

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
131	Alternative Uses of Land	0%	50%	0%	0%
201	Plant Genome, Genetics, and Genetic Mechanisms	0%	0%	25%	0%
204	Plant Product Quality and Utility (Preharvest)	4%	0%	25%	100%
205	Plant Management Systems	0%	0%	50%	0%
402	Engineering Systems and Equipment	96%	50%	0%	0%
	Total	100%	100%	100%	100%

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2014	Extension		Research	
	1862	1890	1862	1890
Plan	5.4	0.5	5.0	1.0
Actual Paid	1.0	0.2	12.5	0.4
Actual Volunteer	288.0	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
84322	9737	491208	11930
1862 Matching	1890 Matching	1862 Matching	1890 Matching
93306	4173	1815584	11480
1862 All Other	1890 All Other	1862 All Other	1890 All Other
0	0	392713	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, printed materials

V(E). Planned Program (Outputs)

1. Standard output measures

2014	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	7543	442594	7853	1572

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

Year: 2014
Actual: 1

Patents listed

Chappell, J. Rerouting the photorespiration pathway in plants for increasing bioproduct yield. Application 20140283219. Issued August 8, 2014.

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2014	Extension	Research	Total
Actual	2	5	7

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Published research journal articles

Year	Actual
2014	2

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	Expanding available lignocellulose-degrading enzymes for bio-based energy and industrial applications

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
2014	5102

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Providing ample alternatives for sustainable energy is critical to Kentucky communities. One primary way is to make improvements in and around homes to increase the efficiency of energy use and other valuable resources. Extension is faced with the issues of effectively collecting energy from renewable resources.

What has been done

KSU Extension specialist for Sustainable Programs worked with the Director of the Family Resource Center at Winburn Elementary School in Lexington, KY, as well as with a Family and Consumer Sciences Agent in Fayette County. The team developed a five-week Sustainable Moms Series. Topics covered included: eating sustainably on a budget (looking for fresh, organic products when they are at lowest prices), green cleaning and living, sustainable meal planning, how to have a sustainable holiday season (purchases that are economical and beneficial for the environment), creating gifts and decorations from repurposed materials

University of Kentucky Extension Agents from four districts partnered with a University of Kentucky Extension Specialist along with local farmers to plant and harvest 26 corn silage varieties on 3 farms across Kentucky. Performance data was collected to assess any increase in the quality and yield of milk.

Extension offered workshops to producers on high tunnel vegetable profitability.

Results

The KSU Sustainable Moms program consisted of 12 individuals of Hispanic descent. The participants provided feedback on how they benefited from the program. Answers ranged from having saved money on recent shopping purchases while focusing more on having fresh produce in their grocery carts, to turning down thermostats in their homes and having family members wear sweaters around the house.

The results from the corn silage project were printed as the official UK Corn Silage Hybrid Performance Test publication of the University of Kentucky Cooperative Extension Service. Farmers from Kentucky and across the United States are using this information to select corn silage varieties for increased milk production.

Sixty percent of participants rated the high tunnel vegetable conference workshops as significant for their operations and 12 percent rated it very significant. Eighty-nine percent said they learned a lot from the information presented.

4. Associated Knowledge Areas

KA Code	Knowledge Area
131	Alternative Uses of Land
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
2014	3857

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

The agricultural economy of Eastern Kentucky since the tobacco buyout has depended on livestock and forage production. However, more information is needed to increase profitability of farm operations.

What has been done

Morgan, Wolfe, Menifee, Whitley and Elliott counties teamed with UK Extension specialists and the Master Grazer Program to offer a one day grazing school for 38 attendees. Located at the Morgan County Extension Farm, the field day covered topics on why rotational grazing and no-till can help sustain the land, how to build permanent and temporary fences, constructing portable water systems, what and how to seed pastures, basics and benefits of clovers, laying out your grazing plan, understanding soil sample results, plus knowing and treating your pasture weeds.

Results

Farmers commended the Master Grazer program for its hands on approach, classroom demonstrations, visual demonstrations and practical information. As a result, 62% of the surveyed producers indicated adopting rotational grazing instead of continuous grazing; 62% also stated they would use temporary fencing to create more grazing paddocks; 95% gained knowledge on the importance of soil testing; and, 71% gained confidence to design a watering system to provide ready access to any paddock.

In one county, 100 percent of the farms have received Restricted Use Pesticide Certification and 5,300 acres of row crops (95%) are now grown as No-till.

4. Associated Knowledge Areas

KA Code	Knowledge Area
131	Alternative Uses of Land
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
2014	1322

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

As seed companies continue to release more technology through corn and soybean hybrids, unbiased, local, research based, variety trials that showcase how these new hybrids perform under Kentucky growing conditions and management have become increasingly important.

What has been done

The Hardin County Cooperative Extension Service, in cooperation with the Hardin County Grain Committee, continue to carry out the Hardin County Corn and Soybean Variety Trials. A field day was held, and 68 producers from Hardin and surrounding counties were on hand to see a visible comparison between 31 different corn varieties from 11 different companies, and 42 different Roundup Ready and Liberty Link soybean varieties from 10 companies.

University of Kentucky Extension Agents from four districts partnered with a University of Kentucky Extension Specialist along with local farmers to plant and harvest 26 corn silage varieties on 3 farms across Kentucky.

Area Grain Producer meetings for 5 counties were held in Boyle County, with 81 producers attending to learn from U.K. specialists and agents about corn, small grains and soybean production and to promote soil sampling vigorously as an important management practice.

Results

Producers that attended these events have added grass waterways back to eroding areas, and additional acres are using no-till methods for grain production.

The Bracken County Extension Service has planted a cover crop demonstration to showcase different options of cover crops, their benefits, and growth habits. This will be highlighted at summer and fall workshops.

A producer in one County, experienced a difference in savings of \$47.14 an acre which meant that he saved \$942.80 on 20 acres of corn after learning more about the importance of soil testing.

4. Associated Knowledge Areas

KA Code	Knowledge Area
131	Alternative Uses of Land

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
2014	13480

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Many of today's youth are not in touch with the environment and the need to sustain our natural resources. Extension has the potential to contribute to the education of youth in this area.

What has been done

Clay County Extension implemented a Forestry Field Day to give youth an opportunity to observe wildlife, engage in tree measurement and assist in cleaning up waterways.

Bullitt County Extension worked with youth to help improve the landscaping around the high school and built a compost bin for use in the school greenhouse.

A total of 31 youth from Daviess County participated in a farm field day. Results of a written survey given immediately following the event indicated that 95% of the youth learned something new about agriculture and 74% thought that agriculture was more important after participating in the farm tour.

KSU Extension offered workshops during Earth Day for over 600 Jefferson County youth.

Results

Clay County Youth learned how to better protect their environment, understand the value of renewable and non-renewable resources, and the importance of forests in an ecosystem. All of the teachers were very pleased to see that the information the students learned reinforced classroom lessons and gave them real, hands on experience.

4. Associated Knowledge Areas

KA Code	Knowledge Area
131	Alternative Uses of Land
402	Engineering Systems and Equipment

Outcome #5

1. Outcome Measures

Expanding available lignocellulose-degrading enzymes for bio-based energy and industrial applications

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 use of renewable lignocellulosic biomass including byproducts from agriculture and forestry for the production of biofuels and other products is a vital alternative to fossil-based energy and chemical resources. However, a number of obstacles, such as the thermo-chemical conversion of biomass, must be overcome prior to achieving a sustainable production of biofuels. This situation would be greatly improved if we understood more about wood-feeding insects, the best examples of highly efficient enzymatic lignocellulose digestive systems extant in nature. Wood-feeding Dictyopterans including termites and woodroaches are, by far the most efficient lignocellulose-processing bioreactors on this planet, uniquely capable of breaking down seemingly recalcitrant lignocelluloses efficiently and rapidly. Although our pressing need for bioenergy and biomass conversion has redirected termite research to focus more on lignocellulose digestion and degradation, there is virtually no information available on the wood-feeding cockroach, *Cryptocercus*, the evolutionary ancestor of termites. Rather than picking and choosing a few representatives from over 2,700 termite species, which may or may not be informative, dissecting the genomic information from the evolutionary ancestor for all termite species provides an all-important reference point for understanding the elusive lignocelluloses digestion machinery within the wood-feeding Dictyopterans.

What has been done

A genomics and metagenomics-mediated approach was employed to better understand the framework of lignocellulose digestion machinery and digestive contributions of host and symbiont in the wood-feeding cockroach, *C. punctulatus*. Two independent sequencing efforts have been carried out for the during of the project: 1) tissue-specific transcriptome sequencing of the entire digestive tract, including salivary gland, foregut, midgut, and hindgut, respectively; and 2) metatranscriptome sequencing of *C. punctulatus* hindgut, including pro- and eukaryotic symbionts. Comparative genomics analysis identified a list of lignocellulases highly conserved among the wood-feeding Dictyopterans. Of those found, we characterized a group of endogenous genes from woodroach salivary gland, including two endoglucanases and two laccases.

Results

The initial characterization study shows that both enzymes can act synergistically in the degradation of natural woody materials, and is likely the core enzymes within the lignocellulose digestion machinery among wood-feeding Dictyopterans. Moreover, woodroach laccases can efficiently biodegrade the reactive dye, Remazol Brilliant Blue R (RBBR), which has potential for diverse industrial applications, e.g., textile industry. Highly active and chemical/thermal stable lignocellulolytic biocatalysts are a major bottleneck for the large-scale production of biofuels from lignocellulosic biomass. This research provides a list of core enzymes fundamentally important to the degradation of woody materials, suggesting the potential applications in the biomass conversion of agricultural and forestry byproducts, as well as other industrial needs.

4. Associated Knowledge Areas

KA Code	Knowledge Area
402	Engineering Systems and Equipment

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

Increased awareness, change in practices

Key Items of Evaluation

Surveys, observations