

V(A). Planned Program (Summary)

Program # 2

1. Name of the Planned Program

Biotechnology, Biomaterials, and 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
112	Watershed Protection and Management	20%	0%	15%	0%
124	Urban Forestry	5%	0%	0%	0%
132	Weather and Climate	5%	0%	0%	0%
201	Plant Genome, Genetics, and Genetic Mechanisms	0%	0%	20%	50%
202	Plant Genetic Resources	2%	0%	10%	0%
203	Plant Biological Efficiency and Abiotic Stresses Affecting Plants	10%	0%	5%	50%
206	Basic Plant Biology	5%	0%	5%	0%
402	Engineering Systems and Equipment	10%	0%	20%	0%
403	Waste Disposal, Recycling, and Reuse	11%	0%	0%	0%
511	New and Improved Non-Food Products and Processes	15%	0%	20%	0%
601	Economics of Agricultural Production and Farm Management	10%	0%	5%	0%
605	Natural Resource and Environmental Economics	7%	0%	0%	0%
	Total	100%	0%	100%	100%

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2013	Extension		Research	
	1862	1890	1862	1890
Plan	3.7	0.5	3.9	1.0
Actual Paid Professional	3.0	0.0	4.2	1.0
Actual Volunteer	26.0	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
91969	0	68881	93447
1862 Matching	1890 Matching	1862 Matching	1890 Matching
96313	0	181398	106731
1862 All Other	1890 All Other	1862 All Other	1890 All Other
233948	0	936371	93807

V(D). Planned Program (Activity)

1. Brief description of the Activity

The Sustainable Energy program includes laboratory research, development of pilot scale projects in the field, educating clientele on the merits of particular energy practices and conversion technologies, and engaging the private sector to spur the commercialization and economic development of innovative and efficient energy systems. Specific examples of activity areas of this program are listed below:

- * Develop biomass use for biofuels
- * Designing optimum forestry and crops for bioenergy production.
- * Produce value-added bio-based industrial products.
- * Logistics/material handling
- * Processing and management of end use waste products and byproducts
- * Analysis of the global impacts of new generation biofuels
- * Demonstration and commercialization of technologies that increase US energy independence
- * Development of programs to train students and current county educators (in-service) to meet the new sustainable energy challenges.
- * Energy conservation
- * Alternative energy
- * Understanding agricultural energy use and opportunities for conservation
- * Smart and sustainable energy systems for communities
- * Understanding the cost differences of energy usage
- * Public outreach and engagement around energy public policy development
- * Youth development programs to teach energy conservation, alternative energy sources, electricity and recycling.

2. Brief description of the target audience

- Farmers
- Citizens
- Agency personnel
- Economic developers
- Regional planners
- Commercial Producers
- Land Owners
- 4-H Youth
- K-12 Youth

- State and Federal Agency Personnel
- Extension Educators
- Policy Makers
- Consumers
- Ag Related Businesses
- Energy Service Companies (ESCOs)

3. How was eXtension used?

eXtension was not used in this program

V(E). Planned Program (Outputs)

1. Standard output measures

2013	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	1387	2009	5	0

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

Patent Applications Submitted

Year: 2013

Actual: 1

Patents listed

Insecticidal Carbamates Exhibiting Species-Selective Inhibition of Acetyl Cholinesterase (AChE). Patent number 8,618,162

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2013	Extension	Research	Total
Actual	0	64	64

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number of Train the Trainer and In-service Energy Workshops

Year Actual

2013 60

Output #2

Output Measure

- Number of On-farm Demonstrations

Year	Actual
2013	1

Output #3

Output Measure

- Bioenergy Featured Case Studies
Not reporting on this Output for this Annual Report

Output #4

Output Measure

- Number of educational meetings, workshops, conferences, training sessions, and field days

Year	Actual
2013	120

Output #5

Output Measure

- Number of fact sheets, publications, newsletters, and other print resources

Year	Actual
2013	64

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Increase farm profitability due to more energy efficient practices
2	Increase the number of individuals using energy more sustainably
3	Increase knowledge of sustainable energy conversion technologies
4	Characterization of Genes that Regulate Wood Formation and Biomass Accumulation
5	Bio-product utilization efforts spur economic development

Outcome #1

1. Outcome Measures

Increase farm profitability due to more energy efficient practices

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Dairy and poultry operations, greenhouse facilities, and flue-cured tobacco farms in Virginia are significant consumers of energy. Farmers are challenged with rising fuel and electricity expenses that increase the cost of production and reduce already tight operating margins. Fluctuations in energy costs make budgeting more difficult.

What has been done

: Virginia Cooperative Extension, with financial support from the Virginia Tobacco Indemnification and Revitalization Commission, implemented a pilot farm energy efficiency program. The educational program focused the attention of agricultural producers on the cost of energy that they use, energy conservation options, and opportunities to cost-share projects to reduce farm energy consumption.

Results

As part of the program, 71 farms performed on-farm energy audits and 58 completed the audit. Qualified energy auditors and trained data collectors from several firms used for the project conducted the audits.

As a result, more than \$1 million in energy savings was identified, including:

- * 1,258,776 kWh electrical usage
- * 603,315 gallons propane fuel
- * 19,336 gallons fuel oil
- * 63,298 million BTUs
- * 4,315 MTCO₂e greenhouse gas emissions

Approximately 76 percent of the recommended energy conservation measures have a payback period shorter than five years.

Farmers completed an on-farm energy audit were offered a 25 percent cost share, up to \$2,500 per farm, as an incentive to upgrade to energy-efficient equipment. Twenty-four farms

implemented the cost-saving projects identified in the audits, and 14 farms applied for USDA REAP [Rural Energy for America Program] energy conservation grants, of which 11 were successful and will receive \$220,225 in funding.

The project engaged multiple Virginia partners, including the Virginia Department of Mines, Minerals and Energy; USDA Natural Resources Conservation Services; USDA Rural Development; and Virginia Foundation for Agriculture, Innovation and Rural Sustainability. Because the value of energy audits in identifying cost savings for agricultural producers was validated, Extension and its partners are applying for a second grant to launch an expanded project.

4. Associated Knowledge Areas

KA Code	Knowledge Area
402	Engineering Systems and Equipment
403	Waste Disposal, Recycling, and Reuse
601	Economics of Agricultural Production and Farm Management

Outcome #2

1. Outcome Measures

Increase the number of individuals using energy more sustainably

Not Reporting on this Outcome Measure

Outcome #3

1. Outcome Measures

Increase knowledge of sustainable energy conversion technologies

Not Reporting on this Outcome Measure

Outcome #4

1. Outcome Measures

Characterization of Genes that Regulate Wood Formation and Biomass Accumulation

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

The U.S. forest products industry employs over 1 million people and produces thousands of paper, fiberboard, lumber and engineered wood products with an estimated value, in 2004, of \$243 billion in U.S. sales (DOE, Industrial Technologies Program, Fiscal Year 2004 Report). Xylem is the wood-forming tissue in plants and hence is the raw material for the forest products industry. It is the structure, arrangement and relative proportions of the xylem cell types, that determines the physical properties of woods and hence their suitability for specific applications. Remarkably little is known about the genetic mechanisms that regulate wood formation.

What has been done

Researchers use Arabidopsis and poplar to study wood formation. Arabidopsis is a good choice for such studies because its genome has been fully sequenced and several unique resources have been developed for facilitating rapid characterization of genetic mechanisms. Poplar is a model for forest products research and was the subject of a recently completed genome sequencing effort. For the poplar work, we are supported by two feedstock genomics grants from the DOE to study poplar protein-protein interactions and their integration into woody biomass signaling networks. Additionally, we are supported by USDA-NIFA to study the roles of sugar signaling genes in woody biomass production.

Results

We are characterizing Arabidopsis and poplar genes controlling a variety of activities that contribute to wood formation and overall biomass accumulation, including a gene that negatively regulates lignocellulose production and programmed cell death in xylem, genes that are putative components of a signaling pathway that regulates cell fate in the xylem, and genes involved in novel protein-protein interaction networks relevant to wood formation. We have cloned over 400 genes associated with wood formation in poplar. These are being used to identify protein-protein interactions important to wood formation <http://xylome.vbi.vt.edu/>. Results from these investigations can be incorporated into bioengineering and breeding strategies for manipulating economically important aspects of the structure of wood.

4. Associated Knowledge Areas

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

Outcome #5

1. Outcome Measures

Bio-product utilization efforts spur economic development

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Virginia ranks as a top state for business due to an efficient infrastructure, talented workforce, lower costs of doing business, among other factors. To remain competitive Virginia businesses must explore methods to minimize production costs and to increase the marketability and value of their products and services.

What has been done

Extension serve as a resource to private businesses based in, or considering relocating to, the Commonwealth of Virginia which are exploring opportunities related to byproduct utilization, energy efficiency and deployment of appropriate renewable energy technologies. VCE's Agricultural Byproduct Utilization program assisted private businesses with information to better explore opportunities to reduce their operating costs, utilize undervalued biomass feedstocks, develop new business models, among other areas.

Results

Examples and case studies of these efforts include: 1) developed an anaerobic digestion facility co-located with Shenandoah Valley facility with large thermal energy requirements, 2) agricultural feed supplement firm explored opportunities to transform annual waste disposal of 174 tons and expenses of \$12,876, into potential revenue stream which achieved the firm's corporate management goal of zero waste, 3) assisted a small business to expand their suite of services to include conducting farm energy audits as a registered Technical Service Provider (This firm has now conducted 40+ farm energy audits), and 4) assist Shenandoah Valley composter in identifying practices to improve the quality and marketability of dairy manure-based compost.

4. Associated Knowledge Areas

KA Code	Knowledge Area
403	Waste Disposal, Recycling, and Reuse
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

- Natural Disasters (drought, weather extremes, etc.)
- Economy
- Appropriations changes
- Public Policy changes
- Government Regulations
- Competing Public priorities
- Competing Programmatic Challenges
- Populations changes (immigration, new cultural groupings, etc.)
- Other (Availability and competitive access to federal grants)

Brief Explanation

The business income derived, acceptance of biotechnology, and energy usage could be affected by natural disasters, changes in the economy, government regulations and public policy changes. The availability of federal and state grants and initiatives can be affected by government priorities and changes in the economy. If greater emphasis is placed on energy conservation and alternative energy sources are implemented, these practices and alternatives will be encouraged. These factors may have immediate impact as they significantly influence items such as production economics, industry infrastructure, marketing systems, and consumer demand. Good economic conditions encourage use of alternative energy sources and viable biotechnologies. In Virginia, increasing petroleum values in traditional businesses and logistics are a significant challenge. The recent increase in bioenergy and biotechnology production and anticipated future growth of this alternative fuel sources will likely have major impacts. Scope of such impacts is unknown, but anticipated direction has influenced this planned program.

Changes in energy production capacity, energy costs, and federal resources (grants & contracts) could have unpredictable effects. The general economy, public policy and governmental regulations impact production and sales of bioenergy and acceptance of biotechnology. Appropriations and competing programmatic challenges affect the dedication of personnel and programs to the described programs. Population changes affect supply and demand for alternative energy products.

V(I). Planned Program (Evaluation Studies)

Evaluation Results

Soaring energy costs affect every area of a community and have caused community leaders to seek guidance from researchers and Extension. Based on 2007 data, farms in

Southside and Southwest Virginia spent over \$58 million in fuel and \$16 million in electricity and other utilities, spending nearly \$75 million in total. Energy management is key to reducing soaring energy costs and increasing agricultural profits.

Virginia Cooperative Extension submitted and received a \$248,842 grant from the Virginia Tobacco Indemnification & Community Revitalization Commission in January 2010 to begin a new pilot program for Southside and Southwest Virginia farmers interested in energy efficiency improvements. This program a) raises awareness of opportunities to improve energy efficiency resulting in reduced production costs; b) assists farmers in conducting an on-farm energy assessment to identify energy savings opportunities specific to their operation; c) provides financial incentives to upgrade to energy efficient equipment and systems identified by the energy assessment; and d) provides energy efficiency resources required to pursue renewable energy and energy efficiency grants and subsidized loans through the USDA Rural Energy for America Program.

Energy audit reports conducted in 2013 for the 2010-2012 project of 58 farms which identified farm-specific efficiency improvement opportunities with the potential to generate energy-cost savings of approximately: 1,258,776 (kWh) in electrical usage; 603,315 (gallons) propane fuel; 19,336 (gallons) fuel oil; 63,298 Million BTUs; 4,315 (MTCO_{2e}) greenhouse gas emission reductions; \$20,326 average per farm energy savings; and \$1,178,917 aggregate energy savings. Approximately 76% of the recommended energy conservation measures had a payback period less than five years.

Key Items of Evaluation

- Identified **\$1.2 million in farm energy savings** with 76% of the savings having a payback period of less than 5 years.
- Conducted **58 energy audits**.
- Provided **24 farms cost share funding**.
- Enabled **11 farms to receive a USDA REAP grant**.
- Engaged **3 energy audit firms with 1 in Virginia**.
- Secured **technical assistance for USDA REAP grants**.
- Trained **12 Virginia data collectors**.
- Provided over **200 agricultural entrepreneurs the tools to improve farm energy efficiency**