A declining trend in sheep numbers that began in 1942 has been stopped and the industry is stable at around 36,000 animals. The project has demonstrated the profitability of fall lambing using tools developed in the project and currently being applied on project collaborators' farms. This has led to increased income for sheep producers in the

region. The beginnings of utilization of the same tools in goats is encouraging for that species also, which is growing in number. The project has provided a basis for continuing on-farm research with these small ruminant species in West Virginia and the surrounding region, including several cooperators in Pennsylvania and Maryland.

United States agriculture and forestry faces a major threat by many pests (e.g. insects, weeds, and plant diseases) distributed over large geographic areas. Specifically, noxious invasive species have caused considerable economic loss and environmental damage to agriculture and forestry in the United States. The result of damage and loss caused by such pests is sometimes irreversible without accurate management of the threat in a timely manner. One project is designed to develop spatially targeted pest management systems using geospatial and/or aerospace technologies for efficient detection of pests and for precise delivery of control measures against major pests in agriculture and forestry. To achieve this goal, there are three objectives: development of unmanned aerial vehicle (UAV) systems for aerial detection of major pests; development of precision aerial delivery systems for biological and chemical control measures using UAV systems; and, investigation of spatial distribution patterns of hemlock woolly adelgid and invasive bees using geospatial technology.

For objective 1, a new platform, multi-rotor named WVU Octo was developed and configured to carry approximately 15-16 lbs. of payload with an estimated flight time (hover) of about 15 minutes. For objective 2, An aerial dispensing system for precision delivery of mile-a-minute weevil (a biological control agent against mile-a-minute weeds) was developed. As the weevil does not have a high flight capability, it is critical that they are delivered precisely where the mile-a-minute weed infestation is located. Towards that goal, a low cost, delivery mechanism was designed, constructed and tested in the field. They were constructed out of medium strength cardboard, featuring a ridge like interior structure that would house the weevils. For objective 3, an experiment was conducted to characterize the distribution and to decide a suitable sample units of hemlock woolly adelgid (HWA) ovisacs. A total 744 branches with 100cm in 31 trees were sampled. In each tree, 24 branches were measured its vertical height and then, cut with regard to six vertical heights and four cardinal directions. The cut branches were brought to the lab to count the number, measure twig lengths at the smallest node level, and map the location of ovisacs within a branch. By using a standard and smaller sample unit, more consistent, reliable results might be acquired with less effort, and the tree damage by sampling could be decreased.

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

2014	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: 2014
 Actual: 0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2014	Extension	Research	Total
Actual	0	12	0

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Presentation on research at professional meetings

Year	Actual
2014	19

Output #2

Output Measure

- Popular press articles on research

Year	Actual
2014	3

Output #3

Output Measure

- Completed graduate degree programs

Year	Actual
2014	12

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
4	Improve production and incomes of sheep producers in the State.

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
2014	23

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Beef cattle and poultry are the largest agricultural industries in the state. The well-being of the agricultural sector is therefore dependent on being competitive in these industries.

What has been done

Long term research and extension programs at WVU have sought to improve the nutrient content of pasture grasses and increase reproduction success in cattle.

Results

This year income in the cattle industry increased by 23 percent. Much of this was due to unusually high market prices but production, in terms of marketable weight, was also up 5 percent.

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
2014	17

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. Marketing and consumer acceptance have been the focus in recent years, including research on the firmness of trout muscle tissue.

Results

Continued steady growth in the aquaculture industry.

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
2014	25

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 .poultry and egg revenues, though turkey revenues have declined. Prices of poultry were up 20 percent in the latest reporting year and production was up 3 percent.

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

Outcome #4

1. Outcome Measures

Improve production and incomes of sheep producers in the State.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Sheep production has been declining in WV since 1942. What was once an important part of the State agricultural economy has, over time, become a minor industry.

What has been done

A long-term Hatch project ended in 2014. The project's goals were to develop marketing and production technologies to enhance the economic status of the West Virginia sheep industry. The long term goal of this project was to utilize a systems-based approach to revitalize and expand the sheep industry in the Appalachian region, thereby improving the competitive position and income of independent, small livestock producers and enhancing growth and development of rural communities. Specific objectives were: 1) to shift lambing date in test flocks from the current pattern of March and April to November and December, 2) to implement specific changes in production of pasture and harvested feed, reproductive management, breeding and selection, flock health programs, predator control measures and utilization of marketing alternatives to enable efficiency and profitability from the shift in lambing date, 3) to increase utilization of sheep as an enterprise, with attendant increases in (a) quality and productivity of pastures currently used mainly for cattle, (b) diversity and amount of farm income, and (c) contribution of small, independent livestock producers to the rural community, and 4) to evaluate the economic effects of the altered season of lambing compared to spring lambing.

Results

Over the period from 1998 through 2014, this project has contributed to stabilization of the sheep industry in West Virginia. A declining trend in sheep numbers that began in 1942 has been stopped and the industry is stable at around 36,000 animals. The project has demonstrated the profitability of fall lambing using tools developed in the project and currently being applied on project collaborators' farms. This has led to increased income for sheep producers in the region. The beginnings of utilization of the same tools in goats is encouraging for that species also, which

is growing in number. The project has provided a basis for continuing on-farm research with these small ruminant species in West Virginia and the surrounding region, including several cooperators in Pennsylvania and Maryland.

4. Associated Knowledge Areas

KA Code	Knowledge Area
301	Reproductive Performance of Animals
307	Animal Management Systems

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Economy
- Appropriations changes
- Competing Public priorities

Brief Explanation

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 use 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. We have spent two years evaluating our farming operations and management structures. We have decided, based on those evaluations, to reorganize our farm operations and our field research. Formerly, the farms were under the control of the individual departments in the College. We have decided to centralize the basic operations of the farms within the Experiment Station, while leaving the research leadership in the departments. We have appointed a director of farm operations who reports to the director of the experiment station. All farm laborers report to the director. Research technicians and research staff report to the department chairs. We are still in the process of implementing and evaluating this reorganization. We will report on progress next year.

Key Items of Evaluation

We have spent two years evaluating our farming operations and management structures. We have decided, based on those evaluations, to reorganize our farm operations and our field research. Formerly, the farms were under the control of the individual departments in the College. We have decided to centralize the basic operations of the farms within the Experiment Station, while leaving the research leadership in the departments. We have appointed a director of farm operations who reports to the director of the experiment station. All farm laborers report to the director. Research technicians and research staff report to the department chairs. We are still in the process of implementing and evaluating this reorganization. We will report on progress next year.

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: 2014	Extension		Research	
	1862	1890	1862	1890
Plan	0.0	0.0	3.0	0.0
Actual Paid	0.0	0.0	2.9	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	385112	0
1862 Matching	1890 Matching	1862 Matching	1890 Matching
0	0	603266	0
1862 All Other	1890 All Other	1862 All Other	1890 All Other
0	0	285369	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

West Virginia citizens have the highest level of obesity in the Nation (35.1%, Center for Disease Control, 2013, in a tie with Mississippi). 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 next phase of the study will look at the effects of diet on polycystic kidney disease progression.

While health benefits of consuming omega-3 DHA enhanced foods is generally accepted by the scientific community as is the need for increasing fiber in diets, one common source of Omega 3, surimi, a form of processed fish protein, is very low in fiber. Another research project is looking at fortifying surimi from Alaskan Pollock with dietary fiber. Research is currently underway studying how to best produce fiber-enhanced surimi products in ways that will be accepted by consumers.

Finally, several projects have continued to look at various interventions with families and children to try and increase awareness of the importance of nutrition and exercise in combatting childhood obesity.

2. Brief description of the target audience

The target audience for this program area includes dietitians, 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

2014	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: 2014
 Actual: 0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2014	Extension	Research	Total
Actual	0	12	0

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Presentations on research at scientific meetings

Year	Actual
2014	10

Output #2

Output Measure

- Popular press articles on research

Year	Actual
2014	5

Output #3

Output Measure

- Completed graduate degree programs

Year	Actual
2014	5

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 nutrition 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).

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
2014	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

West Virginia citizens have the highest level of obesity in the Nation (tied with Mississippi) (35.1 %, Center for Disease Control, 2013, an increase over last year's 33.8 %). 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

Several projects have continued to look at various interventions with families and children to try and increase awareness of the importance of nutrition and exercise in combatting childhood obesity.

Results

Unfortunately, the results have been negative so far, with the rate of obesity in the State continuing to increase annually. Our focus in our integrated programs is on childhood obesity, so hopefully, as those children become adults, the rate of obesity in the State will start to decrease.

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 nutrition 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

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Economy
- Appropriations changes
- Competing Public priorities

Brief Explanation

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 use 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. The majority of the faculty in our health and nutrition area are new. In addition, the University is completing a cluster hire in the health disparities area. We will gain two more faculty members due to that cluster hire. So far the program has been very successful at attracting competitive AFRI and NIH funding and pilot outreach programs have been implemented in conjunction with WVU Extension. This program is scheduled for full review about three years from now.

Key Items of Evaluation

The majority of the faculty in our health and nutrition area are new. In addition, the University is completing a cluster hire in the health disparities area. We will gain two more faculty members due to that cluster hire. So far the program has been very successful at attracting competitive AFRI and NIH funding and pilot outreach programs have been implemented in conjunction with WVU Extension. This program is scheduled for full review about three years from now.

V(A). Planned Program (Summary)

Program # 6

1. Name of the Planned Program

Production/Sustainable Forestry

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			60%	
124	Urban Forestry			10%	
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: 2014	Extension		Research	
	1862	1890	1862	1890
Plan	0.0	0.0	7.0	0.0
Actual Paid	0.0	0.0	7.2	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	14270	0
1862 Matching	1890 Matching	1862 Matching	1890 Matching
0	0	957036	0
1862 All Other	1890 All Other	1862 All Other	1890 All Other
0	0	533033	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 bio-product 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. Past work has included identification of underutilized hardwood species including red maple and yellow poplar. One important issue on economic utilization of these species involves developing low-cost methods of screening wood samples to determine whether or not the particular sample is suitable for high-grade veneers or structural or nonstructural applications. The goal of the project during this project period was to develop an automated non-destructive optical and high-speed ultrasonic waveform capturing system for evaluating full size veneer and lumber that allows for mechanical property predictions, an improved classification/sorting system, and quantification of various inherent wood characteristics (e.g., grain pattern, diving grain, and defect percentage). The non-destructive system was successfully developed. Specifically, the system was designed as a low-cost system that utilized a linear slide to move a CCD camera over the length of the lumber and veneer. The system allows for taking images at various rates and image resolutions. At the completion of the project period, the system has been developed and we have begun to start evaluating lumber and veneer material. Specifically, work was underway to scan and grade lumber produced from three red oak logs. The work hopes to be able to grade and classify defects and grain patterns. Additionally, we plan to create a program that recomposes the log into a 3-D replication using the details gained from the lumber. This process would allow for determining if a better cutting solution may be possible to improve the grade of the final lumber and veneer material. The end result of this work will be greater utilization of low-cost underutilized hardwood species in the timber industry.

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. Progress this reporting period included experiments that determined strain deformation) measured on the bark of trees is statistically the same as strain on the xylem or wood measured in a laboratory. These tests confirm that it will be possible to utilize stereo a photogrammetry system to measure strain and thus applied load transfer in standing tree without the need of destructive testing.

Another project is designed to explore an efficient means to effectively enhance the productivity and value of eastern hardwood stands. Many thousands of acres of newly regenerated stands are created with 40,000+ stems/ac. Decades will typically pass before the next treatment. By this time, a significant portion of the rotation has passed without any attempt to improve productivity or species composition, thereby continuing the sub-optimal growth and a high-representation of low-value species. Improving the growth and representation of species with high monetary and ecologic value will improve economic and amenity returns to landowners. The objectives of this research will focus on addressing questions related to improving the profitability and productivity of natural and artificially regenerated eastern forests by focusing on non-traditional areas associated with pine and hardwood culture.

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

2014	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: 2014

Actual: 0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2014	Extension	Research	Total
Actual	0	5	0

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Presentations on research at professional meetings

Year	Actual
2014	22

Output #2

Output Measure

- Popular press articles on research

Year	Actual
2014	4

Output #3

Output Measure

- Completed graduate degree programs

Year	Actual
2014	9

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Growth in state timber industry - % change
2	Development of new state wood products and materials and new uses for forestry by products.
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 Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	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 and to find processes to reduce production costs and increase the value of products from these underutilized 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. Past work has included identification of underutilized hardwood species including red maple and yellow poplar. One important issue on economic utilization of these species involves developing low-cost methods of screening wood samples to determine whether or not the particular sample is suitable for high-grade veneers or structural or nonstructural applications. The goal of the project during this project period was to develop an automated non-destructive optical and high-speed ultrasonic waveform capturing system for evaluating full size veneer and lumber that allows for mechanical property predictions, an improved classification/sorting system, and quantification of various inherent wood characteristics (e.g., grain pattern, diving grain, and defect percentage). The non-destructive system was successfully developed. Specifically, the system was designed as a low-cost system that utilized a linear slide to move a CCD camera over the length of the lumber and veneer. The system allows for taking images at various rates and image resolutions.

Results

At the completion of the project period, the system has been developed and we have begun to start evaluating lumber and veneer material. Specifically, work was underway to scan and grade lumber produced from three red oak logs. The work hopes to be able to grade and classify

defects and grain patterns. Additionally, we plan to create a program that recomposes the log into a 3-D replication using the details gained from the lumber. This process would allow for determining if a better cutting solution may be possible to improve the grade of the final lumber and veneer material. The end result of this work will be greater utilization of low-cost underutilized hardwood species in the timber industry.

4. Associated Knowledge Areas

KA Code	Knowledge Area
123	Management and Sustainability of Forest Resources

Outcome #2

1. Outcome Measures

Development of new state wood products and materials and new uses for forestry by products.

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

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 use 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. 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. In addition, this year, we were evaluated by the directors of the McIntire Stennis Program. In general our review was very positive, particularly regarding our program of research. We were advised to work more closely with West Virginia State University. We took that advise seriously and met with faculty and directors at WVSU, sharing the details of our research programs. We have identified two areas for collaboration: applied research in restoring damaged soils and ecosystems and urban forestry.

Key Items of Evaluation

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. In addition, this year, we were evaluated by the directors of the McIntire Stennis Program. In general our review was very positive, particularly regarding our program of research. We were advised to work more closely with West Virginia State University. We took that advise seriously and met with faculty and directors at WVSU, sharing the details of our research programs. We have identified two areas for collaboration: applied research in restoring damaged soils and ecosystems and urban forestry.

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: 2014	Extension		Research	
	1862	1890	1862	1890
Plan	0.0	0.0	2.0	0.0
Actual Paid	0.0	0.0	0.6	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	9319	0
1862 Matching	1890 Matching	1862 Matching	1890 Matching
0	0	51056	0
1862 All Other	1890 All Other	1862 All Other	1890 All Other
0	0	107104	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. Woody biomass is being examined as the potential main feedstock for a wide array of bioenergy projects due to the fact that it can be used as either a combustion fuel or as a feedstock for the development of liquid fuels, while simultaneously creating environmental and economic benefits for the region. However, the development of these bioenergy projects will be incumbent on the ability to source feedstocks at sufficient quantities and competitive prices for economically feasible biofuel production.

A mathematical model to maximize profit in the biomass utilization processes was developed. This model considers the costs in harvest, transportation of raw materials, storage, transportation of stored materials, intermediate processing, transportation of processed material and conversion to final product. All the possible pathways to utilize biomass are considered in the study. The objective function of this mathematic model is to maximize the profit. This is the total revenue less the sum of the cost in harvest, transportation, storage, processing and final conversion. The constraints are included by considering the biomass availability, biomass handling system, storage system balance, woody biomass demand and number of facilities. Some preliminary applications were obtained which proved the good performance of the model. The final solution of this model will also provide the optimal choice of pathway. This type of model is essential to determine the economic feasibility of using forest biomass in the production of biofuels.

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

2014	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: 2014
 Actual: 0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2014	Extension	Research	Total
Actual	0	5	0

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Presentations on research at professional meetings

Year	Actual
2014	12

Output #2

Output Measure

- Energy policy papers

Year	Actual
2014	0

Output #3

Output Measure

- Completed graduate degree programs

Year	Actual
2014	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).
4	Examine the economic profitability in WV of utilizing biomass to produce biofuels and biomaterials

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)

Not Reporting on this Outcome Measure

Outcome #2

1. Outcome Measures

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

Not Reporting on this Outcome Measure

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

Outcome #4

1. Outcome Measures

Examine the economic profitability in WV of utilizing biomass to produce biofuels and biomaterials

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

WV is the most heavily forested State in the Nation and thus has abundant supplies of biomass, both in situ and as a by product of the forest products industry. Unfortunately, the economic feasibility of utilizing this biomass is not known, due to the complexity of feedstock sourcing, feedstock logistics, and conversion processes.

What has been done

A mathematical model to maximize profit in the biomass utilization processes was developed. This model considers the costs in harvest, transportation of raw materials, storage, transportation of stored materials, intermediate processing, transportation of processed material and conversion to final product. All the possible pathways to utilize biomass are considered in the study. The objective function of this mathematic model is to maximize the profit. This is the total revenue less the sum of the cost in harvest, transportation, storage, processing and final conversion. The constraints are included by considering the biomass availability, biomass handling system, storage system balance, woody biomass demand and number of facilities.

Results

Some preliminary applications were obtained which proved the good performance of the model. The final solution of this model will also provide the optimal choice of pathway. This type of model is essential to determine the economic feasibility of using forest biomass in the production of biofuels.

4. Associated Knowledge Areas

KA Code	Knowledge Area
511	New and Improved Non-Food Products and Processes
605	Natural Resource and Environmental Economics

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Economy
- Appropriations changes

Brief Explanation

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. This program has been very successful in terms of attracting external funding from DOE and AFRI. We plan to continue this program but we do not have plans to add additional scientists at this time. We are expanding our focus to look at biomaterial from biomass feedstocks, and joint production bioenergy and biomaterials in order to increase the economic feasibility of bioenergy production from residual biomass.

Key Items of Evaluation

This program has been very successful in terms of attracting external funding from DOE and AFRI. We plan to continue this program but we do not have plans to add additional scientists at this time. We are expanding our focus to look at biomaterial from biomass feedstocks, and joint production bioenergy and biomaterials in order to increase the economic feasibility of bioenergy production from residual biomass.

VI. National Outcomes and Indicators

1. NIFA Selected Outcomes and Indicators

Childhood Obesity (Outcome 1, Indicator 1.c)	
0	Number of children and youth who reported eating more of healthy foods.
Climate Change (Outcome 1, Indicator 4)	
0	Number of new crop varieties, animal breeds, and genotypes with climate adaptive traits.
Global Food Security and Hunger (Outcome 1, Indicator 4.a)	
0	Number of participants adopting best practices and technologies resulting in increased yield, reduced inputs, increased efficiency, increased economic return, and/or conservation of resources.
Global Food Security and Hunger (Outcome 2, Indicator 1)	
0	Number of new or improved innovations developed for food enterprises.
Food Safety (Outcome 1, Indicator 1)	
0	Number of viable technologies developed or modified for the detection and
Sustainable Energy (Outcome 3, Indicator 2)	
0	Number of farmers who adopted a dedicated bioenergy crop
Sustainable Energy (Outcome 3, Indicator 4)	
0	Tons of feedstocks delivered.