

V(A). Planned Program (Summary)

Program # 9

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
201	Plant Genome, Genetics, and Genetic Mechanisms	0%	0%	13%	0%
204	Plant Product Quality and Utility (Preharvest)	15%	0%	13%	100%
205	Plant Management Systems	0%	0%	17%	0%
206	Basic Plant Biology	0%	0%	22%	0%
402	Engineering Systems and Equipment	85%	0%	0%	0%
511	New and Improved Non-Food Products and Processes	0%	0%	28%	0%
512	Quality Maintenance in Storing and Marketing Non-Food Products	0%	0%	7%	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	5.4	0.0	5.0	1.0
Actual Paid Professional	1.0	0.0	15.7	1.0
Actual Volunteer	475.0	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
89943	0	435126	32640
1862 Matching	1890 Matching	1862 Matching	1890 Matching
84691	0	2110913	0
1862 All Other	1890 All Other	1862 All Other	1890 All Other
0	0	1069739	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

Sustainable energy research continues to be an important component of plant science and biosystems engineering research programs at the University of Kentucky. Research in energy science included both basic studies in plant biology for developing improved feedstocks and applied, pilot-scale demonstrations of bio-based production processes. The production and utilization of switchgrass as a feedstock continues to be an area of emphasis for our research and extension programs. Another important area of research for UK's programs is the improvement of oilseeds for energy applications and other bio-based chemical development.

2. Brief description of the target audience

- producers
- extension agents
- electric company representatives
- other researchers and extension specialists

3. How was eXtension used?

Webinars, participation in communities of practice, online resources

V(E). Planned Program (Outputs)

1. Standard output measures

2013	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	4510	3274	10005	7289

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

Patent Applications Submitted

Year: 2013
 Actual: 0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2013	Extension	Research	Total
Actual	0	4	4

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Published research journal articles

Year	Actual
2013	4

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Number of individuals who reported an increase in knowledge of sustainable energy as a result of Extension related programming
2	Number of individuals who incorporated practices suggested by Extension that promote sustainable energy (i.e., applied water conservation policies, participating in energy audits, installed energy efficient equipment, etc.)
3	Number of producers who reported an increase in their production of bioenergy crops (corn, soybeans, switchgrass, etc.)
4	Number of youth reporting an increase in knowledge of energy conservation practices
5	Availability of systems for sustainable biomass feedstock production

Outcome #1

1. Outcome Measures

Number of individuals who reported an increase in knowledge of sustainable energy as a result of Extension related programming

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	3569

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Energy costs and conservation issues are of major importance to agriculture producers. With the increased input costs, there has been increased interest in ways to obtain and utilize alternative fuel and renewable sources. However, the general public has limited knowledge of how to learn more about the existing opportunities.

What has been done

Extension is providing seminars to educate the public on sustainable energy. The UK Ag & Biosystems Engineering department has conducted energy audits for producers.

Results

Extension has assisted producers in securing grant funds from USDA and state and local ag development funds to implement a bio-mass boiler projects that would heat greenhouses and packing sheds. The UK Biosystems and Agricultural Engineering Department was asked to help by completing an energy audit. Farmers are proposing several potential energy efficiency improvements. Four farms proposed solar or other renewable energy projects. Adding insulation, changing from incandescent to fluorescent lighting, heat recovery systems, and using preheated ventilation air from the attic were improvements that farmers have become more knowledgeable and are taking into consideration.

4. Associated Knowledge Areas

KA Code	Knowledge Area
402	Engineering Systems and Equipment

Outcome #2

1. Outcome Measures

Number of individuals who incorporated practices suggested by Extension that promote sustainable energy (i.e., applied water conservation policies, participating in energy audits, installed energy efficient equipment, etc.)

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	2561

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Energy costs and conservation issues are of major importance to agriculture producers. With the increased input costs, there has been increased interest in ways to obtain and utilize alternative fuel and renewable sources. However, the general public has limited knowledge of how to learn more about the existing opportunities.

What has been done

Kentucky grain and livestock producers use considerable amounts of electrical energy to operate lights, ventilation fans, grain or feed conveyors, grain dryers, and feed preparation equipment. Electrical energy consumption for large farms can amount to several thousand dollars in utility bills each month. Renewable energy systems have been installed to produce "green power" that can be used for these farming operations.

Results

Producers used the energy assessments to apply for cost share funds to install renewable energy systems on their farms. The annual value of energy generated on the farms was \$116,560 per year.

4. Associated Knowledge Areas

KA Code	Knowledge Area
402	Engineering Systems and Equipment

Outcome #3

1. Outcome Measures

Number of producers who reported an increase in their production of bioenergy crops (corn, soybeans, switchgrass, etc.)

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	2072

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

The production and utilization of biomass energy, such as through switchgrass, continues to be explored due to a need to acquire additional sources of energy.

What has been done

KSU began gasifying farm residues such as sweet sorghum bagasse, pawpaw and blackberry prunings, and dried sunflower stalks, to generate electricity. The process could allow small farmers to use agricultural waste products to make their own electricity, promoting farm resilience and energy independence. Faculty and students in the Chemical and Materials Engineering program worked with a UK 4-H Agent for SET to establish a hands-on bio-fuel research opportunity for local high school students. A survey was conducted by the Bracken Ag Advancement Council and the Extension Service to determine the level of producer interest in a facility to further explore the use of plant materials as a source of energy.

Results

The process could allow small farmers to use agricultural waste products to make their own electricity, promoting farm resilience and energy independence. In Bracken County, indications from the survey show a very positive interest in utilizing marginal land and supplying a domestically produced renewable fuel. A steering committee with members from 5 counties is now determining the next step in continuing the study to further evaluate the science, engineering, and financial specifics of the project. Hopkins County is also exploring opportunities.

4. Associated Knowledge Areas

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

Outcome #4

1. Outcome Measures

Number of youth reporting an increase in knowledge of energy conservation practices

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	14428

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Youth often lack exposure to nature and their role in promoting a sustainable environment. Non-formal programs provide children with a unique opportunity to experience substantial outdoor immersion and often influence affective development. These benefits suggest that an expansion of the depth and scope of non-formal outdoor programs is necessary to achieve the long-term goal of an environmentally literate population.

What has been done

Faculty and students in the Chemical and Materials Engineering program worked with a UK 4-H Agent for SET to establish a hands-on bio-fuel research opportunity for local high school students. In a joint effort to spark interest and increase science proficiency the Bracken County 4-H program and Bracken County Middle School conducted an intensive week long program called "The Power of Wind" utilizing the National Science Day and National 4-H Council Wind Energy Curricula.

Results

Throughout the program in Bracken County, over 100 students learned through hands on experiments how wind energy can be harvested to create electricity. Students then applied what they had learned by working in teams to build a wind turbine that would produce as much power as possible. Each team was allowed to test the electrical output, and then redesign their turbine to increase the amount of electricity they created. Almost every team increased their electrical output during their second test by utilizing the skills and knowledge they had learned from the lessons and their first wind test. After the culminating event, students wrote an essay about what they learned in the program. In Laurel County, pre and posttest evaluations from students, teachers and volunteers demonstrated that 90% of the students attending an environmental day camp reported an increase in knowledge of environmental awareness, 60% of students reported

an increase in the practice of environmentally conscious procedures when evaluated one month later.

4. Associated Knowledge Areas

KA Code	Knowledge Area
402	Engineering Systems and Equipment

Outcome #5

1. Outcome Measures

Availability of systems for sustainable biomass feedstock production

2. Associated Institution Types

- 1862 Extension
- 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)

In recent years, production of perennial biomass crops has been proposed as an economic opportunity for the use of lands that are only marginally acceptable for other agricultural uses. Coupling available biomass markets with crops that require few inputs is a key component to developing a sustainable bioenergy feedstock system. Warm-season forages, such as switchgrass, have been proposed for biomass production due to their potential to serve as both a forage crop and biomass feedstock. Once established, switchgrass grows well on marginal land, but it takes several years to produce a significant crop. Further evaluation is needed on the potential for production on marginal land as well as its utility in biomass energy production.

What has been done

A five-year pilot study on the biomass potential of switchgrass in Kentucky was conducted with 20 farmers in cooperation with the East Kentucky Power Cooperative . Investigators tested a variety of methods for establishing switchgrass crops, evaluated the environmental benefits of the crop, and the timing of harvesting for maximum yield and utility.

Results

While a number of factors limit the biomass market, the project successfully demonstrated the utility of switchgrass as a dual-use crop on lands that are not optimal for traditional crop

production or grazing. Researchers found that switchgrass seeds soaked in water for 6 days prior to planting had substantially greater germination and establishment rates than non-treated seeds. This is significant because it is easy for farmers to implement with little or no capital investment, overcoming one of the primary production barriers to switchgrass adoption. Early cutting of switchgrass for hay production was shown to not cause a significant yield loss when harvested again in late fall for biomass. Furthermore, inputs have been shown to be minimal, with established stands producing good quality forage even during the 2012 drought. A decision support tool for farmers weighing the economic costs and benefits of establishing switchgrass was developed in conjunction with the pilot project. Of the farmers who took part in the pilot testing, half have maintained their switchgrass stands for continued use as hay or for grazing and are poised to take advantage of biomass energy opportunities should a market develop.

4. Associated Knowledge Areas

KA Code	Knowledge Area
204	Plant Product Quality and Utility (Preharvest)
511	New and Improved Non-Food Products and Processes
512	Quality Maintenance in Storing and Marketing Non-Food Products

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Natural Disasters (drought, weather extremes, etc.)
- Economy
- Appropriations changes
- Government Regulations
- Competing Programmatic Challenges

Brief Explanation

V(I). Planned Program (Evaluation Studies)

Evaluation Results

Gain in knowledge, awareness increased

Key Items of Evaluation

Pre-post surveys, follow interviews, informal discussions, secondary data sources