2016 University of Tennessee and Tennessee State University Combined Research and Extension Annual Report of Accomplishments and Results

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I. Report Overview

1. Executive Summary

The Tennessee Agricultural Research and Extension System serves the needs of Tennesseans with research and outreach in the food, agricultural, natural resources, and human sciences. The University of Tennessee (UT) Extension and the Tennessee Agricultural Experiment Station (UT AgResearch) comprise the 1862 institution and the Tennessee State University (TSU) Cooperative Extension Program and the TSU Institute for Agricultural Research comprise the 1890 institution. This report represents the combined efforts of UT Extension, UT AgResearch, TSU Cooperative Extension Program, and the TSU Institute for Agricultural Research.

UT and TSU Extension extend the knowledge and expertise of the state's two land grant institutions to the 6.5 million people of Tennessee through agents and specialists in all 95 counties. Our work is providing education that produces solutions to societal, economic and environmental issues. Engagement of the state's citizens occurs where they live, work and play through hundreds of programs which are planned, conducted and evaluated by UT and TSU Extension. In FY 2016, Extension continued its excellence in economic development and outreach.

Extension's Excellence in Economic Development: Extension's educational programs in 4-H youth development, agriculture and natural resources, family and consumer sciences and community economic development produce substantial returns for Tennessee. Using research, questionnaires, observations and sales records, an estimated impact was $512 million for FY 2016. It was estimated that for every $1 in public funds invested in Extension, $8.03 was returned to the people of Tennessee in increased revenue, increased savings and one time capital purchases.

The recurring economic impacts were estimated at over $311 million. These recurring economic values include increased revenue, increased savings and one time capital purchases associated with Extension programs in crop variety trials/pest control, forage systems, 4-H camping, pesticide safety education, integrated pest management, turfgrass weed management, apiculture, and optimizing beef production. Using a UT System standard formula, an estimated 6,222 jobs were created or maintained because of the recurring economic impacts produced by Tennessee Extension. The one time, non recurring economic values were estimated at over $201 million from Extension programs in nutrition education, health literacy, Tennessee Saves, and volunteerism.

Extension's Excellence in Outreach: UT and TSU Extension professionals and the volunteers they recruited, trained and managed made more than 4.7 million direct contacts through group meetings, onsite visits (farm, home, and workplace), phone calls, direct mail, and client visits to local Extension offices. In addition, indirect educational methods included mass media, exhibits, and Internet resources.

Data for the Extension portion of this report utilized the Extension reporting system, System for University Planning, Evaluation and Reporting (SUPER). For the past ten years (2006-2016), this reporting system has been demonstrated to the administrators of 20 state Extension organizations who regarded it as a national model for Extension accountability.

In the attached report, you will see that agricultural research at TSU in 2016 was closely aligned with priority research areas emphasized by NIFA, and that productive research is being conducted in areas of state, national and global concern. In a continuation our recent expansion efforts, this past year we have again enhanced our research capacity through new construction and hiring of a number of new faculty in the areas of food and environmental science areas.

Utilizing NIFA funding, new laboratories are being constructed and older laboratories are being renovated to provide state-of-the-art support for the research conducted by our faculty. Additionally, new support facilities have been constructed at our Agricultural Research and Education Centers to support field and greenhouse research.
We have a talented faculty who have dedicated themselves to improving the lives of others. Examples of research accomplishments include:

- Identification of new water-smart crops for US farmers and improving nutritional values of existing crops
- Reducing obesity and improving human health through the development of fortified breads
- Novel uses for pollutants, such as coal fly ash, as soil amendments for better crops.
- Saving nursery producers money through new insect control that reduce pesticide use and have longer protection periods.
- Development of new biopeticides to replace harmful synthetic pesticides
- Reduction of carbon dioxide levels in the atmosphere through optimization of soil nutrient use.
- Preventing disease through the development of new methods of detecting foodborne illness
- Enhancing biomass yields for bioenergy crops with lower production costs by adopting ecologically sound intercropping techniques.

Some past reviews of our TSU Research Annual Report expressed concerns that some outcomes seemed to lean toward Extension rather than research. We are continuing to employ a process to re-work all of our outcomes. Results of this process are included in this year's Annual Report. Emphasis continues to be placed on capturing the ultimate impact of our research using the logic model format.
Since 2008, the College of Agriculture, Human and Natural Sciences at TSU has experienced tremendous growth, adding almost two dozen new faculty and completing construction on a number of new research facilities, however the goal of agriculture research at TSU remains the same: to generate and communicate new knowledge in the agricultural and environmental sciences for the prosperity of the citizens of Tennessee, the nation and the world. We employ a dedicated faculty and staff who have received their education and training from many of the best institutions and training centers in the United States and several countries around the world. This group of individuals takes pride in partnering with NIFA to advance agricultural and environmental research at Tennessee State University and make a positive difference in our society. The research detailed in this report illustrates our commitment to educating our students, serving our stakeholders and improving the lives of the world's citizens.
UT AgResearch efforts included steady advances in biomass production and processing to reduce dependence on foreign oil, varietal support for the state's nursery industry, extensive testing and development of agronomic crop varieties to meet consumer and farmer needs, and improvements in the reproductive health of various livestock populations. Our research strengthened and improved the state's critical hardwood lumber processing industry. We continued to provide nationwide leadership in soil erosion modeling and no till agriculture. We used beneficial insects to protect ecosystems in the Great Smoky Mountains, and helped lead the national public policy conversation through our agricultural and natural policy research centers. We also promoted technologies to minimize wastewater impact, and helped safeguard the public with important food safety research.
UT AgResearch data were derived from the detailed annual online reports of approximately 140 Ph.D. faculty and specialized staff. This information is collected for each calendar year, and then aggregated to reflect collaborative efforts between faculty, and across academic departments and specialty centers. Once aggregated, the information is keyed to program areas, and separated into current impacts (for the annual report) and program directions (for the plan of work).

Total Actual Amount of professional FTEs/SYs for this State

Year: 2016	Extension		Research	
	1862	1890	1862	1890
Plan	450.0	90.0	340.0	76.0
Actual	450.0	81.0	300.6	69.8

II. Merit Review Process

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

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

2. Brief Explanation

The merit review and peer review processes established in the latest Plan of Work were implemented seven years ago. At that time, the external university panel review was completed with program planning and evaluation experts from Virginia Tech and the University of Maryland. This review panel found that the Tennessee Plan of Work was of exceptional quality. The panel's major suggestion was to continue a strong needs assessment and evaluation process focused on measuring substantial outcome indicators. The Plan of Work planned programs have only had minor changes since that time, therefore, an out-of-state review panel was not conducted in FY 2016.
The Merit Review Process at Tennessee State University consists primarily of a review done by an Internal University Panel which reviewed and approved the annual plans of work and annual reports submitted by extension personnel. Many of the plans were reviewed by experts at TSU and UT at the faculty and administrator level as well. Curriculum developed faculty in conjunction with their annual plans were also peer reviewed by experts at each institution as well.
The program review system for TSU research remains the same has it has in previous years. Each Planned Program in this Annual Report was approved by an internal review panel; some programs had the benefit of an additional review by an external panel. These panels are composed of agricultural researchers and administrators in the 1890 University system. Faculty proposals for Planned Programs are evaluated for relevance, scientific soundness, and appropriateness of planned outcomes. Only those proposed programs that successfully meet all criteria are developed into executable Planned Programs. A number of strategies have been developed to ensure that approved programs are successful, meeting goals and remaining relevant: (1) discipline-specific faculty focus groups are utilized to provide support and to programs; (2) an administrator within the College of Agriculture, Human and Natural Sciences meets with every project leader semiannually to monitor the progress of the planned programs; (3) if the program is not progressing as planned, appropriate remedial steps are initiated. We feel these procedures contribute significantly to ensuring the Planned Programs are executed completely and with maximum benefit to stakeholders.
UT AgResearch underwent a formal week-long unit review several years ago. The five reviewers were deans and directors of various peer agricultural research units and affiliated organizations. The reviewers absorbed a 200+ page self-study, responded to detailed strategic questions, and met separately with university administration, unit leaders, remote research center directors, department heads, faculty, and staff. The review produced a written report, whose recommendations were shared in various AgResearch personnel meetings, and have already influenced efforts to increase our research productivity by various

means, including adjustments to our field research funding model.
UT AgResearch's merit review was strengthened by the continued use of our online workplan submission process. Workplans are the core of many planned research programs -- the details of how the project actually gets done on the ground. Our evolving online system allows rapid interactive review and revision of workplans between PI, department head, research center director, Deans, and compliance officers. With a central document repository, all those involved can literally be "on the same page," no matter where they are located

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
- Targeted invitation to non-traditional stakeholder individuals
- Targeted invitation to selected individuals from general public
- Survey of traditional stakeholder groups
- Survey of traditional stakeholder individuals
- Survey specifically with non-traditional groups
- Survey of selected individuals from the general public
- Other (Local and State Advisory Councils)

Brief explanation.

The merit review and peer review processes established in the latest Plan of Work was conducted seven years ago. It included an external university panel review by program planning and evaluation experts from Virginia Tech and the University of Maryland. This review panel found that the Tennessee Plan of Work was of exceptional quality. The panel's major suggestion was to continue a strong needs assessment and evaluation process focused on measuring substantial outcome indicators. The Plan of Work planned programs have only had minor changes since that time, therefore, an out-of-state review panel was not conducted in FY 2016.
TSU research continues to utilize an increased level of stakeholder input in our hiring processes and in determining areas of research emphasis. For the research activities conducted in the planned programs, community groups, industry associations or individual stakeholders are contacted and solicited for participation. For example, in programs where needs are more commodity-based, trade organizations (i.e. Amaranth Institute, Tennessee Organic Growers Association, Tennessee Nursery and Landscape Association, Tennessee Goat Producers Association, Southern Nursery Association, Guinea Fowl Breeders Association) are routinely utilized for input and direction. In other cases, individuals are contacted and participation is requested. For much of the research in the area of nursery plants, surveys of nursery producers were performed and periodic meetings were held with a Nursery Advisory Group that is maintained by the University. Our research programs relating to forestry work closely with the Nashville Metro Tree Advisory Council, the Forestry Division of the Tennessee Department of Agriculture, and with the Tennessee Urban Forestry Council; those programs examining new sources of feed stock for biofuels utilize the expertise and stakeholder evaluation available in our state Plant Material Advisory Committee and Plant Materials Committee; our environmental programs maintain a close relationship with the Cumberland River Compact, a non-profit organization concerned with the health and wellbeing of the Cumberland Watershed that encompasses much of Middle Tennessee. A number of different programs maintain an active presence on social media (Facebook, Twitter) and utilize feedback gained from those sources.
One of UT AgResearch's highest priorities is to be continuously engaged with the clientele who rely on our programs. In pursuit of this, the Institute of Agriculture formed three Regional Advisory

Councils (RACs) to help guide its programs and priorities. The RACs are organized geographically based upon the Extension regions and the state's grand divisions. The AgResearch Regional Advisory Councils provide a forum to discuss trends and issues in Tennessee with a broadly representative group of our clientele.

Each UT AgResearch department has an advisory group, while most research and education centers have advocacy groups. These groups meet once or more each year (typically at least twice). Current research activities and plans for future activities are reviewed at each meeting. Reactions and suggestions from the groups are received and factored into the research agenda setting process. Membership in each group is by invitation of the department head or center director, and typically consists of industry and regional representatives, local leaders, scientific peers, commodity group members, and other relevant stakeholders.

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
- Open Listening Sessions
- Needs Assessments
- Use Surveys
- Other (See below.)

Brief explanation.

All Tennessee Extension Agents receive instruction in selecting needs assessment strategies and in selecting individuals for Advisory Committees. Community leaders selected for Advisory Committees are chosen to represent the diversities (i.e., gender, age, racial/ethnic, socio-economic, political, educational, etc.) of the county or area served. Extension Agents recruit individuals who have participated in past and current Extension programs; and they recruit individuals who have not used Extension to serve on local advisory committees and participate in open listening sessions.

In FY 2016, UT and TSU Extension made 4,874 contacts for needs assessment purposes, and 309 (6.7%) were young people under 18 years of age. Statewide needs assessment methods included:

- 263 advisory committee meetings
- 71 focus group meetings
- 593 interviews with key informants

Both TSU and UT Extension administrators meet with the State Extension Advisory Council (a joint effort of TSU and UT Extension) at least twice a year to help determine the needs and direct educational programs. Input from non-traditional stakeholder individuals is seen as particularly valuable to the institutions. At the county level, extension agents meet with local advisory councils and various stakeholders to determine programming needs.

Several years ago, UT AgResearch retained a PR firm to reinforce our understanding of a number of critical stakeholders: largely oblivious Tennessee public; federal, state, and local legislators; and opinion leaders, industry and academic research partners, and the residents around our 10 regional research centers (the regional field laboratories).

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The methods used by TSU research to identify appropriate stakeholders are consistent with those used in previous years. We do not employ a single defined strategy to identify stakeholders, rather they are identified through methods most suitable for a specific program. Our goal is to identify stakeholders in a manner that will provide the most useful and accurate feedback possible about stakeholder concerns. Groups that serve the stakeholders (community based groups) or groups that represent stakeholders (industry and trade associations) are a primary source of input.

Individual stakeholders are utilized where there are no associated groups representing the program area (such as biodiesel producers), or when an opportunity for face-to-face interaction (i.e. at an association meeting, field site visit, or community event) is presented. In these cases, individuals involved the program outputs are identified and queried for input.

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 with the general public (open meeting advertised to all)
- Survey specifically with non-traditional individuals

Brief explanation.

The System for University Planning, Evaluation and Reporting (SUPER) tracks Extension's needs assessment efforts across Tennessee. In FY 2016, Extension conducted 71 different focus groups and 593 interviews with key informants. Regarding interviews with key informants, 58% involved individuals who were not previously active in Extension (defined as those not previously on an Extension mailing list). These individuals were identified in various ways such as asking Advisory Committee members and community leaders to suggest names. TSU Extension continued to use stakeholder input to expand its outreach to small and limited resource farmers and producers through its annual Small Farm Expo and Small and Limited Resource Producer Outreach Conferences. TSU has also started participating in "TSU on the Hill" as well as a way to connect with stakeholders. Stakeholder input was also used to target and expand leadership development training for extension agents in each of the three regions of the state.

In addition to the various UT AgResearch regional, research center, and departmental advisory groups, some of the ways we collect stakeholder input include:

• "UT Day on the Hill", an annual meeting with producers and farmers, industry groups, legislators, and affiliated organizations.
• Direct contacts through our AgResearch and ten regional center websites.
• Participation in various commodity and agricultural interest groups and associations.
• Individual interactions at more than a dozen field days throughout the state.
• Feedback from Extension colleagues, or, in the case of joint appointments, individual knowledge from Extension activities.

UT AgResearch holds monthly meetings of academic department heads and research center directors, and annual meetings with selected principal investigators. These sessions are very helpful

in refining our focus as we share different perspectives on the expressed needs of various constituents.

Most stakeholder input for TSU research is collected in either face-to-face discussions, interaction with commodity groups or via survey instruments. Each of these methods are effective. The face-to-face discussions are often held with individual stakeholders, community group representatives or trade association representatives, or with individual stakeholders in a group setting, this allows for questions and answers to direct and stimulate discussion of areas of importance to stakeholders. Survey instruments are a useful tool to assess information from broader groups of stakeholders. While some stakeholders prefer the anonymity and brevity of a survey instrument (often resulting in increased participation), a survey instrument does not always allow for discussion of previously unrecognized areas of concern. Recently, the use of social media has increased. Feedback gained from Facebook and Twitter has been used to collect information on stakeholder needs and concerns. Audience response recorders are being incorporated into opportunities for real-time feedback during group presentations or engagements. All research presentations to non-academic stakeholders now solicit feedback via evaluations The information gained from these surveys is incorporated into program focus areas.

3. A statement of how the input will be considered

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

Brief explanation.

The State Action Agendas (state plans of work) delineated programs, curricula, partners and resources for addressing stakeholder concerns. Individual plans were created and implemented by Extension Agents and Specialists based on the results of the needs assessment. The plans were monitored and adjusted by Regional Program Leaders and Department Heads. In FY 2016, stakeholder input was used to identify volunteer leaders, identify new audiences, and identify and secure locations for Extension programs. Stakeholder input was used to modify these Extension programs:

• Our **Environmental and Water Quality Impacts** planned program was modified to increase our efforts in crop nutrient stewardship. With low crop prices, increasing prices of nitrogen and phosphorus fertilizers, and the contribution of production agriculture to diminished water quality in the Mississippi River Basin, fertility practices needed to be reevaluated to benefit our producers and the environment. A multi-disciplinary, integrated research and Extension program was established to develop and disseminate information pertaining to crop fertility practices and associated economic and environmental impacts.

• Our **Health and Safety** planned program was strengthened by formalizing our UT Extension Healthy Homes Partnership. Representatives on this advisory group come from 21 organizations including the City of Memphis City Code Enforcement, Tennessee Commission on Children and Youth, and Tennessee Housing Development Agency. This partnership has expanded Extension programming to improve indoor air quality and to reduce indoor health hazards. In 2016, the Extension Clean and Healthy Homes programs were provided in 38 counties, up from 27 in 2015.

• Our **Forestry, Wildlife and Fisheries** planned program was modified over the past two years

to focus on the an integrated research and Extension shortleaf pine initiative. Even though shortleaf pine is a native to Tennessee, the species has been discriminated against by industry in favor of loblolly pine, resulting in a generation of landowners and natural resource professionals who know very little about shortleaf pine, much less mixed pine-hardwood stands that historically occurred. UT installed a 60-acre research/demonstration project at each of two UT AgResearch Stations: Cumberland Forest in Morgan County and Highland Rim Forest in Franklin County. Additionally, based on best management practice survey results, our Master Logger Program renewed emphasis on stream crossings and water quality associated with water bars and skid trails.

• TSU Extension continued to use stakeholder input to improve programming and identify staffing needs across the state. Youth programming in the STEM areas, leadership development, financial planning, beginning farmer training and outreach, obesity/health and nursery crop were all identified as needs and issues that should be prioritized by TSU Extension.

As previously stated, TSU research utilizes stakeholder input in hiring processes and research steering. Insights provided by these individuals place emphasis on the communication skills and knowledge of current discipline needs/trends rather than the traditional items such publication and grant history/potential. New faculty hired in these positions reflect these qualities.

An example of stakeholder feedback is in our organic production programs. Many of our producers in Tennessee were initially concerned with the process involved to convert farms from conventional production to organic and research to achieve the transition most efficiently. However recently, feedback received from individual growers as well as the Tennessee Organic Growers Association has emphasized the need for new mulches to suppress weed populations. Our organic team has now added weed control and mulch evaluations to their research portfolio as a result of this input from these stakeholders. Also, as in most recent years, a concern of stakeholders, regardless of area of research, is in the areas of economics and health. Examples of concerns are curtailing expenses, increasing efficiency, finding new markets and, finally, staying in business. Much of our research, regardless of topic or emphasis, addresses these economic themes.

One perhaps overlooked means of stakeholder input that affects UT AgResearch programs is the publication feedback loop, where the acceptance for publication, reviewer comments, and the ultimate traction of a particular publication (in citations) provide an impetus, particularly for pre-tenure faculty, to work on research that is timely and compelling.

In research, partly due to the previous PR firm's recommendations and brainstorming sessions, we made changes in our "branding" to "UT AgResearch", updated our website layout, and increased the quantity of available research content. A public-facing new hire is now in place, to address a lack of stakeholder connection in the west Tennessee area.

Brief Explanation of what you learned from your Stakeholders

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UT AgResearch regularly modifies research directions, drops obsolete or dead-end programs, and adds directions that are emerging. Examples of some programs in flux include urban forestry, bioinformatics, genomics, biomass (sources, processing, end uses), urban storm water, native grasses, and emerging agronomic and forestry pests. Research feedback shows a strong continuing interest in the entire biofuels/bioenergy spectrum - even with declining fuel prices, particularly to provide new income streams for farmers and new state job opportunities. Food safety also continues to be very much "on the table" -- recent news stories and large-scale public health and economic impacts seem to be on the public's mind.

IV. Expenditure Summary

1. Total Actual Formula dollars Allocated (prepopulated from C-REEMS)			
Extension		Research	
Smith-Lever 3b & 3c	1890 Extension	Hatch	Evans-Allen
8959920	2938031	6057465	3412660

2. Totaled Actual dollars from Planned Programs Inputs				
	Extension		Research	
	Smith-Lever 3b & 3c	1890 Extension	Hatch	Evans-Allen
Actual Formula	8959920	2739226	6393465	3380111
Actual Matching	39905831	3176849	20946086	3380111
Actual All Other	7351166	245593	12687038	1867976
Total Actual Expended	56216917	6161668	40026589	8628198

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

V. Planned Program Table of Content

S. No.	PROGRAM NAME
1	4-H Positive Youth Development
2	Agronomic Crop Systems
3	Animal Systems
4	Childhood Obesity
5	Economic Infrastructure and Commerce
6	Environmental and Water Quality Impacts
7	Family Economics
8	Food Safety
9	Forestry, Wildlife, and Fishery Systems
10	Health and Safety
11	Horticultural Systems
12	Human Development
13	Sustainable Energy

V(A). Planned Program (Summary)

Program # 1

1. Name of the Planned Program

4-H Positive Youth Development

☑ 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
803	Sociological and Technological Change Affecting Individuals, Families, and Communities	25%	25%	0%	0%
806	Youth Development	75%	75%	0%	0%
	Total	100%	100%	0%	0%

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2016	Extension		Research	
	1862	1890	1862	1890
Plan	158.0	17.0	0.0	0.0
Actual Paid	153.0	26.0	0.0	0.0
Actual Volunteer	35.0	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**
3046373	844594	0	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
13567984	979527	0	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
200000	29656	0	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

• **Clubs/Project Groups -** At least 65 Tennessee counties organized over 2,500 4-H clubs where workforce preparation will be the major emphasis. Project work was emphasized, and the experiential learning model was followed to highlight jobs and careers aligned with 4-H projects. Activity sheets emphasized practical skills aligned with jobs and careers.

• **School Enrichment -** Various school enrichment programs in at least 50 Tennessee counties focused on science, engineering and technology. Youth were exposed to jobs and careers associated with science fields.

• **Mass media** - Mass media was used to inform parents, participants and stakeholders about program opportunities and achievements.

• **Youth from Under-Served and Limited Resource Families:**In FY 2016, TSU Extension 4-H Youth Development programs placed special emphasis on SET programs in clubs, afterschool settings and other venues to reach youth. The ultimate outcome was increased science literacy among the state's young people. TSU Extension placed special emphasis on reaching under-served and limited resource youth.

2. Brief description of the target audience

Tennessee youth in grades 4-12 were targeted for this program. To encourage participation of underserved and minority youth, the majority of programs were conducted in public schools.

3. How was eXtension used?

The 4-H Positive Youth Development Program was enhanced through the service of seven Tennessee Extension personnel on the "For Youth, For Life" and "Military Families" Community of Practice (CoP). Tennessee Extension personnel shared implementation strategies, outcome measurement, and evaluation protocols with their CoP colleagues.

V(E). Planned Program (Outputs)

1. Standard output measures

2016	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	286600	0	719163	6889781

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

Patent Applications Submitted

Year:	2016
Actual:	0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2016	Extension	Research	Total

Actual	4	0	0

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number of volunteers utilized in delivering this program.

Year	Actual
2016	347

Output #2

Output Measure

- Number of exhibits produced.

Year	Actual
2016	1455

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Achieving Goals: Number of youth who now put their goal in writing.
2	Achieving Goals: Number of youth who now report they set high goals.
3	Achieving Goals: Number of high school youth who have set a goal for their job or career.
4	Communicating: Number of youth who can express ideas with a poster, exhibit, or other display.
5	Communicating: Number of youth who can use technology to help themselves express ideas.
6	Communicating: Number of youth who have learned at least five jobs in which communication skills are important.
7	Communicating (Public Speaking): Number of youth who can deal with their nervousness when giving a speech or talk.
8	Communicating (Public Speaking): Number of youth who can select a topic for a speech or talk.
9	Communicating (Public Speaking): Number of youth who can speak loudly enough to be heard when giving a speech or talk.
10	Communicating (Public Speaking): Number of youth who feel comfortable sharing their thoughts and feelings in a speech or talk.
11	SET: Number of youth who can design a scientific procedure to answer a question.

Outcome #1

1. Outcome Measures

Achieving Goals: Number of youth who now put their goal in writing.

2. Associated Institution Types

- 1862 Extension
- 1890 Extension

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	7556

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

What has been done

Results

4. Associated Knowledge Areas

KA Code	Knowledge Area
806	Youth Development

Outcome #2

1. Outcome Measures

Achieving Goals: Number of youth who now report they set high goals.

2. Associated Institution Types

- 1862 Extension
- 1890 Extension

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	6307

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

What has been done

Results

4. Associated Knowledge Areas

KA Code	Knowledge Area
806	Youth Development

Outcome #3

1. Outcome Measures

Achieving Goals: Number of high school youth who have set a goal for their job or career.

2. Associated Institution Types

- 1862 Extension
- 1890 Extension

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	5275

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

What has been done

Results

4. Associated Knowledge Areas

KA Code	Knowledge Area
806	Youth Development

Outcome #4

1. Outcome Measures

Communicating: Number of youth who can express ideas with a poster, exhibit, or other display.

2. Associated Institution Types

- 1862 Extension
- 1890 Extension

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	7325

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

What has been done

Results

4. Associated Knowledge Areas

KA Code	Knowledge Area
806	Youth Development

Outcome #5

1. Outcome Measures

Communicating: Number of youth who can use technology to help themselves express ideas.

2. Associated Institution Types

- 1862 Extension
- 1890 Extension

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	6920

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

What has been done

Results

4. Associated Knowledge Areas

KA Code	Knowledge Area
806	Youth Development

Outcome #6

1. Outcome Measures

Communicating: Number of youth who have learned at least five jobs in which communication skills are important.

2. Associated Institution Types

- 1862 Extension
- 1890 Extension

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	6354

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

What has been done

Results

4. Associated Knowledge Areas

KA Code	Knowledge Area
806	Youth Development

Outcome #7

1. Outcome Measures

Communicating (Public Speaking): Number of youth who can deal with their nervousness when giving a speech or talk.

2. Associated Institution Types

- 1862 Extension
- 1890 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	13463

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

What has been done

Results

4. Associated Knowledge Areas

KA Code	Knowledge Area
806	Youth Development

Outcome #8

1. Outcome Measures

Communicating (Public Speaking): Number of youth who can select a topic for a speech or talk.

2. Associated Institution Types

- 1862 Extension
- 1890 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	15460

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

What has been done

Results

4. Associated Knowledge Areas

KA Code	Knowledge Area
806	Youth Development

Outcome #9

1. Outcome Measures

Communicating (Public Speaking): Number of youth who can speak loudly enough to be heard when giving a speech or talk.

2. Associated Institution Types

- 1862 Extension
- 1890 Extension

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	14041

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

What has been done

Results

4. Associated Knowledge Areas

KA Code	Knowledge Area
806	Youth Development

Outcome #10

1. Outcome Measures

Communicating (Public Speaking): Number of youth who feel comfortable sharing their thoughts and feelings in a speech or talk.

2. Associated Institution Types

- 1862 Extension
- 1890 Extension

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	11402

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

What has been done

Results

4. Associated Knowledge Areas

KA Code	Knowledge Area
806	Youth Development

Outcome #11

1. Outcome Measures

SET: Number of youth who can design a scientific procedure to answer a question.

2. Associated Institution Types

- 1862 Extension
- 1890 Extension

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	4816

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

What has been done

Results

4. Associated Knowledge Areas

KA Code	Knowledge Area
803	Sociological and Technological Change Affecting Individuals, Families, and Communities
806	Youth Development

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Competing Public priorities

Brief Explanation

V(I). Planned Program (Evaluation Studies)

Evaluation Results

The National Science Foundation's (NSF), "Science and Engineering Indicators 2016," concluded that most Tennessee 4th and 8th graders did not demonstrate proficiency in the knowledge and skills taught at their grade level in science and mathematics. Therefore, Extension 4-H programs emphasized science, technology, engineering, and mathematics to bolster science literacy and inform youth about career pathways. In FY 2016, we evaluated 4-H programming using surveys. Our evaluation results showed that Tennessee 4-H programs improved science literacy with the following results:

- 5,487 youth can use specific scientific knowledge to form a question.
- 5,731 youth can ask a question that can be answered by collecting data.
- 4,816 youth can design a scientific procedure to answer a question.
- 5,812 youth can record data accurately.

Key Items of Evaluation

In FY 2016, our evaluation results showed that Tennessee 4-H programs improved science literacy with the following results:

- 5,487 youth can use specific scientific knowledge to form a question.
- 5,731 youth can ask a question that can be answered by collecting data.
- 4,816 youth can design a scientific procedure to answer a question.
- 5,812 youth can record data accurately.

V(A). Planned Program (Summary)

Program # 2

1. Name of the Planned Program

Agronomic Crop 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
102	Soil, Plant, Water, Nutrient Relationships	0%	0%	9%	0%
104	Protect Soil from Harmful Effects of Natural Elements	0%	0%	2%	0%
133	Pollution Prevention and Mitigation	0%	0%	3%	0%
201	Plant Genome, Genetics, and Genetic Mechanisms	0%	0%	18%	30%
202	Plant Genetic Resources	0%	0%	17%	30%
203	Plant Biological Efficiency and Abiotic Stresses Affecting Plants	0%	0%	2%	10%
204	Plant Product Quality and Utility (Preharvest)	0%	0%	2%	10%
205	Plant Management Systems	50%	50%	8%	10%
211	Insects, Mites, and Other Arthropods Affecting Plants	5%	5%	6%	0%
212	Pathogens and Nematodes Affecting Plants	5%	5%	15%	10%
213	Weeds Affecting Plants	0%	0%	6%	0%
402	Engineering Systems and Equipment	0%	0%	6%	0%
511	New and Improved Non-Food Products and Processes	0%	0%	4%	0%
601	Economics of Agricultural Production and Farm Management	40%	40%	0%	0%
611	Foreign Policy and Programs	0%	0%	2%	0%
	Total	100%	100%	100%	100%

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2016	Extension		Research	
	1862	1890	1862	1890
Plan	4.0	1.0	65.0	13.0
Actual Paid	45.0	14.0	68.6	12.1

Actual Volunteer	10.0	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**
895992	495487	1053595	585950
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
3990583	574647	5772521	585950
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
100000	34856	3337707	323818

V(D). Planned Program (Activity)

1. Brief description of the Activity

The Extension portion of this report includes cotton, irrigation, entomology, plant pathology and row crops management and marketing issues. It is organized via the Innovation-Decision Process (Rogers, 1995). It is important to organize the agronomic crop systems planned program activity in this way because producers of various row crops, in various locations in the state are in different stages of this process for the array of research-based practices. Based on needs assessments conducted by Extension Specialists, the following practices were targeted: conservation-tillage; planting insect-tolerant crops; planting herbicide-tolerant crops; spaying crops with foliar fungicide to manage disease; using recommended varieties (based on UT field trial results)

Knowledge: Newspaper articles, radio programs, websites and newsletters were used to build awareness of UT Extension resources and practices for more profitable production. Mass media was used to highlight pests and pesticides in a timely manner.

Persuasion: Farm visits and group meetings were used to showcase practices.

Decision: Group meetings and classes were held in which Extension specialists delivered detailed instruction to producers.

Implementation: On-farm demonstrations were conducted, particularly in the 31 West Tennessee counties, to highlight research-based practices. To the extent possible, integrated research and extension activities were conducted such as result demonstrations and test plots in all 31 West Tennessee counties.

Confirmation: Farm visits and telephone calls assisted producers to continue use of the practices, respond to environmental factors, and realize greater profits.

UT AgResearch helps agronomic producers in a variety of areas. Producers of corn, soybeans, wheat, and commercial vegetables are challenged each year with high costs of production, relatively low profit margins, and a host of other issues such as plant diseases, weather, and competition from other countries in world markets. Because farmers often operate with a relatively low profit margin, economic feasibility as well as efficacy of new genetics or technology for pest and disease control is of paramount importance. Farmers need to be aware of the comparative performance of new technologies in order to make appropriate decisions on pest and disease management. Little information exists about the economics of those technologies and systems under differing production conditions. In addition, the economics of systems vary as the combination of system and production environment change, and as relative prices

and costs change.

2. Brief description of the target audience

The primary audience for this program consisted of Tennessee row crop producers. The secondary audiences were the professionals, business owners/cooperatives, and government officials who served row crop producers.

3. How was eXtension used?

Tennessee Extension personnel were part of the eXtension "Plant Breeding and Genetics" Community of Practice.

V(E). Planned Program (Outputs)

1. Standard output measures

2016	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	65488	7887771	2072	1130

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

Patent Applications Submitted

Year:	2016
Actual:	3

Patents listed

Novel Methods for Isolating and Transforming Protoplasts, Elizabeth M. Dlugosz, Scott C. Lenaghan, C. Neal Stewart, Jr.

Resistance genes to soybean cyst nematode based on epigenetics, Hewezi T, Rambani A, Stewart CN Jr, Mazarei M, Pantalone V

Vectors for screening promoters and methods thereof, Scott C. Lenaghan, Taniya Dhillon, Elizabeth Dlugosz, C. Neal Stewart, Jr.

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2016	Extension	Research	Total
Actual	20	99	0

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number of exhibits displayed to promote awareness and participation in this planned program.

Year	Actual
2016	3

Output #2

Output Measure

- Number of research-based publications distributed as part of this program.

Year	Actual
2016	2487

Output #3

Output Measure

- Research fertilizer products to improve crop productivity and food mineral nutrition. (Yin)

Year	Actual
2016	1

Output #4

Output Measure

- Evaluate treatments for soilborne fungal pathogens of snapbeans and soybeans. (Canaday) Not reporting on this Output for this Annual Report

Output #5

Output Measure

- Develop new cereal varieties (West)

Year	Actual
2016	1

Output #6

Output Measure

- Test drought tolerant soybeans (Cheng)

Year	Actual
2016	1

Output #7

Output Measure

- Enhance bioactive food components (Kopsell, Armel, Sams, Deyton)

Year	Actual
2016	1

Output #8

Output Measure

- Genetically improve soybean yields (Pantalone)

Year	Actual
2016	1

Output #9

Output Measure

- Address Genetic Resistance to Bt Toxins (Jurat-Fuentes)

Year	Actual
2016	1

Output #10

Output Measure

- Use Remote Sensing for Variable-rate Nitrogen Application (Gwathmey, Yin)
  Not reporting on this Output for this Annual Report

Output #11

Output Measure

- Understand Soybean Mosaic Virus Virulence (Hajimorad)

Year	Actual
2016	1

Output #12

Output Measure

- Evaluate New Crop Varieties (Allen)

Year	Actual
2016	1

Output #13

Output Measure

- Fact Sheet of recommendations to farmers/producers to grow/manage pigeon pea in Tennessee and surrounding states. (Duseja)

Year	Actual
2016	1

Output #14

Output Measure

- Investigate appropriate use of unmanned aircraft systems (Freeland)
  Not reporting on this Output for this Annual Report

Output #15

Output Measure

- Utilize Kudzu Bug transcriptome for insecticidal gene silencing approaches (Jurat-Fuentes)

Year	Actual
2016	1

Output #16

Output Measure

- Effects of Irrigation Timing on Cotton on High AWHC soils (Larson)

Year	Actual
2016	1

Output #17

Output Measure

- Leveraging Insect Gut-Healing Response to Pesticides and Pathogens (Jurat-Fuentes)

Year	Actual
2016	1

Output #18

Output Measure

- Value of Soil Test Information for Potassium in Upland Cotton (Lambert, Larson)

Year	Actual
2016	1

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Row Crops Production: Number of participants who implemented one or more management practices based on data provided by UT (e.g., conservation tillage, plant population, growth retardants, IPM strategies, disease and weed control).
2	Row Crops Production: Number of producers, farm workers and other ag professionals who received pesticide certification, recertification and pesticide safety training.
3	Row Crops Production: Number of participants who improved their income by following the recommended best management practices for crop production, including plant pest management.
4	Soybeans: Number of producers who learned soybean best management practices that can improve production potential (e.g., conservation tillage, winter covers, plant population, row spacing, planting dates, plant growth regulators, harvest, variety selection, irrigation, fertility).
5	Continued adoption of automatic section control on planters (Velandia, Larson, Buschermohle)
6	Create genetic mapping populations of soybean (Pantalone)
7	Investigate insect resistance to biopesticides (Jurat-Fuentes)
8	Identify Molecular and Genomic Plant Defense Mechanisms (Chen, Grant)
9	Explore Nematode and Arthropod Biodiversity (Bernard)
10	Attack the Soybean cyst Nematode (Hewezi)
11	Agronomic research in seeding establishment, summer cover and intercropping to aid in the use of pigeon pea as an alternate crop for small holder agriculture in Tennessee. (Duseja)
12	Precision protocols will be developed for nucleic acid extraction from isolated cotton pollen and microspores towards molecular marker based analyses of cotton lines. (Aziz)
13	Agricultural and Environmental Sciences research knowledge will be enhanced for undergraduate and/or graduate students through laboratory experiential learning. (Aziz)
14	Improve amaranth as an alternative crop and increase profitability of farming in small acreages through the production of alternative crops. (Blair)
15	Increase soybean genetic diversity. (Taheri)
16	Identify vegetable cultivars suitable for organic management system and to improve efficiency of organic farming by proper allocation of inputs. (Nandwani)
17	Research to better understand the bacterial wilt disease process and the role of individual genes in the disease process. (Dumenyo)

18	A Novel Technology to Assess High Quality Genotypes (Lamour)
19	Colorado Potato Beetles Selected for Resistance to RNAi (Jurat-Fuentes)

Outcome #1

1. Outcome Measures

Row Crops Production: Number of participants who implemented one or more management practices based on data provided by UT (e.g., conservation tillage, plant population, growth retardants, IPM strategies, disease and weed control).

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	3267

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

What has been done

Results

4. Associated Knowledge Areas

KA Code	Knowledge Area
205	Plant Management Systems
211	Insects, Mites, and Other Arthropods Affecting Plants
213	Weeds Affecting Plants

Outcome #2

1. Outcome Measures

Row Crops Production: Number of producers, farm workers and other ag professionals who received pesticide certification, recertification and pesticide safety training.

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	514

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

What has been done

Results

4. Associated Knowledge Areas

KA Code	Knowledge Area
205	Plant Management Systems
211	Insects, Mites, and Other Arthropods Affecting Plants

Outcome #3

1. Outcome Measures

Row Crops Production: Number of participants who improved their income by following the recommended best management practices for crop production, including plant pest management.

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	1923

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

What has been done

Results

4. Associated Knowledge Areas

KA Code	Knowledge Area
205	Plant Management Systems
211	Insects, Mites, and Other Arthropods Affecting Plants
601	Economics of Agricultural Production and Farm Management

Outcome #4

1. Outcome Measures

Soybeans: Number of producers who learned soybean best management practices that can improve production potential (e.g., conservation tillage, winter covers, plant population, row spacing, planting dates, plant growth regulators, harvest, variety selection, irrigation, fertility).

Not Reporting on this Outcome Measure

Outcome #5

1. Outcome Measures

Continued adoption of automatic section control on planters (Velandia, Larson, Buschermohle)

Not Reporting on this Outcome Measure

Outcome #6

1. Outcome Measures

Create genetic mapping populations of soybean (Pantalone)

Not Reporting on this Outcome Measure

Outcome #7

1. Outcome Measures

Investigate insect resistance to biopesticides (Jurat-Fuentes)

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	1

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

What has been done

Results

4. Associated Knowledge Areas

KA Code	Knowledge Area
201	Plant Genome, Genetics, and Genetic Mechanisms
202	Plant Genetic Resources
211	Insects, Mites, and Other Arthropods Affecting Plants

Outcome #8

1. Outcome Measures

Identify Molecular and Genomic Plant Defense Mechanisms (Chen, Grant)

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	1

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

What has been done

Results

4. Associated Knowledge Areas

KA Code	Knowledge Area
201	Plant Genome, Genetics, and Genetic Mechanisms
202	Plant Genetic Resources
211	Insects, Mites, and Other Arthropods Affecting Plants
212	Pathogens and Nematodes Affecting Plants
213	Weeds Affecting Plants

Outcome #9

1. Outcome Measures

Explore Nematode and Arthropod Biodiversity (Bernard)

Not Reporting on this Outcome Measure

Outcome #10

1. Outcome Measures

Attack the Soybean cyst Nematode (Hewezi)

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	1

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

What has been done

Results

4. Associated Knowledge Areas

KA Code	Knowledge Area
201	Plant Genome, Genetics, and Genetic Mechanisms
202	Plant Genetic Resources
205	Plant Management Systems
212	Pathogens and Nematodes Affecting Plants

Outcome #11

1. Outcome Measures

Agronomic research in seeding establishment, summer cover and intercropping to aid in the use of pigeon pea as an alternate crop for small holder agriculture in Tennessee. (Duseja)

Not Reporting on this Outcome Measure

Outcome #12

1. Outcome Measures

Precision protocols will be developed for nucleic acid extraction from isolated cotton pollen and microspores towards molecular marker based analyses of cotton lines. (Aziz)

2. Associated Institution Types

- 1890 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	2

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Individual gamete genotyping provides several advantages including minimum sample requirement, genetic identification of parent, overcoming the complexity of polyploidy, reducing the costs of genetic analyses, and facilitating gametic merit assessment. Such molecular markers? based analyses on Upland cotton (Gossypium hirsutum) lines with chromosome or segment substituted from Pima cotton (G. barbadense) would supplement plant breeding efforts for improving cotton seed oil and protein traits for food/feed usage.

What has been done
Individual isolated pollen grains of Upland cotton, Pima cotton and their two chromosome substitution progeny lines were germinated to release their DNAs and genomic DNA was increased by modified primer extension pre-amplification (PEP) procedure. Also from select cotton lines, microspores just released from tetrad developmental stage (uninucleate) were individually isolated and gamete DNA was extracted as well as amplified through multiple displacement amplification (MDA) using REPLI-g Single Cell Kit (QIAGEN, Valencia, CA). The parental samples along with PEP and MDA amplified individual gamete DNAs were then analyzed using simple sequence repeat (SSR) as well as amplified fragment length polymorphism (AFLP) markers.

Results
The amplification of parental SSR and AFLP markers from both mature pollen and uninucleate (just released from tetrad developmental stage) microspore cotton samples was successfully reported for the first time. Six parental SSRs were demonstrated for CS-B17 gametes and 10 parental SSRs were confirmed in CS-B25 pollen samples. Also over 80 parental AFLPs were analyzed for their presence in G. hirsutum CS-B17 and CS-B25 pollen grains. The single mature pollen as well as uninucleate microspores? genotyping could detect the identity of cotton lines and thus can serve as important tool for enhancing breeding efficiencies.

4. Associated Knowledge Areas

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

Outcome #13

1. Outcome Measures

Agricultural and Environmental Sciences research knowledge will be enhanced for undergraduate and/or graduate students through laboratory experiential learning. (Aziz)

2. Associated Institution Types

- 1890 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	8

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
NIFA's priority area includes enhancing student recruitment and retention in TSU agricultural sciences to increase the educational opportunities for target populations. The need for students is to heighten interest in science, engineering, and technology (SET), as well as research through unique approaches while pipelining them into the degree programs in natural resources through SET education.

What has been done
Though primarily focused on research, this project also supported educational endeavors by providing laboratory-based trainings during the academic year for students to prepare them for practical aspects of the agriculture discipline. All three possible levels through higher educational institute, i.e., precollege, undergraduate and graduate students? training opportunities were provided. Thus, four graduate students (October 2016- May/September 2016), two pre-college students (June-July 2016) and two undergrad students (since September 2016) were involved through the research-based trainings.

Results
The two pre-college students trained, made presentations an audience of faculty, staff, graduate students, precollege students and precollege students? families. Two undergraduate students involved so far, have prepared and submitted their presentations for 14th Annual Tennessee Louis Stokes Alliance for Minority Participation Undergraduate Research Conference and TSU?s 39th Annual University-Wide Research Symposium competition. The four TSU graduate students

successfully defended their theses after trainings, and graduated with the degrees of Master of Science in Department of Agricultural and Environmental Sciences.

4. Associated Knowledge Areas

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

Outcome #14

1. Outcome Measures

Improve amaranth as an alternative crop and increase profitability of farming in small acreages through the production of alternative crops. (Blair)

2. Associated Institution Types

- 1890 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Alternative crops are needed by Tennessee farmers who rely on a small gamut of possible crops (corn, soybean, forage and cotton) on most acreage in the state. One attractive new crop is the Grain Amaranth, a C4 plant like maize but which is from the broadleaf family of plants (dicotyledons) and which is harvested for small seed and forage potential. In this research we advanced from last year?s screening of single row plots of USDA and Seed Savers Exchange (SSE) germplasm to a more detailed screening of double row plots (one hilled, one not hilled) for evaluation of the best genotypes. We improved the experiments with augmented design using a block of replicates, checks and comparable species. This will lead to improved grain amaranth varieties available for growing conditions in Tennessee.

What has been done
Adaptation was measured by keeping fertilization completely organic. No pesticides were used to allow diseases and insect to take their affect on the crop. An improved transplanting system was developed for seedlings planted from late April to early May in the greenhouse, with field planted late May to early June (by transplants). Number of plots were 33 accessions of American gardener varieties from SSE. For the USDA 79 plots with augmented design of 6 repeated accessions, 71 individual accessions, plus two Amaranthus species were examined. In addition to agronomic testing in the field, molecular analysis was performed. DNA was extracted for 260 individuals and submitted to marker analysis with 42 KASP assays while the most promising 94

were extracted for genotyping by sequencing (GBS) analysis. For genome wide association study (GWAS) analysis a total of 112 plots additional genotypes were planted in single repetition, double row plots and bordered by maize. An F3 population was advanced in the field and a total of c. 80 single F4 plants were harvested and weighted for harvest index data.

Results

These variety trials were very much appreciated by the Amaranth Institute conference members who toured the fields in early August. Results include the identification of best-bet amaranth varieties and the development of molecular marker techniques for amaranth. The most adapted varieties included those with rapid germination such as the replicated materials USDA38, USDA42, USDA61, USDA91, USDA92, USDA102 and the overall higher yields of SSE varieties compared to mean of USDA genotypes. In marker technologies we perfected 42 KASP markers and ordered 45 more and are assembling sequence data for GBS markers in amaranth.

4. Associated Knowledge Areas

KA Code	Knowledge Area
202	Plant Genetic Resources
203	Plant Biological Efficiency and Abiotic Stresses Affecting Plants

Outcome #15

1. Outcome Measures

Increase soybean genetic diversity. (Taheri)

2. Associated Institution Types

- 1890 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	1

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Generating new soybean germplasm is necessary for addressing increasing demands for food and feed. It is also necessary to improve nutritional values in soybeans. Lower allergens and lower phytic acid are other important traits which are in high demand by consumers and producers.

What has been done

More than 10,000 soybean seeds have been treated with EMS for generating random mutation in soybean genome. About 2000 M1 plants survived the treatment and grew to full maturity. Seeds were harvested from these plants and about 12 seeds were planted from each M1 plant in the second growing season for phenotypic evaluation and DNA examination in summer 2016. The data generated from this germplasm enhancement will be used in fishing out mutations in reported genes involved in beneficial traits.

Results

In 2016, we manually planted more than 20,000 soybeans seeds from the 2000 M1 mutants which 6500 of them survived to maturity. The performance of these plants was measured in the field, recorded their phenotype and collected tissue samples for DNA extraction. This collection is a valuable resource in screening for agronomic traits such as higher oil or protein content, better fatty acid profile, less allergens and better nutritional values

4. Associated Knowledge Areas

KA Code	Knowledge Area
201	Plant Genome, Genetics, and Genetic Mechanisms
202	Plant Genetic Resources

Outcome #16

1. Outcome Measures

Identify vegetable cultivars suitable for organic management system and to improve efficiency of organic farming by proper allocation of inputs. (Nandwani)

2. Associated Institution Types

- 1890 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	66

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

New cultivars of vegetables are always of interest to growers and consumers. Current information regarding cultivar performance under organic, humid subtropical conditions in Tennessee remains insufficient. A significant challenge for organic growers is weed control in crop production due to the restrictions on use of synthetic herbicides and chemical applications.

What has been done

Field trials of tomato, leafy greens, and sweetpotato crops continued in 2016. Several varieties grown in organic cropping system and evaluated during growing season at TSU-CAHNS certified organic farm. Various mulch treatments applied in organic sweetpotato variety trial to manage weed populations and control.

Results

Sixty six varieties of organic tomato (26), leafy greens (25) and sweetpotato (15) were identified for improved agronomic characteristics, higher yields, resistance to pest and diseases, and palatability. Mulch products were evaluated to provide lower occurrence of weeds in sweetpotato fields.

4. Associated Knowledge Areas

KA Code	Knowledge Area
202	Plant Genetic Resources
204	Plant Product Quality and Utility (Preharvest)
205	Plant Management Systems

Outcome #17

1. Outcome Measures

Research to better understand the bacterial wilt disease process and the role of individual genes in the disease process. (Dumenyo)

2. Associated Institution Types

- 1890 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	1

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Bacterial wilt disease, caused by the pathogenic bacterium, Erwinia tracheiphila is one of the most destructive diseases of cucurbits crops in the world. The causal organism is vectored by striped and spotted cucumber beetles. The bacterium has received little research attention because of slow growth and the successful use of chemical agents to control the insect vectors. However, chemical the insecticides also kill other beneficial insects such as the pollinators. To manage the disease through the pathogen rather than the vector, a fundamental understanding of the basic biology of the bacterium is required.

What has been done
The goal is to create genetic tools that are needed for molecular analysis of the bacterial wild pathogen, E. tracheiphila. The transposon is the main genetic tool needed for random and systematic creation of bacterial mutants lacking specific genes. An R6K-based mini-Tn5 transposon carrying gfp gene and positive antibiotic selection for insertion was developed. Following discovery that this transposon is capable of replicating in E. tracheiphila strains, two alternates approaches were proposed to accomplish the objective of generating mutants in E. tracheiphila: 1) purification of the transposase for in vitro mutagenesis and 2) modification of the transposon vector with sacB gene to allow the use of the transposon in E. tracheiphila.

Results
The initial transposon designed had promoter-less gfp and nptII genes for positive selection of insertion, Cm resistant gene, and origin of replication within the transposon ends. The transposon was used for mutagenesis of Pectobacterium, E. coli and Pseudomonas. The mutants generated fluorescent to varying degrees, and retained remained resistant to the antibiotic kanamycin. The transposase purified failed to induce mutagenesis in E. tracheiphila. The modified transposon clones were obtained and under test.

4. Associated Knowledge Areas

KA Code	Knowledge Area
212	Pathogens and Nematodes Affecting Plants

Outcome #18

1. Outcome Measures

A Novel Technology to Assess High Quality Genotypes (Lamour)

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Genotyping is very expensive.

What has been done

Discovered a novel technology to assess high quality genotypes at a very low cost.

Results
Disclosed the discovery, started a biotech company and are working with multiple groups to test the technology and prove the concept.

4. Associated Knowledge Areas

KA Code	Knowledge Area
104	Protect Soil from Harmful Effects of Natural Elements
201	Plant Genome, Genetics, and Genetic Mechanisms
202	Plant Genetic Resources
203	Plant Biological Efficiency and Abiotic Stresses Affecting Plants
204	Plant Product Quality and Utility (Preharvest)
212	Pathogens and Nematodes Affecting Plants

Outcome #19

1. Outcome Measures

Colorado Potato Beetles Selected for Resistance to RNAi (Jurat-Fuentes)

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Insecticidal gene silencing by RNA interference (RNAi) is being expected to revolutionize insect control in agriculture given its specificity and efficacy. While a number of products are currently in the pipeline of biotech companies, there is no available information on the ability of insects to develop resistance to RNAi. This information is vital to design effective resistance prevention and management strategies.

What has been done
We have selected a population of Colorado potato beetle for resistance to RNAi.

Results
Availability of this colony opens the door to research identifying the resistance mechanism/s involved.

4. Associated Knowledge Areas

KA Code	Knowledge Area
201	Plant Genome, Genetics, and Genetic Mechanisms
202	Plant Genetic Resources
203	Plant Biological Efficiency and Abiotic Stresses Affecting Plants
205	Plant Management Systems
211	Insects, Mites, and Other Arthropods Affecting Plants
212	Pathogens and Nematodes Affecting Plants

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Natural Disasters (drought, weather extremes, etc.)
- Economy

Brief Explanation

Soybeans were planted and harvested on more than 1.67 million acres in Tennessee in 2016. Warmer temperatures and variable rainfall created a lower yield environment in most counties across the state and there was a final state average yield of 44 bushels/acre (Jan 2016 NASS quick facts). Soybean prices were mediocre and most producers received close to $9.50 per bushel for their crop. The 2016 growing season for Corn started with a wet spring followed by a growing season that included warmer temperatures and more variable rainfall across the state. Farmers reported a mixture of both optimal and low corn yields that were location dependent. The final state average yield was 151 bushels/acre (Jan 2016 NASS Quick stats). Corn prices were low due to the large U.S. crop with producers receiving closer to $3.30 per bushel for their crop on average.

V(I). Planned Program (Evaluation Studies)

Evaluation Results

For our organic research, attendees/participants in program activities will be provided a Post Test after an educational activity i.e. in-service training or training workshop. The issue-based questions will record the knowledge of the participants before and after the activity. Data collection will include sampling of research outcomes and to be clearly recorded based upon level of importance to stakeholders.
The success of the transposon construction project was evaluated by its ability to be utilized in generation mutants in Pectobacterium, E. coli and Pseudomonas. The objective of generating mutants in E. tracheiphila however was not met and the transposon replicated in the bacterium. The success of the modification will be measured by the ability to use the modified vector in generation mutants in E. tracheiphila. There is a backup plan to use

commercial transposase in the in vitro mutagenesis.
This research project is aimed at developing tools that are usable by scientific community towards enhancing plant breeding efficiency for cotton nutritional traits. Thus empirically the program success was realized by assessing the number of interested international/national students who applied to join the cotton research program after learning (usually through web-site resources) about such activities at Tennessee State University. During the period under report more than 15 potential graduate students and/or post-doctoral researchers made contacts to join the cotton research project at TSU. The strengthened institutional capacities through student trainings and faculty research is also another evaluation estimate of program success.
Overall, the impact of the research was documented through the number of people reached with our research output in the forms of publications, conference presentations and citations of our work. The impact was also documented by the number of students who were trained in the process including both graduate and undergraduate students. As a laboratory research program, formative evaluation is continuing. Generally, an experiment has to accomplish it goal before we can proceed to the next.
Our evaluation studies of extension agronomic crop systems programs show the following:

- 231101 acres were planted and managed using GPS technology, seeding rates, applications of fertilizer and lime, plant growth regulators, defoliants or pesticides.
- 521 producers increased their knowledge of irrigation by learning about the latest in irrigation practices, principles, and benefits.
- 180 producers increased their return on 80,150 acres by $4.58 million by utilizing irrigation instead of dry land production.
- 1069 producers increased their marketing knowledge by learning about the current market situation and different alternative marketing tools.
- 212 producers increased their return on 103,980 acres by $2.8 million due to utilizing forward pricing market opportunities as compared to selling at harvest.
- 181 producers utilized UT fertility recommendations.

Key Items of Evaluation

- 180 producers increased their return on 80,150 acres by $4.58 million by utilizing irrigation instead of dry land production.
- 212 producers increased their return on 103,980 acres by $2.8 million due to utilizing forward pricing market opportunities as compared to selling at harvest.

V(A). Planned Program (Summary)

Program # 3

1. Name of the Planned Program

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
205	Plant Management Systems	0%	0%	12%	0%
301	Reproductive Performance of Animals	15%	15%	19%	0%
302	Nutrient Utilization in Animals	0%	0%	19%	30%
303	Genetic Improvement of Animals	10%	10%	0%	25%
304	Animal Genome	0%	0%	0%	25%
305	Animal Physiological Processes	0%	0%	9%	0%
306	Environmental Stress in Animals	0%	0%	2%	0%
307	Animal Management Systems	60%	60%	0%	10%
311	Animal Diseases	15%	15%	10%	0%
312	External Parasites and Pests of Animals	0%	0%	4%	0%
315	Animal Welfare/Well-Being and Protection	0%	0%	21%	0%
402	Engineering Systems and Equipment	0%	0%	2%	0%
603	Market Economics	0%	0%	0%	10%
712	Protect Food from Contamination by Pathogenic Microorganisms, Parasites, and Naturally Occurring Toxins	0%	0%	2%	0%
	Total	100%	100%	100%	100%

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2016	Extension		Research	
	1862	1890	1862	1890
Plan	44.0	5.0	30.0	9.0
Actual Paid	41.0	4.0	22.7	9.4
Actual Volunteer	9.0	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**
815353	113146	802867	455201
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
3631431	131223	2850093	455201
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
200000	11102	251267	251561

V(D). Planned Program (Activity)

1. Brief description of the Activity

The Extension efforts the Animal Sciences planned program focused on production and management of beef cattle, dairy cattle, goats, and horses.
Regarding beef production and management, the major programs were the Master Beef Producer Program and the Advanced Master Beef Producers Program. These efforts were led by a team of UT Extension specialists and agents, with the support and involvement of representatives of state agencies, businesses and organizations that have an interest in the state's cattle industry. These programs teach beef producers through multiple sessions and include all aspects of effective cow-calf production and issues facing the beef industry. The goal is to enhance the profitability and competitiveness of cow-calf operations by providing technical information and instruction.
Extension dairy cattle programs utilized farm visits by Extension agents and specialists to help producers learn the benefits of pasture and grazing and the need for production and sound financial records to manage their operations. In 2016, some of the new areas for Extension programming were sharing research-based information about certified organic dairy production and other niche marketing opportunities.
Tennessee horse owners depend on UT Extension's research-based programs for horse health and nutrition. UT Extension taught rotational grazing to increase forage production, vaccinations, dental care, and correct deworming practices.
Extension goat programs were led by TSU and focused on genetic improvement, nutrition, health, and reproduction. TSU Extension organized a Tennessee Master Goat Producer Program. This program has helped goat producers to improve their production efficiency.

Goats are an environmentally adaptive specie of livestock, extremely opportunistic and afford the small limited resource landowner(s) an alternative enterprise. The goat provides food security, high quality protein (for human nutrition), biological land enhancement and many 'value-added' products to increase revenue generated on a holistically sustainable rural farm. With the decrease in planted tobacco acreage and income from this traditional crop, the production of goats becomes a natural alternative. Tennessee continues to rank second in meat goats in the U.S. The total number of meat goats in Tennessee on January 1, 2009 was 133,000 head, up 9,000 head from 2008. Milk goats totaled 5,800 head, unchanged from the previous year (TN Farm Facts, February 4, 2009). Meat goat numbers have been significantly increasing within the United States since the early 1990's but goat meat consumption has surpassed available supply, based on ethnic group statistics. The importation of goat meat (30 pound carcass equivalent) surpassed export in 1994. There is no longer an export value for goat meat; the import value has tripled.

The Tennessee Browsing Academy was established in May 2007 as an extensive four day hands-on training for producers, educators / government agency personnel interested in the biological and

environmentally sound practices of vegetative management with small ruminants (specifically goats). This class is taught through lecture and applied practices as the participants learn new techniques.

The most outstanding example of successful outcomes encompassing the work of extension specialists, county extension agents, and clients is the Master Meat Goat Producer Program. The Small Ruminant College has become an annual two-day event covering a different major production theme each year. Along with the two days of both inside lectures and outside hands-on demonstrations, the attendees receive proceedings to complement the topics covered. Work will continue in working with small ruminant farmers as well as with professionals through Heifer International. Presentations and demonstrations in the state are designed for extension agents, government agencies, meat goat organizations, farmer forum initiatives, and 4-H groups.

UT AgResearch conducts applied and basic research in animal health, nutrition, physiology, and genomics to address high priority problems of the livestock industries. We disseminate information gained from these studies to producers, veterinarians, and others associated with the animal industries through outreach programs and publications.

Surveillance of possible disease vectors is maintained by AgResearch throughout the insect season; suspected vectors are tested for appropriate viruses. Risk factor analysis test results are compared between sites where disease risk is high vs. those where disease risk is low. Mastitis susceptible and resistant dairy cows are used to identify potential genes, immune components, and other factors associated with and responsible for mastitis resistance. A series of trials uses pigs to test various feeding regimens and feed additives to determine effects on the number of antibiotic resistant foodborne pathogens occurring in those animals and their environment. Additional studies are detecting the prevalence of antibiotic resistant bacteria associated with cattle and surrounding environments. These studies should help determine strategies to limit such foodborne risks.

Other Activities:
Conduct research on the longitudinal survival and reproductive output of meat goat does.
Conduct research on nutritional requirements for Guinea fowl.
Perform genome mapping of important production qualities in Guinea fowl.
Conduct focus group meetings to collect information from producers and consumers.
Develop and administer surveys to selected producers and consumers.
Identify selected meat goat consumers/ethnic groups/communities.

2. Brief description of the target audience

Producers, veterinarians, and others associated with the animal industry. Tennessee cattle producers are primarily cow-calf operators. All of the state's cow-calf operators compose the target audience for this planned program.

Dairy and meat goat producers, the national meat goat industry, institutions of meat goat research, ruminant livestock producers, students, public officials, Guinea fowl and poultry industries, small farmers, scientific community.

3. How was eXtension used?

Tennessee Extension personnel were was part of the following eXtension Communities of Practice that informed our work on this planned program:

- Beef Cattle

- Goats
- Horses
- Sheep

V(E). Planned Program (Outputs)

1. Standard output measures

2016	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	355864	24281280	96830	0

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

Patent Applications Submitted

Year:	2016
Actual:	3

Patents listed

Using extracellular vesicle derived microRNA (miRNA) as markers of embryo mortality, Ky Pohler
Pregnancy Associated Glycoprotein (PAG) Genes As Markers of Bull Fertility, Ky Pohler
Methods for improvement of semen quality, Rispoli, L.A., Edwards, J.L. and F.N. Schrick

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2016	Extension	Research	Total
Actual	22	78	0

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number of exhibits displayed to promote awareness of and participation in this planned program.

Year	Actual
2016	76

Output #2

Output Measure

- Number of research-based publications distributed as part of this program.

Year	Actual
2016	282

Output #3

Output Measure

- Identify Cattle Resistant to Tall Fescue Toxicosis (Kojima)
  Not reporting on this Output for this Annual Report

Output #4

Output Measure

- Evaluate Alternative Heating Systems for Broiler Houses (Hawkins)
  Not reporting on this Output for this Annual Report

Output #5

Output Measure

- Improve Reproductive Efficiency in Cattle (Rispoli)

Year	Actual
2016	1

Output #6

Output Measure

- Promote Native Grasses in Forage Systems (Keyser)

Year	Actual
2016	1

Output #7

Output Measure

- Improve nutrient utilization in heat-stressed lactating dairy cows (Ruis)

Year	Actual
2016	1

Output #8

Output Measure

- Artificial Insemination Success with African Elephants (Rispoli)

Year	Actual
2016	1

Output #9

Output Measure

- Mastitis: Isolate bactericidal molecules from Staphyl. chromogens (Kerro Dego)

Year	Actual
2016	1

Output #10

Output Measure

- Prepartum Ration to Boost Calves' Profitability in Finishing? (Boyer, Lewis, Griffith, Rhinehart)

Year	Actual
2016	1

Output #11

Output Measure

- Risks to Fall and Spring Calving (Boyer)

Year	Actual
2016	1

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Extension Economic Impact: The total economic impact of Extension animal systems programs. (The target is expressed in millions of dollars.)
2	Beef Production and Marketing: Number of beef producers who utilized improved sires, artificial insemination or other genetic improvement methods.
3	Beef Production and Marketing: Number of beef producers who improved marketing methods.
4	Beef Production and Marketing: Number of producers who improved forages for livestock by broadleaf weed control, planting clover, stockpiling fescue or planting warm-season grasses.
5	Beef Production and Marketing: The number of calves managed according to Beef Quality Assurance (BQA) guidelines.
6	Goat Production: Number of goat producers who have implemented practices related to genetic improvement, nutrition, health, reproduction and other information as a result of the Master Goat Program.
7	Detect Mastitis Onset Using Behavioral Changes (Krawczel)
8	Develop Diagnostic Devices for Animal/Human Diseases (Eda)
9	Exploit Pathways for Leanness in Poultry/Humans (Voy)
10	Supplement Nutrients for Improved Reproduction (Mulliniks)
11	Research to provide new information on the benefit of a new sire breed option (Savannah) and creep feeding on improving the doe output and economic return for commercial meat goat enterprises. (Browning)
12	Efficiency of feed utilization in poultry through knowledge and implementation of optimum nutrient requirements, especially methionine and cysteine. (Nahashon)
13	Genetic resource information for future and rapid selection of well performing animals and those that can transmit superior economic traits to future generations. (Nahashon)
14	Discovery of modes of action of probiotics and new nutrient sensing pathways leading to establishment of precise nutrient requirements of poultry, especially chickens and guinea fowl. (Nahashon)
15	Research to enhance income for meat goat producers through increased consumer knowledge about goat meat and retailer knowledge of goat meat preferences. (Ekanem)
16	Enhanced producer knowledge of marketing information to expand goat meat sales to existing markets. (Ekanem)
17	Efficacy of fat deposition reduction in poultry through genotyping by sequencing approach for analysis of chicken genome. (Wang)

18	Investigate supplements to reduce post-weaning stress on piglets (Kattesh)
19	Extension Small Ruminant Programs produced Economic Value for Producers
20	Mastitis Experimental Teat Dip Challenge Model (Kerro Dego)

Outcome #1

1. Outcome Measures

Extension Economic Impact: The total economic impact of Extension animal systems programs. (The target is expressed in millions of dollars.)

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	66

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

What has been done

Results

4. Associated Knowledge Areas

KA Code	Knowledge Area
307	Animal Management Systems

Outcome #2

1. Outcome Measures

Beef Production and Marketing: Number of beef producers who utilized improved sires, artificial insemination or other genetic improvement methods.

2. Associated Institution Types

- 1862 Extension
- 1890 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	3009

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

What has been done

Results

4. Associated Knowledge Areas

KA Code	Knowledge Area
303	Genetic Improvement of Animals

Outcome #3

1. Outcome Measures

Beef Production and Marketing: Number of beef producers who improved marketing methods.

2. Associated Institution Types

- 1862 Extension
- 1890 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	2603

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

What has been done

Results

4. Associated Knowledge Areas

KA Code	Knowledge Area
307	Animal Management Systems
603	Market Economics

Outcome #4

1. Outcome Measures

Beef Production and Marketing: Number of producers who improved forages for livestock by broadleaf weed control, planting clover, stockpiling fescue or planting warm-season grasses.

2. Associated Institution Types

- 1862 Extension
- 1890 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	1909

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

What has been done

Results

4. Associated Knowledge Areas

KA Code	Knowledge Area
302	Nutrient Utilization in Animals
307	Animal Management Systems

Outcome #5

1. Outcome Measures

Beef Production and Marketing: The number of calves managed according to Beef Quality Assurance (BQA) guidelines.

2. Associated Institution Types

- 1862 Extension
- 1890 Extension

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	4835

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

What has been done

Results

4. Associated Knowledge Areas

KA Code	Knowledge Area
307	Animal Management Systems

Outcome #6

1. Outcome Measures

Goat Production: Number of goat producers who have implemented practices related to genetic improvement, nutrition, health, reproduction and other information as a result of the Master Goat Program.

2. Associated Institution Types

- 1890 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	148

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

What has been done

Results

4. Associated Knowledge Areas

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

Outcome #7

1. Outcome Measures

Detect Mastitis Onset Using Behavioral Changes (Krawczel)

Not Reporting on this Outcome Measure

Outcome #8

1. Outcome Measures

Develop Diagnostic Devices for Animal/Human Diseases (Eda)

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	1

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

What has been done

Results

4. Associated Knowledge Areas

KA Code	Knowledge Area
311	Animal Diseases
315	Animal Welfare/Well-Being and Protection

Outcome #9

1. Outcome Measures

Exploit Pathways for Leanness in Poultry/Humans (Voy)

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	1

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

What has been done

Results

4. Associated Knowledge Areas

KA Code	Knowledge Area
302	Nutrient Utilization in Animals
303	Genetic Improvement of Animals
305	Animal Physiological Processes

Outcome #10

1. Outcome Measures

Supplement Nutrients for Improved Reproduction (Mulliniks)

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	1

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

What has been done

Results

4. Associated Knowledge Areas

KA Code	Knowledge Area
301	Reproductive Performance of Animals
302	Nutrient Utilization in Animals
305	Animal Physiological Processes
307	Animal Management Systems

Outcome #11

1. Outcome Measures

Research to provide new information on the benefit of a new sire breed option (Savannah) and creep feeding on improving the doe output and economic return for commercial meat goat enterprises. (Browning)

2. Associated Institution Types

- 1890 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	1

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Producers need to better assess the ability of breeds to contribute to efficient market kid production under limited inputs. Many producers have made poor breed choices that have led to non-sustainable operations. Creep-feeding in meat goat systems has often been recommended and implemented without sufficient research to support the recommendation.

What has been done
Savanna bucks have been compared to Kiko and Spanish bucks for preweaning progeny performance. Kids born were either creep-fed or not provided creep feed to assess growth and economic outcomes. Presentations and research updates were disseminated to producers at industry and university events disseminating project outcomes.

Results
Research outcomes indicated that Savanna sires did not demonstrate an advantage over Kiko or Spanish sires for kid performance. Creep feeding promoted enhanced kid growth, but not enhanced net economic return. Dissemination of results have allowed 600 new and experienced producers to gain a better understanding of the potential benefits of informed breed selection and creep-feeding for use in commercial meat goat herds.

4. Associated Knowledge Areas

KA Code	Knowledge Area
307	Animal Management Systems

Outcome #12

1. Outcome Measures

Efficiency of feed utilization in poultry through knowledge and implementation of optimum nutrient requirements, especially methionine and cysteine. (Nahashon)

2. Associated Institution Types

- 1890 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	1

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Methionine is an essential amino acids for growth performance of poultry; however, the requirement for the amino acids for optimum growth performance of the guinea fowl is not known. Lack of optimal nutrient profiles can hamper growth performance and increase cost of poultry production.

What has been done
The methionine and cysteine requirement for optimum growth performance of the French guinea fowl was evaluated.

Results
Diets containing 0.50-0.45% Methionine and 0.35% Cysteine were utilized more efficiently by the French guinea fowl. Therefore the requirement for methionine and cysteine by the French guinea fowl was determined to be 0.45-0.50% and 0.35%, respectively.

4. Associated Knowledge Areas

KA Code	Knowledge Area
302	Nutrient Utilization in Animals
303	Genetic Improvement of Animals
304	Animal Genome

Outcome #13

1. Outcome Measures

Genetic resource information for future and rapid selection of well performing animals and those that can transmit superior economic traits to future generations. (Nahashon)

2. Associated Institution Types

- 1890 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	1

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Genetic resource information to aid marker assisted selection for traits of economic importance, such as feed efficiency, and to aid poultry improvement, such as the guinea fowl, is limited. Understanding the nutrient requirements and generating additional genetic resource information to aid breeding will significantly aid poultry production and profitability, especially by small scale farmers willing to raise the bird for commercial purposes.

What has been done
Guinea fowl sequences of the bursa, spleen and bone marrow were generated through de novo sequencing and assembled.

Results
A total of 114.18 Gb of bases were generated and 9 assemblies were realized. These sequences will be utilized in generating immune markers for comparative mapping, future selection and genetic improvement of the avian species. 1000 genes were annotated.

4. Associated Knowledge Areas

KA Code	Knowledge Area

302	Nutrient Utilization in Animals
303	Genetic Improvement of Animals
304	Animal Genome

Outcome #14

1. Outcome Measures

Discovery of modes of action of probiotics and new nutrient sensing pathways leading to establishment of precise nutrient requirements of poultry, especially chickens and guinea fowl. (Nahashon)

2. Associated Institution Types

- 1890 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The gastrointestinal tract (GIT) is an enormous surface inhabited by a complex and diverse community of microorganisms known as the intestinal microflora (IM). Some of these microorganisms have been characterized while others have not, yet they might bear beneficial effects on bird performance by enhancing health and nutrient utilization.

What has been done
The 16s rDNA library of chicken and guinea fowl gastrointestinal microbials was constructed, enriched and sequenced, and analyzed.

Results
Microbial profiles of chicken and guinea fowl revealed phylogenetic diversity of these avian species consisting of almost 150 families. Chicken microbial profiles showed abundance of microbial species compared to guinea fowl. Phylum actinobacteria was more abundant in chickens than guinea fowl. The microbial profile of chicken and guinea fowl revealed diverse probiotic bacteria whose distribution will be correlated with performance characteristics in attempt to improve poultry growth and production performance.

4. Associated Knowledge Areas

KA Code	Knowledge Area
302	Nutrient Utilization in Animals

303	Genetic Improvement of Animals
304	Animal Genome

Outcome #15

1. Outcome Measures

Research to enhance income for meat goat producers through increased consumer knowledge about goat meat and retailer knowledge of goat meat preferences. (Ekanem)

2. Associated Institution Types

- 1890 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	1

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Goat producers need to meet consumer demand for nutritious alternatives to red meat. Producers need the connections with consumers to satisfy demand for goat meat. Retailers seek opportunities to gain new knowledge about goat meat. Students and researchers desire to learn about goat meat marketing research.

What has been done
Team engaged target audiences in training, focus groups, conferences, expo, field days, meetings, seminars, surveys, symposiums, tours and related educational outreach.

Results
More than one-half of study participants (males, aged 51 to 80 years), sold goats at auction markets. Eighty-seven percent of the female producers used the internet in their operations. Results showed that sale of goat meat online increased. About 20 percent of the producers who used the internet to conduct business now sell goats and goat meat online. Almost 42% of participants increased goat meat sale online since they started advertising and marketing goat meat online. Others used online to advertise products, communicate with other farmers, identify competitors, locate auction markets, obtain data on prices, purchase inputs, and maintain inventory.

4. Associated Knowledge Areas

KA Code	Knowledge Area

603 Market Economics

Outcome #16

1. Outcome Measures

Enhanced producer knowledge of marketing information to expand goat meat sales to existing markets. (Ekanem)

2. Associated Institution Types

- 1890 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	1

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Market information is a critical factor for both producers and consumers. Good and timely information about the market and trends in the preferences of consumers allow the producers to track price changes and adjust production decisions accordingly.

What has been done
Project provided producer/consumer education on healthy attributes of goat meat to enhance market connections. Seminars, symposium, visits, meetings, exhibitions, and presentations were used in addressing the nutritional value and benefits of consuming goat meat. Knowledge of such benefits enhances the market value and price paid by consumers for goat meat.

Results
Sixty-two percent of non-white consumed goat meat; whites showed increasing interest in consuming more goat meat. Twenty-one percent of the consumers indicated that goat meat has now become a part of their regular diet. Consumers were willing to travel long distances and pay top dollars for goat meat from local and hometown producers. About 31% developed good connections; they knew where to purchase goat meat when they need it, especially during holidays. This increased sales for local producers of goat meat.
Pre and post activity evaluations were used to tract progress and modify project.

4. Associated Knowledge Areas

KA Code	Knowledge Area
603	Market Economics

Outcome #17

1. Outcome Measures

Efficacy of fat deposition reduction in poultry through genotyping by sequencing approach for analysis of chicken genome. (Wang)

Not Reporting on this Outcome Measure

Outcome #18

1. Outcome Measures

Investigate supplements to reduce post-weaning stress on piglets (Kattesh)

Not Reporting on this Outcome Measure

Outcome #19

1. Outcome Measures

Extension Small Ruminant Programs produced Economic Value for Producers

2. Associated Institution Types

- 1862 Extension
- 1890 Extension

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The Tennessee-Alabama Small Ruminant Conference is a three day conference conducted by the UT/TSU Extension and Alabama Cooperative Extension. The 2016 conference served both goat and sheep producers and had educational topics related to, marketing and production contracts, treatment and preventative health practices, forage and pasture management, small ruminant market outlook, developing a biosecurity plan and a live animal grading demonstration.

What has been done

County extension personnel and Extension specialists from Alabama and Tennessee identifies the needs of producers in the area. The planning committee then identifies and schedules speakers with the expertise to address the needs of the producers. The conference was conducted in October and a producer evaluation is distributed to measure impact.

Results
In 2016, 63 participants were in attendance. 45 producers completed the post conference evaluation representing 40 wool sheep, 798 hair sheep, 674 meat goats, and 85 dairy goats. The 45 producers completing the economic evaluation indicated the information learned at the conference would result in changes to their operation with a total direct economic impact of $188,550.

4. Associated Knowledge Areas

KA Code	Knowledge Area
307	Animal Management Systems

Outcome #20

1. Outcome Measures

Mastitis Experimental Teat Dip Challenge Model (Kerro Dego)

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Bovine mastitis is one of the most important bacterial diseases of dairy cattle throughout the world.

What has been done
Evaluation of protective effects of coagulase negative Staphylococcus chromogens surface proteins (CNSCSP) and coagulase positive Staphylococcus aureus surface proteins (CPSASP) as vaccine antigen for protection against bovine Staphylococcus aureus mastitis.

Results

In this project, we developed S. aureus mastitis experimental teat dip challenge model for evaluation of vaccine efficacy and safety. Very recently, we conducted experimental vaccination and challenge study using our model in which cows vaccinated with CNSCSP were fully protected from developing mastitis when experimentally challenged with S. aureus. Currently, we are evaluating protective effects of this vaccine with relatively increased number of cows.

4. Associated Knowledge Areas

KA Code	Knowledge Area
305	Animal Physiological Processes
307	Animal Management Systems
311	Animal Diseases
315	Animal Welfare/Well-Being and Protection

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Natural Disasters (drought, weather extremes, etc.)
- Economy
- Appropriations changes
- Public Policy changes
- Competing Programmatic Challenges
- Populations changes (immigration, new cultural groupings, etc.)

Brief Explanation

The financial impact of Extension animal systems programming fluctuates from year-to-year depending on several factors including commodity prices, public policy, input costs, and land value. However, these programs continue to enhance the lives and livelihoods of Tennessee farmers.

V(I). Planned Program (Evaluation Studies)

Evaluation Results

In the goat research area, the program at TSU has a website with one page dedicated to performance recording. The performance page averaged 6 visitors per week over the last year. Some Kiko producers are using performance records to assess and market their breeding stock. In a survey of past producers contacts, (a) 43% indicated that breed selection was affected or changed, (b) 31% stated that performance recording was started or modified, and (c) 39% noted that within-herd selection and culling procedures were modified as a result of research and outreach activities from this lab.

Pre- and post-educational activities evaluations were used to tract progress and modify workshops and training. Some of the results of showed the following:

Producers and retailers enhance their knowledge and became aware of the various sources of marketing to increase goat meat sales. Producers and consumers said they acquired additional skills to use the various market information, internet and networks to access markets. As a result of additional knowledge, 20 percent of the farmers who used the internet to conduct business now sell goats and goat meat online. Several producers now use the Internet to promote and market their goat meat. More producers are now using

online resources to advertise goat meat and identify competitors, locate markets, and obtain data on prices.

For all research tracking is maintained on the number of publications in scientific journals and citations of the publications, the number of producers attending presentations and webinars.

Extension Optimizes Tennessee Animal Production

In 2016, Extension agents emphasized quality assurance, reproductive management, nutrition, and marketing with Tennessee beef producers, with an economic impact of $65.3 million. Tennessee horse owners depend on UT Extension's research-based programs for horse health and nutrition. UT Extension taught rotational grazing to increase forage production, vaccinations, dental care, and correct deworming practices. These practices helped 205 horse owners, owning more than 1,000 horses, to save a combined $1.3 million.

Key Items of Evaluation

Extension Optimizes Tennessee Animal Production

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V(A). Planned Program (Summary)

Program # 4

1. Name of the Planned Program

Childhood Obesity

☑ 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
502	New and Improved Food Products	0%	0%	0%	50%
701	Nutrient Composition of Food	5%	5%	0%	0%
703	Nutrition Education and Behavior	95%	95%	0%	0%
704	Nutrition and Hunger in the Population	0%	0%	0%	50%
	Total	100%	100%	0%	100%

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2016	Extension		Research	
	1862	1890	1862	1890
Plan	75.0	9.0	0.0	6.0
Actual Paid	68.0	8.0	0.0	4.6
Actual Volunteer	15.0	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**
1343988	283696	0	222759
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
5985875	329020	0	222759
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
5986105	87188	0	123104

V(D). Planned Program (Activity)

1. Brief description of the Activity

Many Tennesseans suffer from chronic diseases or conditions associated with obesity that could be mitigated with healthier diets and more physical activity. UT and TSU Extension pursued the Childhood Obesity planned program to help Tennesseans manage weight, increase physical activity, improve dietary quality, and ultimately, create healthy futures for Tennessee young people. The following programs were delivered to Tennesseans in the places they live, work, and play:

- **Tennessee Shapes Up** was a multi-session program focused on eating meals together as a family and eating more fresh fruits and vegetables.
- **Pathweighs to Health** was a multi-session programs that helped participants to manage weight, recognize true hunger, and pursue strength training.
- **Power U** was targeted to young people through schools and afterschool programs. Extension personnel and volunteers taught 10 interactive lessons in nutrition and healthy lifestyles.
- **Healthy Steps** was taught to the state's pre-schoolers. The curriculum emphasized tasting fruits and vegetables and increasing physical activity.
- **Healthy Food Preparation** taught participants how to cook more meals at home and reduce sugar and salt in their diet.
- **UT's Tennessee Nutrition and Consumer Education Program** (TNCEP) and **TSU's Food Nutrition Education Program** are worked to improve nutrition and health among the state's SNAP recipients and those eligible for SNAP.
- **Expanded Food and Nutrition Education Program** (EFNEP) was conducted by both UT and TSU Extension to expand nutrition education to the state's low-income families, particularly those with young children.

All Extension obesity prevention programs emphasized the following:

- how to use MyPlate.gov and following Dietary Guidelines.
- how to use the Healthy Plate Method.
- decreasing consumption of high-fat foods like fried foods, bologna, hot dogs, etc.
- increasing consumption of fruits, vegetables and whole-grains.

The goal of healthier Americans has been addressed through TSU research in novel ways to increase fiber intake for obesity reduction and the identification of naturally occurring compounds for anti-aging properties.

2. Brief description of the target audience

Because of the prevalence of obesity in the state, all consumers and youth were potential members of the targeted audience. The TNCEP and EFNEP programs targeted Tennessee's limited resource population. In addition, the TSU Food Nutrition Education Program targeted eligible food stamp recipients.

3. How was eXtension used?

The Childhood Obesity planned program was enhanced through the service of:

- 12 Tennessee Extension personnel on the "Families, Food, and Fitness" CoP.
- two Tennessee Extension personnel on the "A,B,Cs of Omega 3's" CoP.

The "Families Food, and Fitness" CoP continues to make extensive use of social media in Tennessee to promote educational programs and resources related to improving dietary quality and increasing physical activity.

V(E). Planned Program (Outputs)

1. Standard output measures

2016	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	245538	13766943	278536	50

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

Patent Applications Submitted

Year: 2016

Actual: 0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2016	Extension	Research	Total
Actual	3	2	0

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number of exhibits displayed to promote program awareness and participation.

Year	Actual
2016	1189

Output #2

Output Measure

- Number of research-based publications distributed as part of this program.

Year	Actual
2016	1294

Output #3

Output Measure

- Number of flavonoids examined for reducing oxidative stress in fibroblast cells.

Year	Actual
2016	0

Output #4

Output Measure

- Number of flavanoids examined for adipocyte differentiate efficiency in fibroblast cells.

Year	Actual
2016	0

Output #5

Output Measure

- Number of focus groups held to determine perceived benefits, value and needs for relationships by probing habits, needs, preferences, values and lifestyles associated with food and media.

Year	Actual
2016	0

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Tennessee Shapes Up: Number of participants who decreased consumption of high-fat foods such as chips, fast food, fried foods, sausage, bacon, bologna, hot dogs, etc.
2	Tennessee Shapes Up: Number of participants who decreased consumption of high-sugar foods and sweetened beverages, such as soft drinks, Kool Aide type beverages, sweetened tea, etc.
3	Tennessee Shapes Up: Number of participants who increased consumption of fruits.
4	Tennessee Shapes Up: Number of participants who increased consumption of vegetables.
5	Tennessee Shapes Up: Number of participants increased consumption of whole grains.
6	Increase in the number of flavanoid compounds that can be used for supplemental nutrition. (Boadi)
7	Public acceptance of soy fiber fortified breads for increased fiber consumption. (Wu)
8	Establish the fundamental mechanism by which cost-effective, naturally available compounds can promote health and extend lifespan in humans.(Si)

Outcome #1

1. Outcome Measures

Tennessee Shapes Up: Number of participants who decreased consumption of high-fat foods such as chips, fast food, fried foods, sausage, bacon, bologna, hot dogs, etc.

2. Associated Institution Types

- 1862 Extension
- 1890 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	6030

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

What has been done

Results

4. Associated Knowledge Areas

KA Code	Knowledge Area
703	Nutrition Education and Behavior

Outcome #2

1. Outcome Measures

Tennessee Shapes Up: Number of participants who decreased consumption of high-sugar foods and sweetened beverages, such as soft drinks, Kool Aide type beverages, sweetened tea, etc.

2. Associated Institution Types

- 1862 Extension
- 1890 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	5617

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

What has been done

Results

4. Associated Knowledge Areas

KA Code	Knowledge Area
703	Nutrition Education and Behavior

Outcome #3

1. Outcome Measures

Tennessee Shapes Up: Number of participants who increased consumption of fruits.

2. Associated Institution Types

- 1862 Extension
- 1890 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	5172

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

What has been done

Results

4. Associated Knowledge Areas

KA Code	Knowledge Area
703	Nutrition Education and Behavior

Outcome #4

1. Outcome Measures

Tennessee Shapes Up: Number of participants who increased consumption of vegetables.

2. Associated Institution Types

- 1862 Extension
- 1890 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	4439

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

What has been done

Results

4. Associated Knowledge Areas

KA Code	Knowledge Area
703	Nutrition Education and Behavior

Outcome #5

1. Outcome Measures

Tennessee Shapes Up: Number of participants increased consumption of whole grains.

2. Associated Institution Types

- 1862 Extension
- 1890 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	4117

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

What has been done

Results

4. Associated Knowledge Areas

KA Code	Knowledge Area
703	Nutrition Education and Behavior

Outcome #6

1. Outcome Measures

Increase in the number of flavanoid compounds that can be used for supplemental nutrition. (Boadi)

Not Reporting on this Outcome Measure

Outcome #7

1. Outcome Measures

Public acceptance of soy fiber fortified breads for increased fiber consumption. (Wu)

2. Associated Institution Types

- 1890 Extension
- 1890 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	3

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Due to increasing chronic disease issues, the general public is paying more attention to their diets. Fiber is one important factor in diet to prevent obesity, diabetes and other chronic diseases. Currently, Americans are consuming 50% less fiber than recommended levels. In Tennessee, soy is a major crop. Soy fiber could be a very good fiber source for making fiber-enriched products. Bread is a common foodstuff worldwide. Once fiber is incorporated into breads, most people can easily increase their daily fiber consumption without changing eating habits. Thus, people can meet their daily fiber requirement if these products are readily available.

What has been done
Three fiber fractions were separated from defatted soy flour, namely soluble, insoluble and total fiber. Soluble and insoluble fibers carry different physiological functions. These fiber fractions were incorporated into wheat bread at various ratios. Their impact on bread dough quality, glucose releasing profile, and anti-obesity effect were evaluated.

Results
Results indicated there was no significant difference between soluble and insoluble fiber on dough quality when 5% and 10% soy fiber was added. Three bread recipes were developed. Soluble fiber could significantly lower the glucose-releasing profile in the intestinal tract. Obesity cells accumulated fewer fat droplets when treated with soluble and total fiber than the insoluble fiber. The results indicated that both soluble and total soy fiber exhibit obvious anti-obesity effect. The insoluble fiber extended a certain effect on glucose attenuation but the results were not as significant as the soluble and total fractions. The results were presented in classroom and in symposiums. More people are aware that there is a different between insoluble fiber and soluble fiber. Questions are raised like "where we can find soluble-fiber enriched products"?. More than 30 youth (high school students) from the summer Apprenticeship program have looked at the

soluble and insoluble fiber-enriched bread. Many students have answered the questionnaire and indicated that it was the 1st time that they knew about the importance of dietary fiber in terms of chronic disease prevention.

4. Associated Knowledge Areas

KA Code	Knowledge Area
502	New and Improved Food Products

Outcome #8

1. Outcome Measures

Establish the fundamental mechanism by which cost-effective, naturally available compounds can promote health and extend lifespan in humans.(Si)

2. Associated Institution Types

- 1890 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	1

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
More and more adults are obese, and have muscle dysfunction, which may contribute to the accelerating of aging process and decrease of quality of our daily life.

What has been done
Animal tissues have been collected and proteins were analyzed. Aging-reduced actin protein expression in the muscle was reversed by treatment. Tissues have been used for RNA sequence and metabolome analysis. Two funding proposals using the preliminary data from this project have been submitted.

Results
Cocoa epicatechin intake affects some aging-related genes expression. Dietary cocoa intake improves lipids and protein metabolism in mice. Cocoa supplementation improves skeletal muscle function and immune function in mice. One PhD student graduated in 2016 and two more PhD students are working on this project.

4. Associated Knowledge Areas

KA Code	Knowledge Area

704 Nutrition and Hunger in the Population

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Appropriations changes
- Public Policy changes
- Government Regulations
- Competing Programmatic Challenges

Brief Explanation

V(I). Planned Program (Evaluation Studies)

Evaluation Results

Monthly, quarterly and yearly reviews are conducted for laboratory research to compare progress with stated goals. To date, all timelines have been met and no remedial actions have been required. UT and TSU Extension evaluated all Childhood Obesity planned programs through a combination of surveys, observation, and interviews. Our evaluation demonstrated:

- 152 **EFNEP** participants used food labels to make healthier choices.
- 258 **Healthy Food Preparation** participants now prepare vegetables without salt.
- 190 pre-school teachers participating in the **Healthy Steps** program reported increased physical activity among pre-schoolers in the program. These teachers were from 14 counties.
- 2960 students in the **Power U** program increased physical activity. These youth were from 46 schools in 28 counties.
- 1110 **Tennessee Shapes Up** participants lost a combined 5889 pounds (5.3 pounds on average per person).
- 3303 participants increased physical activity through their participation in the UT **TNCEP** program and TSU **Food Nutrition Program**.

Key Items of Evaluation

UT and TSU Extension evaluated all Childhood Obesity planned programs through a combination of surveys, observation, and interviews. Our evaluation demonstrated:

- 152 **EFNEP** participants used food labels to make healthier choices.
- 258 **Healthy Food Preparation** participants now prepare vegetables without salt.
- 190 pre-school teachers participating in the **Healthy Steps** program reported increased physical activity among pre-schoolers in the program. These teachers were from 14 counties.
- 2960 students in the **Power U** program increased physical activity. These youth were from 46 schools in 28 counties.

- 1110 **Tennessee Shapes Up** participants lost a combined 5889 pounds (5.3 pounds on average per person).
- 3303 participants increased physical activity through their participation in the UT **TNCEP** program and TSU **Food Nutrition Program**.

V(A). Planned Program (Summary)

Program # 5

1. Name of the Planned Program

Economic Infrastructure and Commerce

☑ 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	0%	0%	6%	0%
601	Economics of Agricultural Production and Farm Management	30%	30%	30%	40%
602	Business Management, Finance, and Taxation	5%	5%	0%	0%
603	Market Economics	5%	5%	6%	40%
604	Marketing and Distribution Practices	30%	30%	0%	0%
605	Natural Resource and Environmental Economics	0%	0%	27%	0%
606	International Trade and Development	5%	5%	6%	0%
607	Consumer Economics	10%	10%	0%	20%
608	Community Resource Planning and Development	15%	15%	14%	0%
610	Domestic Policy Analysis	0%	0%	11%	0%
	Total	100%	100%	100%	100%

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2016	Extension		Research	
	1862	1890	1862	1890
Plan	32.0	7.0	35.0	2.0
Actual Paid	32.0	6.0	24.4	3.0
Actual Volunteer	7.0	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**
645114	191246	617071	145277
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
2873220	221799	1500518	145277
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
75000	15491	860029	80286

V(D). Planned Program (Activity)

1. Brief description of the Activity

UT AgResearch analysis includes assessment of market potential, market feasibility studies for new agri-industry ventures, buyer and consumer preferences studies, market segmentation analysis and buyer profiling, analysis of new product acceptance, analysis of marketing alternatives, and analysis of valuation of product attributes. To evaluate the impacts of various policies, management strategies, or economic conditions on a farm's bottom line and financial strength, we are developing a set of representative farms that encompass major segments of agriculture in Tennessee. Methods for evaluating risk include risk-based econometric models, risk-based mathematical programming models, generalized stochastic dominance criteria, dynamic optimization, and subjective probability assessment criteria.

The UT Extension MANAGE program and TSU's Farm Management program helped families analyze their total farming business so they could make informed decisions regarding their future. Extension staff trained in farm and financial management helped families to:

- review their current financial situation
- capitalize on strengths and reduce weaknesses in the farm business
- develop individualized farm and financial plans
- explore alternatives both on and off the farm
- evaluate capital investment opportunities including land and/or machinery purchases
- analyze likely consequences of changing the scope of enterprises
- determine appropriate production practices

In addition to individualized farm and financial planning assistance, Extension offered hundreds of workshops to help farmers improve their financial situation. For example, workshops were offered in improved marketing, goal-setting, and strategic planning.

Although the MANAGE program cannot and did not remove uncertainty of the future, it provided farm families with a clear understanding of their current financial situation and helped them evaluate their alternatives for the future. Making informed decisions today may be the best way to prepare for tomorrow's opportunities. The educational programs were offered at no cost to participating farm families in all 95 Tennessee counties.

Land is a great source of wealth in the African-American community. In addition to providing economic stability, land ownership is highly correlated to one's social and economic well-being. Many urban residents who desire to return to the land of their origin find themselves confronted by various obstacles in terms of retaining rightful land ownership. In addition to problems they face of landownership retention are efforts to engage in profitable land use development, and operate viable farming enterprises.

Production inputs have changed over the past two decades. As a result of this, there was a reduction in the number of crops produced. In-service training on "Small Farm Outlook" continued to make landowners aware of resources that are available to them for land retention and crop production. The

training provided information on ways to keep land through estate planning, lessening their property, and legal issues for seniors (the aging population).

Leadership development workshops focused on leadership, healthy self-esteem, positive risk-taking, achieving goals, ethical decision making, public speaking and responsible citizenship. Extension personnel will also lead, train, recruit and coordinate more volunteers.

2. Brief description of the target audience

- Limited-resource and small farmers
- Farmers transitioning from tobacco to other crops
- Policy-makers at the state, federal, and municipal level
- Businesses looking to expand or relocate to Tennessee

3. How was eXtension used?

eXtension was used by UT in following Ways.

V(E). Planned Program (Outputs)

1. Standard output measures

2016	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	197910	7329027	31294	0

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

Patent Applications Submitted

Year:	2016
Actual:	0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2016	Extension	Research	Total
Actual	17	38	0

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number of exhibits displayed to promote program awareness and participation.

Year	Actual
2016	838

Output #2

Output Measure

- Number of research-based publications distributed as part of this program.

Year	Actual
2016	520

Output #3

Output Measure

- Perform economic analyses of various industries and agricultural practices (Jensen)
  Not reporting on this Output for this Annual Report

Output #4

Output Measure

- Promote local food production and consumption (Hellwinckel)
  Not reporting on this Output for this Annual Report

Output #5

Output Measure

- A Payment System for Forest Carbon Sequestration? (Cho, English)

Year	Actual
2016	1

Output #6

Output Measure

- Economic Impacts of River Navigability on Corn, Soybean Stakeholders (Yu)

Year	Actual
2016	1

Output #7

Output Measure

- Effect of Consolidating Ocmulgee Monument with Surrounding Lands (English, Jensen)

Year	Actual
2016	1

Output #8

Output Measure

- Environmental Advantages and Economic Challenges of Switchgrass (English, Larson)

Year	Actual
2016	1

Output #9

Output Measure

- Farmer Support for a New Milk Processing Plant (Hughes)

Year	Actual
2016	1

Output #10

Output Measure

- Estimating Impacts of Biofuel Production on the SE Economy (English, Lambert)

Year	Actual
2016	1

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Land Ownership Information Program: Number of African-American landowners who increased their knowledge of property rights and responsibilities.
2	Land Ownership Information Program: Number of African-American landowners who developed farm management plans.
3	Land Ownership Information Program: Number of African-American landowners who developed estate plans to reduce the financial and legal risks farm family businesses face as they transition between generations.
4	Farm Financial Analysis and Planning: Number of farm families and rural business operators who implemented partial budgeting decisions (examples include sell calves now or later and evaluating equitable leasing arrangements)
5	Farm Financial Analysis and Planning: Number of farm families who developed whole farm plans to improve their farm financial performance.
6	Tennessee Extension Leadership Development: Small businesses or non-profits developed by limited resource leaders.
7	Assess the Local Food System/the Knoxville Foodshed (Hellwinckel)
8	Research to contribute scientific evidence and knowledge of the impacts of severe weather events on food prices and food consumption, and whether and how changes in food prices and severe weather conditions affect food consumption, in particular for low-income households. (Li)
9	Advance the sustainability of small farm enterprises through assessment of income risks and the role of diversification strategies among small farms in Tennessee and the United States.(Khanal)
10	Promote the growth of the Tennessee viticulture industry by determining the impact of production designations (eco-labeling and other certifications) on consumer perception, preference and willingness to pay. (Lim)
11	Evaluating Logistics Configurations to Deliver Switchgrass to Markets (English, Larson)

Outcome #1

1. Outcome Measures

Land Ownership Information Program: Number of African-American landowners who increased their knowledge of property rights and responsibilities.

2. Associated Institution Types

- 1890 Extension

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	26

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

What has been done

Results

4. Associated Knowledge Areas

KA Code	Knowledge Area
601	Economics of Agricultural Production and Farm Management

Outcome #2

1. Outcome Measures

Land Ownership Information Program: Number of African-American landowners who developed farm management plans.

2. Associated Institution Types

- 1890 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	11

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

What has been done

Results

4. Associated Knowledge Areas

KA Code	Knowledge Area
601	Economics of Agricultural Production and Farm Management

Outcome #3

1. Outcome Measures

Land Ownership Information Program: Number of African-American landowners who developed estate plans to reduce the financial and legal risks farm family businesses face as they transition between generations.

2. Associated Institution Types

- 1890 Extension

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	22

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

What has been done

Results

4. Associated Knowledge Areas

KA Code	Knowledge Area
601	Economics of Agricultural Production and Farm Management

Outcome #4

1. Outcome Measures

Farm Financial Analysis and Planning: Number of farm families and rural business operators who implemented partial budgeting decisions (examples include sell calves now or later and evaluating equitable leasing arrangements)

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	413

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

What has been done

Results

4. Associated Knowledge Areas

KA Code	Knowledge Area
601	Economics of Agricultural Production and Farm Management

Outcome #5

1. Outcome Measures

Farm Financial Analysis and Planning: Number of farm families who developed whole farm plans to improve their farm financial performance.

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	1118

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

What has been done

Results

4. Associated Knowledge Areas

KA Code	Knowledge Area
601	Economics of Agricultural Production and Farm Management

Outcome #6

1. Outcome Measures

Tennessee Extension Leadership Development: Small businesses or non-profits developed by limited resource leaders.

Not Reporting on this Outcome Measure

Outcome #7

1. Outcome Measures

Assess the Local Food System/the Knoxville Foodshed (Hellwinckel)

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	1

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

What has been done

Results

4. Associated Knowledge Areas

KA Code	Knowledge Area
601	Economics of Agricultural Production and Farm Management
603	Market Economics
604	Marketing and Distribution Practices
605	Natural Resource and Environmental Economics
607	Consumer Economics

Outcome #8

1. Outcome Measures

Research to contribute scientific evidence and knowledge of the impacts of severe weather events on food prices and food consumption, and whether and how changes in food prices and severe weather conditions affect food consumption, in particular for low-income households. (Li)

Not Reporting on this Outcome Measure

Outcome #9

1. Outcome Measures

Advance the sustainability of small farm enterprises through assessment of income risks and the role of diversification strategies among small farms in Tennessee and the United States.(Khanal)

2. Associated Institution Types

- 1890 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	1

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Small farms, having limited quantities of land, capital, limited managerial ability, and limited skilled labor, are unable to keep pace with agricultural advancements requiring high initial costs, so they carry uncertainty about future survival if they continue to follow conventional commodity production routes. Most small-sized agricultural farms face increasing pressure to increase the profitability and viability of their farming business. For most small farms, the only way to stay in business is to diversify and increase their incomes, either through new alternatives on the farm or from off-farm employment by allocating production assets and resources among different on-farm and off-farm income-generating activities. This is an important issue because sustainability of small farms rests on these strategic diversification activities to mitigate income variability at both farm and household levels.

What has been done
Tennessee farm business households are compared with national and regional average in terms of demographic, economic and financial attributes, and enterprise and income diversification activities using secondary data sources. To investigate more on Tennessee specific farmers, questionnaire has been designed to collect information through primary survey.

Results
Very new program, no results yet.

4. Associated Knowledge Areas

KA Code	Knowledge Area

601	Economics of Agricultural Production and Farm Management
603	Market Economics

Outcome #10

1. Outcome Measures

Promote the growth of the Tennessee viticulture industry by determining the impact of production designations (eco-labeling and other certifications) on consumer perception, preference and willingness to pay. (Lim)

2. Associated Institution Types

- 1890 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
While the American Viticultural Areas (AVA) designation has been extensively utilized by wineries internationally and domestically, it is relatively underutilized in Tennessee. Despite its establishment in 1984, the wine production activities in this area remains largely underdeveloped. As comparison, the Outer Bank Plain AVA, established in 2007, has been credited to substantially increase the profile of wineries in New Jersey. This raises the question if similar success can be replicated in Tennessee, and other areas in the US where there exist potential for growth in wine production.

What has been done
Literature review has been performed. The findings from the literature review has been condensed into a consumer survey, which is the primary instrument for data collection in this study. The survey is expected to be sent out shortly.

Results
Because the data has not been collection. There is no reportable result at this stage.

4. Associated Knowledge Areas

KA Code	Knowledge Area
601	Economics of Agricultural Production and Farm Management
603	Market Economics

607 Consumer Economics

Outcome #11

1. Outcome Measures

Evaluating Logistics Configurations to Deliver Switchgrass to Markets (English, Larson)

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Growing biomass crops for energy production on low productivity lands not used for food production has been suggested as an alternative to reduce dependence on fossil fuels and to mitigate greenhouse gas emissions from transportation fuel. Switchgrass is considered a potential feedstock in various states, including Tennessee, given its high biomass content in a wide range of environments. However, its low density relative to energy value and resulting high logistics costs impede the profitability of switchgrass based bioenergy.

What has been done
Six logistics configurations delivering switchgrass to local or international bioenergy markets were evaluated.

Results
The results highlight the economic challenges of penetrating energy markets for a switchgrass collection/distribution hub. Only one logistics configuration that targets the local market is profitable. However, serving local and international markets becomes more feasible as investment risk declines. The results imply that a clear direction for national bioenergy policy is crucial to developing a biomass feedstock for the U.S. bioenergy industry.

4. Associated Knowledge Areas

KA Code	Knowledge Area
601	Economics of Agricultural Production and Farm Management
605	Natural Resource and Environmental Economics
608	Community Resource Planning and Development

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

Brief Explanation

V(I). Planned Program (Evaluation Studies)

Evaluation Results

University of Tennessee and Tennessee State University Extension helped farmers improve Economic Infrastructure and capabilities by improving knowledge, increasing potential income and help keep better records.
The Farm Management programs helped farmers increased their potential cash income from their farming operation by $ 278659 by implementing financial plans. More than 1100 farmers developed Farm Financial Plans. More than 400 farmers were able to keep better records which will help them keep track of their financial well-being.

Key Items of Evaluation

The Farm Management programs helped farmers increased their potential cash income from their farming operation by $ 278659 by implementing financial plans. More than 1100 farmers developed Farm Financial Plans. More than 400 farmers were able to keep better records which will help them keep track of their financial well-being.

V(A). Planned Program (Summary)

Program # 6

1. Name of the Planned Program

Environmental and Water Quality Impacts

☑ 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	0%	0%	8%	0%
102	Soil, Plant, Water, Nutrient Relationships	20%	20%	17%	10%
111	Conservation and Efficient Use of Water	0%	0%	13%	0%
112	Watershed Protection and Management	80%	80%	29%	30%
132	Weather and Climate	0%	0%	2%	10%
133	Pollution Prevention and Mitigation	0%	0%	0%	20%
135	Aquatic and Terrestrial Wildlife	0%	0%	8%	10%
136	Conservation of Biological Diversity	0%	0%	3%	0%
201	Plant Genome, Genetics, and Genetic Mechanisms	0%	0%	2%	0%
203	Plant Biological Efficiency and Abiotic Stresses Affecting Plants	0%	0%	2%	0%
205	Plant Management Systems	0%	0%	0%	10%
212	Pathogens and Nematodes Affecting Plants	0%	0%	4%	0%
215	Biological Control of Pests Affecting Plants	0%	0%	2%	0%
216	Integrated Pest Management Systems	0%	0%	2%	0%
403	Waste Disposal, Recycling, and Reuse	0%	0%	8%	10%
	Total	100%	100%	100%	100%

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2016	Extension		Research	
	1862	1890	1862	1890
Plan	5.0	1.0	35.0	10.0
Actual Paid	16.0	2.0	18.6	10.4
Actual Volunteer	4.0	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**
313597	80160	639760	503627
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
1396704	92966	1734514	503627
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
50000	0	209462	278323

V(D). Planned Program (Activity)

1. Brief description of the Activity

UT AgResearch is developing economic and policy data by accessing existing sources, generating data from computer models, and surveying market participants. This data is analyzed using appropriate statistical and econometric methods. Watershed scale model assessments are conducted utilizing field-level estimates of alternative management practices (AMPs). Changes in water quality in impaired watersheds resulting from the evaluation of AMPs are measured. The cost of meeting different water quality standards at different points within a watershed and the potential impact of different environmental policies on Tennessee's agriculture are evaluated. A model used to project land use change estimates the probability of land development of individual parcels as a function of parcel-level attributes.

Soil research is fundamental to UT AgResearch's environmental program.The erosion, sediment transport, and contaminant transport capabilities of the RUSLE2 soil erosion model continue to be refined as the model's use increases nationally and around the world. Soil samples are thoroughly characterized in terms of elemental composition, particle size, mineralogy, and other soil chemical and flow characteristics using standard techniques. New methods for decreasing the expense of measuring soil properties by agricultural producers and fellow researchers are developed. The impact of soil processes on climate change is being examined through research on the rates of CO2 efflux as influenced by exposure of soil microorganisms to nitrogen. Quantification of these rates will yield additional information on the need for optimization of the uses on nutrients in plant production.

As new waste treatment approaches are introduced, UT AgResearch provides research-based evaluation of appropriate technologies for Tennessee. Background information on the water quality is collected in various watershed areas, including one where baseline environmental data is being used to evaluate the impact of a dairy production unit on the area. The impact of consumer pharmaceuticals in surface water is being examined and potential mitigation processes explored. Additionally,research on preserving the biodiversity of aquatic species is determining best practices to preserve and enhance biodiversity.

2. Brief description of the target audience

This is currently a research-only targeted program, so the target audience is weighted toward basic/applied research clients i.e. agricultural producers, environmental scientists, environmental regulatory agencies.

3. How was eXtension used?

eXtension was not used in this program

V(E). Planned Program (Outputs)

1. Standard output measures

2016	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	120	150	5	10

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

Patent Applications Submitted

Year:	2016
Actual:	0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2016	Extension	Research	Total
Actual	5	71	0

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number of arbuscular mycorrhizal fungi that enhance biomass productivity by cellulosic herbaceous perennials in fly ash-amended soils.

Year	Actual
2016	0

Output #2

Output Measure

- Leverage the Stormwater Management Center (Buchanan, Ludwig, Tyner, Yoder)

Year	Actual

2016	1

Output #3

Output Measure

- Effect of Bioreductive Processes on Soil Breakdown (Radosevich)

Year	Actual
2016	1

Output #4

Output Measure

- Impact of 34 Years of No-till on Soil Properties (Lee)

Year	Actual
2016	1

Output #5

Output Measure

- Impact of Water Use on Gross Regional Output (Lambert)

Year	Actual
2016	1

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Nursery producers in the target population will be aware of non-point source pollution from field production of specialty crops.
2	Students will be trained in water quality monitoring.
3	Producers in the target population will have increased knowledge of the relationship between land cultivation practices and sediment load to surface water.
4	Increased sustainable biomass production strategies by cellulosic herbaceous perennials in fly ash-amended soil to allow cleanup of toxic materials in the waste product while using the biomass as biofuel feedstock. (Dzantor)
5	Encourage cattle producer adoption of water-quality BMPs (Clark, Lambert, Walker)
6	Develop practical systems for organic forage production (Butler)
7	Study military vehicle tracking and impact (Ayers)
8	Help municipalities evaluate (1) alternative property tax structures that encourage more efficient land development, (2) priority areas for forest landscape restoration to protect ridgelines and hillsides, and (3) rezoning processes that help sustainable development (Cho)
9	Optimize non-chemical methods of soil disinfestation (Butler)
10	Evaluate soil quality under biodegradable mulch (Lee)
11	Research to reduce the impact of pharmaceuticals and personal care products in surface water in rural and urbanizing watersheds. (Dennis)
12	Farmers and homeowners will be educated on the impact of pharmaceuticals and personal care products in surface water and the proper ways to dispose of these chemicals (Dennis)
13	Develop a greater understanding of the mechanisms of the studied emerging contaminants for the scientific community to expedite the decision making process in terms of protecting environmental health. (Rakshit)
14	Improve mechanistic understanding of microbial processing of soil decay and its long-term responses to climate warming. (J Li)
15	Research to influence change in understanding of proper management of riparian landscapes. (Sutton)
16	Crop Nutrient Stewardship Impacts (Integrated Research and Extension)
17	A Biochar-Amended Underground Reactive Barrier (Lee)

18	Wastewater Treatment Tailored to Schools (Buchanan)

Outcome #1

1. Outcome Measures

Nursery producers in the target population will be aware of non-point source pollution from field production of specialty crops.

2. Associated Institution Types

- 1890 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	0

3c. Qualitative Outcome or Impact Statement

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

What has been done
{No Data Entered}

Results
{No Data Entered}

4. Associated Knowledge Areas

KA Code	Knowledge Area
112	Watershed Protection and Management
133	Pollution Prevention and Mitigation

Outcome #2

1. Outcome Measures

Students will be trained in water quality monitoring.

2. Associated Institution Types

- 1890 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	0

3c. Qualitative Outcome or Impact Statement

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

What has been done
{No Data Entered}

Results
{No Data Entered}

4. Associated Knowledge Areas

KA Code	Knowledge Area
112	Watershed Protection and Management
133	Pollution Prevention and Mitigation

Outcome #3

1. Outcome Measures

Producers in the target population will have increased knowledge of the relationship between land cultivation practices and sediment load to surface water.

2. Associated Institution Types

- 1890 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	0

3c. Qualitative Outcome or Impact Statement

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

What has been done
{No Data Entered}

Results
{No Data Entered}

4. Associated Knowledge Areas

KA Code	Knowledge Area
112	Watershed Protection and Management
133	Pollution Prevention and Mitigation

Outcome #4

1. Outcome Measures

Increased sustainable biomass production strategies by cellulosic herbaceous perennials in fly ash-amended soil to allow cleanup of toxic materials in the waste product while using the biomass as biofuel feedstock. (Dzantor)

2. Associated Institution Types

- 1890 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Coal-based electricity generation produces byproducts that can contain hazardous substances with serious threats to human and environmental health. Coal combustion to generate electricity in the U.S. has been declining at a deliberate pace as the nation continues to be faced with disposal on newly generated wastes as well as accumulation from more than six decades. This is particularly true for the coal combustion byproduct known as fly ash (CFA), whose characteristics make it potent pollutant of air, soil, sediment and water. Power utilities care about the fiscally and environmentally expensive costs of current coal waste disposal methods. Furthermore, the public is increasingly concerned about environmental degradation not only from headline-grabbing catastrophic CFA spills but also, insidious seepage of contaminants into drinking water supplies across the nation from hundreds of coal ash dumps.

What has been done

This project investigated using CFA as soil amendment to produce bioenergy crops. CFA contains plant nutrients and can improve water retention properties of soils. Agricultural utilization of CFA has prospects for beneficially consuming the byproduct while relieving pressures on disposals on land or landfills. Investigations focused on enhancing biomass productivities of bioenergy feedstocks, namely eastern gamagrass (GG) and switchgrass (SG) using CFA as soil amendment. One experiment investigated the co-utilization of CFA and poultry litter (another agricultural ?waste? byproduct) to produce the bioenergy feedstocks. Another experiment investigation focused on enhancing the productivities of the feedstock through the mediation of arbuscular mycorrhiza (AM). We hypothesized that AM could neutralize potential toxic components that are invariably associated with coal fly ash (CFA) and thereby enhance both productivity and quality of biomass produced in soils amended with the byproduct.

Results

Results demonstrate that co-amendment of soil with CFA (10%, w/w) and poultry litter (75 mg N/kg) enhanced biomass production of GG and SG over the production in soil without the admixture. Furthermore, soil inoculation with a AM namely Rhizophagus clarus relieved stress caused to SG grown in presence of CFA. Investigations with AM are continuing in efforts to prove or disprove the contention that biomass produced on CFA-amended soils could contain substances that can interfere with conversion biomass to bioenergy.

4. Associated Knowledge Areas

KA Code	Knowledge Area
133	Pollution Prevention and Mitigation
205	Plant Management Systems
403	Waste Disposal, Recycling, and Reuse

Outcome #5

1. Outcome Measures

Encourage cattle producer adoption of water-quality BMPs (Clark, Lambert, Walker)

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Oostanaula Creek within McMinn and Monroe Counties of Tennessee is listed as an impaired waterbody due to pathogens (E. coli), phosphates and siltation.

What has been done
Worked with farmers in the Oostanaula Creek watershed in eastern Tennessee to improve pasture management and reduce the amount of erosion coming from beef, dairy and row crop farms. During the course of the project 400 acres of pasture were renovated and 9 miles of cattle exclusion fencing and heavy use cattle lanes were installed.

Results
The result was an estimated reduction of at least 1,450 tons of sediment moving into the stream. Because of the best management practices that were employed, the water contact advisory for significant parts of the stream were lifted.

4. Associated Knowledge Areas

KA Code	Knowledge Area
112	Watershed Protection and Management
133	Pollution Prevention and Mitigation
135	Aquatic and Terrestrial Wildlife
136	Conservation of Biological Diversity

Outcome #6

1. **Outcome Measures**

Develop practical systems for organic forage production (Butler)

Not Reporting on this Outcome Measure

Outcome #7

1. **Outcome Measures**

Study military vehicle tracking and impact (Ayers)

Not Reporting on this Outcome Measure

Outcome #8

1. **Outcome Measures**

Help municipalities evaluate (1) alternative property tax structures that encourage more efficient land development, (2) priority areas for forest landscape restoration to protect ridgelines and hillsides, and (3) rezoning processes that help sustainable development (Cho)

Not Reporting on this Outcome Measure

Outcome #9

1. **Outcome Measures**

Optimize non-chemical methods of soil disinfestation (Butler)

Not Reporting on this Outcome Measure

Outcome #10

1. **Outcome Measures**

Evaluate soil quality under biodegradable mulch (Lee)

Not Reporting on this Outcome Measure

Outcome #11

1. Outcome Measures

Research to reduce the impact of pharmaceuticals and personal care products in surface water in rural and urbanizing watersheds. (Dennis)

2. Associated Institution Types

- 1890 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Incidence of pharmaceuticals and personal care products is becoming a complex environmental issue. Little is known about the potential health effects to humans or aquatic organisms exposed to the trace levels of these chemical when present in surface water. Humans are primarily responsible for the pathway of pharmaceuticals to surface water, partly through excretion and disposal of unwanted medications to sewers and trash. Farm animals also contribute to some extent, through their excretion of veterinary medicines, and the use of animal manure as soil amendment.
Unfortunately, municipal wastewater treatment plants and septic systems were not engineered to remove these non-biodegradable products and non-metabolized drugs by humans and farm animals. Consequently, minute concentrations of Pharmaceuticals and Personal Care Products have been detected in surface water. Since the safety and health of the environment is directly affected by the disposal of unused pharmaceuticals, consumers need to be aware as well as understand how to ensure the safe disposal of pharmaceuticals and personal care products.

What has been done
Three counties were chosen for the study. The rivers monitored included Cumberland River in Davidson county, Stone River in Rutherford County and Collins River in Warren county. The counties represent urban, urbanizing and rural watersheds respectively, in Middle Tennessee. Stream water sampling for pharmaceuticals and personal care products and water quality parameters were taken during a span of 3 seasons: Spring, Summer and Fall. In each season, water samples were collected weekly for 6 weeks and analyzed for the incidence of pharmaceuticals and personal care products present in the water samples.

Results
Pharmaceutical containing the active ingredients used for the control of type 2 diabetes (thiazolindine); drug used for the treatment of chronic alcoholism (disulfiram);drug used for anti-

inflammatory and anti-fibrotic effect (methyl palmitate); drug associated with steroid derivatives (pregnanes); antibiotic drug (trimethoprim) and insect repellent (deet); were found in all the 3 rivers monitored. Personal care products that were detected in the three rivers included the active ingredients in perfumes, antiperspirants skin conditioners and shampoos. While it is too soon to determine the impact of these compounds in surface water monitored, their detection was in the parts per billion ranges.

4. Associated Knowledge Areas

KA Code	Knowledge Area
112	Watershed Protection and Management

Outcome #12

1. Outcome Measures

Farmers and homeowners will be educated on the impact of pharmaceuticals and personal care products in surface water and the proper ways to dispose of these chemicals (Dennis)

2. Associated Institution Types

- 1862 Extension
- 1890 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	1

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Low-level concentrations of pharmaceuticals and personal care products have been detected in fresh water resources throughout the U.S. The pharmaceuticals detected in our study included those used for treatment of chronic alcoholism, antibiotic drug, and drug used for anti-inflammatory conditions and drugs used for the control of type 2 diabetes. However, little is known about the potential health effects to humans or aquatic organisms exposed to the trace levels of these chemicals when present in surface water. As such there is a dire need of societal awareness on proper disposal of these chemicals especially among homeowners and agricultural producers.

What has been done
Advancing efforts to mitigate this problem, we developed an extension fact sheet detailing the proper disposal of unused pharmaceuticals and personal care products.

Results

Factsheet impact is far reaching and goes beyond the targeted stakeholders (farmers and homeowners); as it will reduce the quantities of Rx drugs entering our nation?s waterways or drugs being stockpiled in homes awaiting misuse or abuse.

4. Associated Knowledge Areas

KA Code	Knowledge Area
112	Watershed Protection and Management

Outcome #13

1. Outcome Measures

Develop a greater understanding of the mechanisms of the studied emerging contaminants for the scientific community to expedite the decision making process in terms of protecting environmental health. (Rakshit)

2. Associated Institution Types

- 1890 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	1

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Environmental science professionals including agencies such as EPA can gain in-depth insight into the fate of emerging contaminants under various laboratory simulated environmental conditions to predict their bioavailability in the environment. In addition, the scientific community will benefit from the knowledge transformed through understanding of the environmental systems and can further deliver it to stakeholders to strengthen their awareness about emerging contaminants, thereby protecting the public health.

What has been done
The ability of phosphate (P) to desorb oxytetracycline (OTC) form kaolinite surface has been investigated under various solution properties using in situ ATR-FTIR experiments.
Antimony binding mechanism on hematite has been investigated using macroscopic, spectroscopic (in situ ATR-FTIR), and surface complexation modeling exercise.
The ability of phosphate to hinder poly tungstate surface complex formation of hematite has been tested using in situ ATR-FTIR

Results

Analyses of infrared (IR) spectra from in situ ATR-FTIR experiments of competitive P and OTC sorption indicated that P could not desorb OTC in the experimental solution property range (i.e. pH, ionic strength, and conc. range).
Antimony indicated strong affinity for hematite surface. Initial surface complexation modeling exercise indicated that antimony binds with hematite via mononuclear monodentate complex. Competitive sorption experiments on W & P binding of hematite indicated that at pH 6.4 no IR bands due to poly tungstate surface complex could be found. For wet chemical experiments, when P was added later, the amount of WO42- sorption was not affected; however, when P was added first or simultaneously, less amount of WO42- was sorbed

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
133	Pollution Prevention and Mitigation

Outcome #14

1. Outcome Measures

Improve mechanistic understanding of microbial processing of soil decay and its long-term responses to climate warming. (J Li)

2. Associated Institution Types

- 1890 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	1

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Soil harbors the largest organic C pool in the terrestrial biosphere, with a total of more than 1500 Gt in the top meter globally. Annual soil CO2 efflux is about six times of that from fossil fuel burning. Microbial communities are the primary drivers of soil organic carbon mineralization and respiratory C loss to atmosphere.
Because both climate warming and nitrogen (N) fertilization can accelerate soil CO2 efflux to atmosphere, investigation of microbial transformation of soil organic C under both climate warming and N fertilization becomes a research priority.

What has been done

Meta-analysis statistical modeling method was employed to examine how N fertilization influenced soil microbial biomass and extracellular enzyme activities as well as soil carbon and nitrogen stocks. The results were published in a peer-review journal paper.
A laboratory incubation experiment involving both N fertilization and soil warming was accomplished in November 2016. A full set of soil microbiology and respiration data were currently analyzed and will be incorporated in another manuscript.

Results
Results showed that soil microbial biomass and extracellular oxidases were depressed but hydrolases were enhanced in response to nitrogen fertilization; in addition, a significantly positive relationship was found between response ratios of hydrolases associated with C and microbial biomass. The identified relationships were significantly different between cropland and forest soils. Furthermore, a significant relationship between soil respiration and hydrolases was also identified. The laboratory incubation study showed significant warming or N fertilization effect on microbial communities including extracellular enzyme activities, respiration and microbial substrate preference, and significant interaction of N fertilization and warming only on β-1,4-xylosidase (BX), a labile substrate acquired enzyme.

4. Associated Knowledge Areas

KA Code	Knowledge Area
132	Weather and Climate

Outcome #15

1. Outcome Measures

Research to influence change in understanding of proper management of riparian landscapes. (Sutton)

2. Associated Institution Types

- 1890 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	1

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The quality of aquatic resources is a topic that concerns the existence of every living organism. A variety of anthropogenic land uses, including urbanization, mining, and agriculture threaten the

quality of water resources throughout Tennessee. Land mitigation via restoration represents a viable option for conservation of landscapes and water quality. However, riparian areas represent habitats that tend to be overlooked and are difficult to restore once they are degraded. Many stream-dwelling organisms, including the eastern hellbender (Cryptobranchus alleganiensis) can be used as biological indicators to gauge the quality of water body along with effectiveness of restoration efforts.

What has been done
We have collaborated with a variety of state-level organizations, including the Tennessee Department of Environmental Conservation, Tennessee Wildlife Resources Agency, and the Nashville Zoo to acquire and develop an extensive occurrence database for the Eastern Hellbender (Cryptobranchus alleganiensis) throughout Tennessee. These occurrences have been used to develop a preliminary habitat model for the state. The process of reviewing the draft habitat model has begun and preliminary results have been presented at two regional conferences. We have implemented sampling based on the habitat model and have sampled over 300 sites throughout TN for C. alleganiensis presence. At each stream sampling site, we collected 1 L of stream water and used 0.45 micrometer filters to extract DNA of all stream organisms present in the stream. We have completed DNA extraction procedures on all stream samples and have completed standardization of all qPCR procedures for identification of C. alleganiensis DNA.

Results
Results indicate that Eastern Hellbenders are primarily regulated to habitats that have a very low anthropogenic footprint. Optimal aquatic habitats appear to be those not yet impacted by agricultural and forestry practices, suggesting that greater measures must be taken to make anthropogenic land-uses more compatible with biodiversity conservation. The loss of aquatic biodiversity due to anthropogenic disturbances should be viewed with great concern as these losses are signaling a greater issue that concerns the quality of our aquatic resources. We are now currently evaluating the preliminary habitat model and will use the results from the eDNA analysis to develop a C. alleganiensis landscape occupancy model.

In addition, to our landscape model efforts, we have also completed microhabitat sampling for larval, sub-adult, and adult C. alleganiensis at 3 sites in east TN. We have developed spatially-implicit microhabitat models and will be refining these over the next year.

4. Associated Knowledge Areas

KA Code	Knowledge Area
112	Watershed Protection and Management
135	Aquatic and Terrestrial Wildlife

Outcome #16

1. Outcome Measures

Crop Nutrient Stewardship Impacts (Integrated Research and Extension)

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
With low crop prices, increasing prices of nitrogen and phosphorus fertilizers, and the contribution of production agriculture to diminished water quality in the Mississippi River Basin, fertility practices need to be reevaluated to better benefit our producers and the environment. Increasing the use of sustainable resource management practices will enable the world to meet present needs while continuously improving future generation?s ability to meet their own needs. This can be done not only by lessening our environmental impacts, improving human health, and improving the economic and social well-being of Tennessee?s communities, but also by increasing productivity to meet current as well as future food, fuel, and fiber demands.

What has been done
An integrated, multi-disciplinary research, education, and outreach program has been established to develop and disseminate information pertaining to crop fertility practices and associated economic and environmental impacts. We promoted the adoption of profitable and environmentally-conscious resource management practices through 83 presentations at field days, county, and/or on-farm demonstrations, and 45 newly-developed publications and/or mass media articles.

Results
The Crop Nutrient Stewardship Workgroup?s educational efforts to promote nutrient efficiency in Tennessee have resulted in the following impacts:
-32,568 producers, crop consultants, and other professionals attending field days, workshops, one-on-one visits and producer meetings increased their knowledge of nutrient management and skills of best management practices that promote sustainable fertilizer management.
-More than 743,000 row crop acres in Tennessee are currently being soil sampled according to UT Soil Testing Procedures.
Over 650,000 row crop acres in Tennessee are currently being grid or zone soil sampled to determine the right fertilizer application rate on a site-specific basis.
-Tennessee row crop producers maximized profitability and reduced the risk of nutrient runoff or leaching in surface or groundwater resources by applying the right fertilizer rate at the right place on over 703,000 acres by using variable rate application technology.
-Based on current UT soil fertility research, Tennessee row crop producers reduced micronutrient costs by an average of 8% and primary nutrient costs by 35% on approximately 678,000 row crop acres using University of Tennessee soil fertility recommendations.
-Over 235,000 acres of winter cover crops were planted in row crop production fields to reduce

soil and nutrient losses to the environment in the period after harvest and prior to spring planting.
-Approximately 80% of producers applied P and K fertilizers in the spring to reduce economic and environmental losses.
-19% of producers planting legume-based cover crops reduced nitrogen inputs by 60 to 80 pounds per acre by utilizing University of Tennessee soil fertility recommendations, thus lowering fertilizer costs and the potential for soil degradation by acidification and nitrogen leaching or runoff into Tennessee?s ground and surface water resources.
-Approximately 49% of row crop producers reduced the potential of nitrogen runoff or leaching by utilizing enhanced efficiency fertilizer products for nitrogen management. Based on 3 years and 2 locations of TN research into the efficacy of nitrogen enhancement products purported to reduce volatilization loss of non-incorporated urea, TN producers now have local facts to guide them in their selection and purchase of such products.
-The 2016 303(d) list of impaired streams published by the Tennessee Department of Environment and Conservation lists streams in which water quality has measurably improved. Current de-listings with impairment previously attributed to an agricultural cause, totaling 419 streambank miles, are the result of nutrient, sediment, and bacterial load reductions from livestock and row crop farms due to cover crop placement, streambank stabilization and buffers, better pasture management, and streamside livestock exclusion.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
112	Watershed Protection and Management
205	Plant Management Systems

Outcome #17

1. Outcome Measures

A Biochar-Amended Underground Reactive Barrier (Lee)

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Animal manure management is generating increased national and international concern. A major reason for this concern is the presence of bioactive chemicals and excess nutrients in the animal wastes. Antibiotics are the most commonly found bioactive chemical in manures because of their widespread use in livestock production, where they are used to treat sick animals, prevent infection, and promote animal growth.

What has been done
While researchers have begun to study the remediation of these contaminants in soil and water systems, there exist few critical and detailed evaluations of the available in situ remediation methods.

Results
Our preliminary research with biochar-amended underground reactive barrier showed that the new system greatly decreased nitrate-nitrogen (N) in groundwater. Such a system may also promote the mitigation of antibiotics and phosphate (P) in affected water.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
112	Watershed Protection and Management
133	Pollution Prevention and Mitigation
136	Conservation of Biological Diversity
403	Waste Disposal, Recycling, and Reuse

Outcome #18

1. Outcome Measures

Wastewater Treatment Tailored to Schools (Buchanan)

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

The limit on the ammonia concentration from wastewater treatment plants is typically 1 to 2 mg/L. Schools are known to have higher ammonia concentrations due to the disproportional amount of urine produced by the students. Rural schools tend to have an individual treatment facility that would have an ammonia discharge limit. As a further complication, schools tend to use very strong sanitizers that can kill-off the bacteria needed to convert the ammonia to nitrate.

What has been done

We offered this problem to a group of engineering students who needed a design project for their Senior Capstone Course. The students developed a sequencing batch reactor with a moving bed to address the ammonia issue.

Results

Their design can provide the additional treatment needed while monitoring the ammonia concentration. While more research needs to be conducted, this methodology has a strong potential to be an effective wastewater treatment system for schools, interstate rest areas and other locations that receive a disproportionate amount of urine.

4. Associated Knowledge Areas

KA Code	Knowledge Area
111	Conservation and Efficient Use of Water
112	Watershed Protection and Management
133	Pollution Prevention and Mitigation
403	Waste Disposal, Recycling, and Reuse

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Public Policy changes
- Competing Public priorities

Brief Explanation

V(I). Planned Program (Evaluation Studies)

Evaluation Results

The Crop Nutrient Stewardship Workgroup's educational efforts to promote nutrient efficiency in Tennessee have resulted in the following impacts:

• 32,568 producers, crop consultants, and other professionals attending field days, workshops, one-on-one visits and producer meetings increased their knowledge of nutrient management and skills of best management practices that promote sustainable fertilizer management.

• More than 743,000 row crop acres in Tennessee are currently being soil sampled according to UT Soil Testing Procedures.

• Over 650,000 row crop acres in Tennessee are currently being grid or zone soil

sampled to determine the right fertilizer application rate on a site-specific basis.

- Tennessee row crop producers maximized profitability and reduced the risk of nutrient runoff or leaching in surface or groundwater resources by applying the right fertilizer rate at the right place on over 703,000 acres by using variable rate application technology.
- Based on current UT soil fertility research, Tennessee row crop producers reduced micronutrient costs by an average of 8% and primary nutrient costs by 35% on approximately 678,000 row crop acres using University of Tennessee soil fertility recommendations.
- Over 235,000 acres of winter cover crops were planted in row crop production fields to reduce soil and nutrient losses to the environment in the period after harvest and prior to spring planting.
- Approximately 80% of producers applied P and K fertilizers in the spring to reduce economic and environmental losses.
- 19% of producers planting legume-based cover crops reduced nitrogen inputs by 60 to 80 pounds per acre by utilizing University of Tennessee soil fertility recommendations, thus lowering fertilizer costs and the potential for soil degradation by acidification and nitrogen leaching or runoff into Tennessee's ground and surface water resources.
- Approximately 49% of row crop producers reduced the potential of nitrogen runoff or leaching by utilizing enhanced efficiency fertilizer products for nitrogen management. Based on 3 years and 2 locations of TN research into the efficacy of nitrogen enhancement products purported to reduce volatilization loss of non-incorporated urea, TN producers now have local facts to guide them in their selection and purchase of such products.
- The 2016 303(d) list of impaired streams published by the Tennessee Department of Environment and Conservation lists streams in which water quality has measurably improved. Current de-listings with impairment previously attributed to an agricultural cause, totaling 419 streambank miles, are the result of nutrient, sediment, and bacterial load reductions from livestock and row crop farms due to cover crop placement, streambank stabilization and buffers, better pasture management, and streamside livestock exclusion.

Key Items of Evaluation

The Crop Nutrient Stewardship Workgroup's educational efforts to promote nutrient efficiency in Tennessee have resulted in the following impacts:

- 32,568 producers, crop consultants, and other professionals attending field days, workshops, one-on-one visits and producer meetings increased their knowledge of nutrient management and skills of best management practices that promote sustainable fertilizer management.
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- Based on current UT soil fertility research, Tennessee row crop producers reduced micronutrient costs by an average of 8% and primary nutrient costs by 35% on approximately 678,000 row crop acres using University of Tennessee soil fertility recommendations.

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- Approximately 49% of row crop producers reduced the potential of nitrogen runoff or leaching by utilizing enhanced efficiency fertilizer products for nitrogen management. Based on 3 years and 2 locations of TN research into the efficacy of nitrogen enhancement products purported to reduce volatilization loss of non-incorporated urea, TN producers now have local facts to guide them in their selection and purchase of such products.
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V(A). Planned Program (Summary)

Program # 7

1. Name of the Planned Program

Family Economics

☑ 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
801	Individual and Family Resource Management	100%	100%	0%	0%
	Total	100%	100%	0%	0%

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2016	Extension		Research	
	1862	1890	1862	1890
Plan	12.0	2.0	0.0	0.0
Actual Paid	10.0	4.0	0.0	0.0
Actual Volunteer	2.0	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**
206078	293969	0	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
917834	340934	0	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
100000	22210	0	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

Extension supported at least 10 regional and local social marketing campaigns organized by UT and TSU Extension. The effort was also supported by coalitions of volunteers across Tennessee. The

Tennessee toolkit for savings lesson plans and activities for teaching financial and savings education wasused in schools, workplaces, community centers and other locations to teach youth and adults. Extension maintained a partnership with national Extension "Financial Security in Later Life" initiative and with the "America Saves" national organization and other national and state partners with the TN Jumpstart Coalition. Extension hosted a bi-annual partnership training conferences to strengthen the capacity of educators to teach financial and savings education. Extension deployed its On My Own curriculum and youth TN Saves in over 100 financial education simulations annually throughout the state to reach 30,000 youth with savings and financial education. Additional classes, newsletters, news releases and community events will be conducted for adult audiences.

2. Brief description of the target audience

Youth and adults were targeted for this program. UT Extension has been a national leader in creating, testing and validating family economic programs for reaching different target audiences, such as youth ages 9-18, young adults, coalition members and consumers.

3. How was eXtension used?

eXtension was used in a number of ways to support this planned program. Most notably, UT Extension has two Extension specialists who contributed to the "Personal Finance" CoP.

V(E). Planned Program (Outputs)

1. Standard output measures

2016	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	57196	936965	59488	0

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

Patent Applications Submitted

Year:	2016
Actual:	0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2016	Extension	Research	Total
Actual	3	0	0

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number of exhibits displayed to promote program awareness and participation.

Year	Actual
2016	253

Output #2

Output Measure

- Number of research-based publications distributed as part of this program.

Year	Actual
2016	480

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	TN Saves: Number of participants who estimated their retirement income needs.
2	TN Saves: Number of participants identified ways to reduce debt.
3	TN Saves: Number of participants who set financial or retirement goals.
4	Youth Financial Education Simulation: Number of participants who felt more strongly that they needed to get a good education.
5	TN Saves: Number of participants who followed a spending plan.
6	TN Saves: Number of participants who initiated or increased savings.
7	TN Saves: Number of participants who reduced debt.
8	TN Saves: Statewide economic impact from reduced debt, increased savings and increased investment. (This outcome target is expressed in millions of dollars.)

Outcome #1

1. Outcome Measures

TN Saves: Number of participants who estimated their retirement income needs.

2. Associated Institution Types

- 1862 Extension
- 1890 Extension

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	7270

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

What has been done

Results

4. Associated Knowledge Areas

KA Code	Knowledge Area
801	Individual and Family Resource Management

Outcome #2

1. Outcome Measures

TN Saves: Number of participants identified ways to reduce debt.

2. Associated Institution Types

- 1862 Extension
- 1890 Extension

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	2733

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

What has been done

Results

4. Associated Knowledge Areas

KA Code	Knowledge Area
801	Individual and Family Resource Management

Outcome #3

1. Outcome Measures

TN Saves: Number of participants who set financial or retirement goals.

2. Associated Institution Types

- 1862 Extension
- 1890 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	4988

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

What has been done

Results

4. Associated Knowledge Areas

KA Code	Knowledge Area
801	Individual and Family Resource Management

Outcome #4

1. Outcome Measures

Youth Financial Education Simulation: Number of participants who felt more strongly that they needed to get a good education.

2. Associated Institution Types

- 1862 Extension
- 1890 Extension

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	20816

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

What has been done

Results

4. Associated Knowledge Areas

KA Code	Knowledge Area
801	Individual and Family Resource Management

Outcome #5

1. Outcome Measures

TN Saves: Number of participants who followed a spending plan.

2. Associated Institution Types

- 1862 Extension
- 1890 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	15516

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

What has been done

Results

4. Associated Knowledge Areas

KA Code	Knowledge Area
801	Individual and Family Resource Management

Outcome #6

1. Outcome Measures

TN Saves: Number of participants who initiated or increased savings.

2. Associated Institution Types

- 1862 Extension
- 1890 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	2343

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

What has been done

Results

4. Associated Knowledge Areas

KA Code	Knowledge Area
801	Individual and Family Resource Management

Outcome #7

1. Outcome Measures

TN Saves: Number of participants who reduced debt.

2. Associated Institution Types

- 1862 Extension
- 1890 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	2307

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

What has been done

Results

4. Associated Knowledge Areas

KA Code	Knowledge Area
801	Individual and Family Resource Management

Outcome #8

1. Outcome Measures

TN Saves: Statewide economic impact from reduced debt, increased savings and increased investment. (This outcome target is expressed in millions of dollars.)

2. Associated Institution Types

- 1862 Extension
- 1890 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	2185709

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

What has been done

Results

4. Associated Knowledge Areas

KA Code	Knowledge Area
801	Individual and Family Resource Management

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Competing Public priorities
- Competing Programmatic Challenges

Brief Explanation

V(I). Planned Program (Evaluation Studies)

Evaluation Results

UT and TSU Educational Programs created a great amount of awareness among adults and youth in Tennessee regarding their personal finances. The Youth Financial Education program helped 611 youth and adults save an average of $346 which amounts to economic impact of $211,406.
TN Saves program helped more than 2300 individuals reduce their debt by an average of $389. This amounted to a total economic impact of $897,423 in the state. The program also helped 2564 people increase or started savings by an average of $420. The total impact of these savings accounted for over $1.07 million.

Key Items of Evaluation

TN Saves program helped more than 2300 individuals reduce their debt by an average of $389. This amounted to a total economic impact of $897,423 in the state. The program also helped 2564 people increase or started savings by an average of $420. The total impact of these savings accounted for over $1.07 million. The Youth Financial Education program helped 611 youth and adults save an average of $346 which amounts to economic impact of $ 211,406.

V(A). Planned Program (Summary)

Program # 8

1. Name of the Planned Program

Food Safety

☑ 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%	2%	0%
203	Plant Biological Efficiency and Abiotic Stresses Affecting Plants	0%	0%	3%	0%
212	Diseases and Nematodes Affecting Plants	0%	0%	6%	0%
302	Nutrient Utilization in Animals	0%	0%	7%	0%
306	Environmental Stress in Animals	0%	0%	4%	0%
311	Animal Diseases	0%	0%	17%	0%
501	New and Improved Food Processing Technologies	0%	0%	12%	40%
502	New and Improved Food Products	0%	0%	3%	0%
503	Quality Maintenance in Storing and Marketing Food Products	10%	10%	4%	0%
504	Home and Commercial Food Service	10%	10%	0%	0%
701	Nutrient Composition of Food	0%	0%	11%	0%
712	Protect Food from Contamination by Pathogenic Microorganisms, Parasites, and Naturally Occurring Toxins	40%	0%	28%	60%
722	Zoonotic Diseases and Parasites Affecting Humans	0%	0%	3%	0%
903	Communication, Education, and Information Delivery	40%	80%	0%	0%
	Total	100%	100%	100%	100%

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2016	Extension		Research	
	1862	1890	1862	1890
Plan	9.0	1.0	40.0	6.0
Actual Paid	12.0	3.0	21.3	7.2
Actual Volunteer	3.0	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**
232958	54987	708907	348664
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
1037551	63772	1765393	348664
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
140061	0	743590	192685

V(D). Planned Program (Activity)

1. Brief description of the Activity

In the Safe Food for Tennessee initiative, UT and TSU Extension taught lessons in homes, schools, community centers, churches, and other accessible locations to consumers. The lessons in "Cook's Corner" and "Safe Food for You" were designed to change attitudes, skills and behaviors in regards to safe food handling practices.

Youth participants received food safety education using Fight BAC and other curricula through their school classroom, community center, after-school program, or other locations to reach youth. Direct methods (group meetings, classes, demonstrations, and on-site visits) and indirect methods (newsletters, TV media programs, web sites, newspaper articles and radio programs) emphasized safe food practices:

- using a thermometer to check the internal temperature of food.
- using a thermometer to check the internal temperature of the refrigerator.

We conduct applied and basic research in food-borne risks and nutrition to address high priority issues for consumers of food products. We disseminate information gained from these studies to food industries and consumers through outreach programs, including workshops and educational events at the county level, and through a variety of publications.

UT AgResearch studies are underway on how non-thermal processing (high pressure, ultrasound, solvents) affect the functional properties of proteins for food and non-food applications. Supercritical carbon dioxide will be used to produce biopolymers encapsulation systems for flavors and nutraceuticals and to modify functional properties of proteins.

AgResearch projects in food safety are multi-pronged in their objectives. A major thrust is characterization of the antimicrobial activity of novel natural (i.e., plant-, animal- or microbial-based) compounds and better targeting through controlled-delivery encapsulation systems and incorporation into nanofibers and packaging films. Encapsulation strategies include micelles, liposomes, chitosans, supercritical carbon dioxide, high pressure homogenization and ultrasound. Novel molecular biology strategies are used to identify stress mechanisms in bacteria that allow them to resist interventions. Additional investigation in food safety examine efficient, novel methods of detecting foodborne pathogens and new techniques in the food processing industry to eliminate food contamination.

Research will also characterize, analyze, and identify pathogenic profiles and patterns of pathogenic

microorganisms in fresh produce and farm environments and deliver educational programs to producers and consumers on hygienic agricultural and food handling practices that are needed to improve fresh produce safety. In addition, the program will reduce antibiotic-resistant bacteria in fresh produce and the farm environment; change the behaviors of consumers and farmers to produce safer fresh produce handling practices and judicious use of antibiotics; and train competitive students.

2. Brief description of the target audience

- Consumers
- Employees of Child Care Centers
- SNAP and WIC clients
- Food producers

3. How was eXtension used?

Four Tennessee Extension personnel served on the Food Safety Community of Practice, including the leader, a specialist in the UT Extension Department of Family and Consumer Sciences.

V(E). Planned Program (Outputs)

1. Standard output measures

2016	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	15715	3840610	1764	0

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

Patent Applications Submitted

Year:	2016
Actual:	0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2016	Extension	Research	Total
Actual	2	54	0

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number of exhibits displayed to promote safe food handling practices.

Year	Actual
2016	40

Output #2

Output Measure

- Number of research-based publications distributed by Extension to educate producers, processors, and consumers.

Year	Actual
2016	166

Output #3

Output Measure

- A. acidoterrestris is a bacterium which has been found in pasteurized fruit juices. High pressure homogenization and dimethyl dicarbonate show promise for aiding in control of growth of vegetative cells of A. acidoterrestris. (Golden)
  Not reporting on this Output for this Annual Report

Output #4

Output Measure

- Develop protein-based ingredients and drug carriers (Harte)
  Not reporting on this Output for this Annual Report

Output #5

Output Measure

- Dietary bioactives Can Reduce Adiposity, Improve Insulin Sensitivity (Voy)

Year	Actual
2016	1

Output #6

Output Measure

- Tree Rosin Reduces Growth of Some Bacterial Species (Gwinn)

Year	Actual
2016	1

Output #7

Output Measure

- Types of Fat in Maternal Diets Affect Adipose Deposition in Offspring (Voy)

Year	Actual
2016	1

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Safe Food Handling for Consumers: Number of consumers who more often washed their hands with soap and warm running water before preparing food.
2	Safe Food Handling for Consumers: Number of consumers who now separate raw, cooked, and ready-to-eat foods while storing and preparing.
3	Safe Food Handling for Consumers: Number of consumers who now use a thermometer to check the internal temperature of food.
4	Safe Food Handling for Consumers: Number of consumers who canned vegetables following a tested recipe.
5	Inactivation of viral pathogens (D'Souza, Davidson)
6	Prevent (rather than respond to) food-borne illness (Buchanan, Critzer, Wszelaki, Lockwood)
7	Target leading foodborne human pathogen C. jejuni (Lin)
8	Research to develop an Immunochemical Fingerprint Analysis method to be specific and sensitive and applicable as a diagnostic assay to identify and differentiate Salmonella isolates from various sources of food contamination. (Chen)
9	Research to develop process innovations and innovative manufacturing technologies providing high quality, novel or modified, healthy products with improved safety profiles using state-of-the-art optical technologies for aflatoxin removal from foods. (Patras)
10	Investigate cell cytotoxicity, cell viability and cytokine analysis using murine macrophage cell line to assess the activity of treated aflatoxins. (Patras)
11	Research to provide logical corridors to mitigate antibiotic-resistance in the Tennessee food system. (Kilonzo Nthenge)
12	Development of science based information on judicious use of antibiotics for agricultural commodity producers. (Kilonzo Nthenge)
13	Fatty Acid Oxidation in Adipose Tissue Coupled to Energy Status (Voy)

Outcome #1

1. Outcome Measures

Safe Food Handling for Consumers: Number of consumers who more often washed their hands with soap and warm running water before preparing food.

2. Associated Institution Types

- 1862 Extension
- 1890 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	271

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

What has been done

Results

4. Associated Knowledge Areas

KA Code	Knowledge Area
504	Home and Commercial Food Service
712	Protect Food from Contamination by Pathogenic Microorganisms, Parasites, and Naturally Occurring Toxins

Outcome #2

1. Outcome Measures

Safe Food Handling for Consumers: Number of consumers who now separate raw, cooked, and ready-to-eat foods while storing and preparing.

2. Associated Institution Types

- 1862 Extension
- 1890 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	78

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

What has been done

Results

4. Associated Knowledge Areas

KA Code	Knowledge Area
504	Home and Commercial Food Service
712	Protect Food from Contamination by Pathogenic Microorganisms, Parasites, and Naturally Occurring Toxins

Outcome #3

1. Outcome Measures

Safe Food Handling for Consumers: Number of consumers who now use a thermometer to check the internal temperature of food.

2. Associated Institution Types

- 1862 Extension
- 1890 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual

2016	369

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

What has been done

Results

4. Associated Knowledge Areas

KA Code	Knowledge Area
503	Quality Maintenance in Storing and Marketing Food Products
504	Home and Commercial Food Service

Outcome #4

1. Outcome Measures

Safe Food Handling for Consumers: Number of consumers who canned vegetables following a tested recipe.

2. Associated Institution Types

- 1862 Extension
- 1890 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	6842

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

What has been done

Results

4. Associated Knowledge Areas

KA Code	Knowledge Area

503	Quality Maintenance in Storing and Marketing Food Products
504	Home and Commercial Food Service
712	Protect Food from Contamination by Pathogenic Microorganisms, Parasites, and Naturally Occurring Toxins

Outcome #5

1. Outcome Measures

Inactivation of viral pathogens (D'Souza, Davidson)

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
New methods are needed to control food-borne pathogens.

What has been done
Chlorine dioxide gas is being researched as an alternate non-thermal process to maintain the nutritional and sensory attributes of fresh produce with the goal to extend shelf-life and inactivate foodborne pathogens (both viral and bacterial) and spoilage microorganisms.

Results
Research with chlorine dioxide gas against Tulane virus showed reduction in infectivity using plaque assays, indicating the suitability of using chlorine dioxide gas to prevent the spread of viruses from formica as a food contact surface.

4. Associated Knowledge Areas

KA Code	Knowledge Area
501	New and Improved Food Processing Technologies
503	Quality Maintenance in Storing and Marketing Food Products
504	Home and Commercial Food Service
712	Protect Food from Contamination by Pathogenic Microorganisms, Parasites, and Naturally Occurring Toxins

Outcome #6

1. Outcome Measures

Prevent (rather than respond to) food-borne illness (Buchanan, Critzer, Wszelaki, Lockwood)

Not Reporting on this Outcome Measure

Outcome #7

1. Outcome Measures

Target leading foodborne human pathogen C. jejuni (Lin)

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	1

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

What has been done

Results

4. Associated Knowledge Areas

KA Code	Knowledge Area
311	Animal Diseases
501	New and Improved Food Processing Technologies
712	Protect Food from Contamination by Pathogenic Microorganisms, Parasites, and Naturally Occurring Toxins

Outcome #8

1. Outcome Measures

Research to develop an Immunochemical Fingerprint Analysis method to be specific and sensitive and applicable as a diagnostic assay to identify and differentiate Salmonella isolates from various sources of food contamination. (Chen)

Not Reporting on this Outcome Measure

Outcome #9

1. Outcome Measures

Research to develop process innovations and innovative manufacturing technologies providing high quality, novel or modified, healthy products with improved safety profiles using state-of-the-art optical technologies for aflatoxin removal from foods. (Patras)

2. Associated Institution Types

- 1890 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	1

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Mycotoxins are fungal metabolites commonly occurring in food, which pose a health risk (i.e. cancer) to the consumer. Maximum levels for major mycotoxins allowed in food have been established worldwide. But still, persistence of mycotoxins or their metabolites is a major safety concern world-wide especially in developing countries. The persistence of aflatoxins (AFB1, AFG1, AFB2 and AFG2), patulin and their metabolites in agricultural products is a major safety concern due to their high resistance to current methods of decontamination.

What has been done
The efficacy of a medium pressure lamp source to reduce aflatoxins (AFB1, AFB2, AFG1) in pure water was investigated. Irradiation experiments were conducted using a collimated beam system operating between 200 to 300 nm. The UV dose delivered considered the optical absorbance of the solution, accounts for the irradiance of the lamp in calculating the average fluence rate. Known concentrations of aflatoxins were spiked in water and irradiated at UV doses ranging from 0-4.88 J. cm-2. Degradation of the molecules was monitored by RP-HPLC equipped with fluorescence detection.

Results
UV irradiation (0-4.88 J. cm-2) significantly reduced aflatoxins in pure water ($p<0.05$). Irradiation doses up to 0-4.88 J.cm-2 reduced content by 67.22% of AFG1, 29.77% of AFB2 and 98.25% of AFB1 ($p<0.05$). Using this technique, an overall reduction of total aflatoxin content of 95% ($p<0.05$) was achieved. We hypothesize formation of ?OH radicals initiated by UV light, may have caused a photolytic damage to the AFB1, AFB2, AFG1 molecules.

4. Associated Knowledge Areas

KA Code	Knowledge Area
501	New and Improved Food Processing Technologies

Outcome #10

1. Outcome Measures

Investigate cell cytotoxicity, cell viability and cytokine analysis using murine macrophage cell line to assess the activity of treated aflatoxins. (Patras)

2. Associated Institution Types

- 1890 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	1

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
This task investigated the effect of UV irradiation on aflatoxins degradation in milli-Q water and and determined the effectiveness of UV treatment of water against aflatoxins-induced cytotoxicity for human hepatoma cell line. In this research study we used HepG2 cell line because these cells retain the functions of fully differentiated primary hepatocytes, including phase I and II enzyme activities and has previously been used as a model cell line to study the mechanisms of toxicity, especially that of hepatotoxins such as AFB1. HepG2 cells are a relative easy to handle tool for the study related with the liver or hepatic cancer.

What has been done
The cells were exposed to the test samples (controls and UV treated) for a period of 24 hrs. Cell viability percentage increased from 59.5 ± 2.6% to 93.5 ± 3.4% as UV-C dose increased to 4.88 J cm-2. Overall, the differences between treated and control cultures were statistically significant ($p<0.05$). It is quite apparent that decrease in aflatoxins concentration was inversely proportional to increase in cell viability as the dose increased from 0- 4.88 J cm-2.

Results
Our results showed that increasing the UV dose decreased the aflatoxins induced cytotoxicity in HepG2 cells. The current study demonstrated that UV irradiation (200- 300 nm wave-length) technique can be an effective physical method of reducing aflatoxins. Aflatoxins trials are going on (in food models).

4. Associated Knowledge Areas

KA Code	Knowledge Area
501	New and Improved Food Processing Technologies

Outcome #11

1. Outcome Measures

Research to provide logical corridors to mitigate antibiotic-resistance in the Tennessee food system. (Kilonzo Nthenge)

2. Associated Institution Types

- 1890 Extension
- 1890 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	1

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Antibiotic-resistant bacteria is a major public health threat, gradually leading to infections that can be challenging to treat. Antibiotic-resistant infections enhance significant and unnecessary costs to the already overburdened U.S. healthcare system. Antibiotic resistant bacteria can enter the food chain through foods of animal origin, contaminated soils, animal feed, spraying and irrigating food crops with contaminated ground and surface water containing antibiotic resistant bacteria derived from animal waste.

What has been done
Through the Tennessee State University Extension Program, farms, and farmers markets were visited and samples including produce, chicken, eggs, water, soil, and animal manure were collected and transported in coolers with ice and analyzed for microbial contamination. The antimicrobial susceptibility of zoonotic and indicator bacteria isolated from farms was determined using the Bauer and Kirby disk diffusion technique. Amikacin, amoxicillin/ clavulanic acid, ampicillin, azithromycin, cefoxitin, cefpodoxime, chloramphenicol, ciprofloxacin, kanamycin,

nalidixic acid, streptomycin, tetracycline, erythromycin, and gentamicin were some of the antibiotics used in this study.

Results

Escherichia coli, Salmonella spp., Shigella spp. and other bacteria including, Enterobacter spp, and Klebsiella were isolated from local foods, water from farms, animal manure, and soil. Pathogenic bacteria such as Shigella and Salmonella; and indicator bacteria including Escherichia coli, Klebsiella , and other showed resistance to ampicillin, cefpodoxime, tetracycline, erythromycin, cefotaxime, gentamicin, and other antibiotics used in human medicine. The MAR index values of isolated bacteria was also evaluated in this study. MAR index values indicate the usage of antibiotics in the environment. Cumulatively, the antibiotic resistance patterns showed MAR index values ranging from 0.08 to 0.70. Three students were also engaged to increase their participation in food safety research activities.

4. Associated Knowledge Areas

KA Code	Knowledge Area
712	Protect Food from Contamination by Pathogenic Microorganisms, Parasites, and Naturally Occurring Toxins

Outcome #12

1. Outcome Measures

Development of science based information on judicious use of antibiotics for agricultural commodity producers. (Kilonzo Nthenge)

2. Associated Institution Types

- 1890 Extension
- 1890 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	1

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Overuse and misuse of antibiotics in food animals is a major cause of antibiotic-resistant bacteria that affect humans. It is important to cautiously use antimicrobials in agricultural settings. This will reduce the spread of antimicrobial resistant bacteria in our agricultural lands

What has been done

A questionnaire based survey was developed and conducted among 25 animal producers. The producers were asked key questions including type of animals, number, types of antibiotics used, record keeping, and collaborations with veterinarians.

Results

Slightly more than half of farms (56%) indicated that animals had developed at least some infections including mastitis, diarrhea, respiratory infections, and skin/foot and as a result the farmers administered antibiotics to the animals. The most surprising practice was that 52% of the farmers indicated not to seek veterinarian?s advice before administering antibiotics; only 40% indicated to collaborate with a veterinarian. A small percentage (8%) indicated they did not have a veterinarian involved on their farms. The data collected indicated that 72% of animals kept were cattle, followed by chicken (16%), pigs (4%), goats (4%), and sheep (4%).

4. Associated Knowledge Areas

KA Code	Knowledge Area
712	Protect Food from Contamination by Pathogenic Microorganisms, Parasites, and Naturally Occurring Toxins

Outcome #13

1. Outcome Measures

Fatty Acid Oxidation in Adipose Tissue Coupled to Energy Status (Voy)

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Fatty acid oxidation in white adipose tissue has been ignored as relevant to systemic metabolism due to the relatively low rates of oxygen consumption in adipose tissue. Nonetheless, genetically engineered mouse models demonstrate that enhancing this pathway improves local and systemic insulin sensitivity and attenuates the inflammation that often precedes and contributes to insulin resistance and the pathogenesis of Type 2 diabetes. Understanding the endogenous physiological regulation of this pathway is difficult in rodents because of the presence of both white and brown adipocytes in white adipose depots.

What has been done
We used broiler chickens as a model to investigate regulation of fatty acid oxidation because avians lack brown adipocytes, allowing us to study a purely white adipose depot.

Results
We found that this pathway can be upregulated by short-term feed restriction and identified potential molecular control mechanisms. These results are important because they highlight control points that may be manipulated by diet to therapeutically alter adipocyte metabolism and attenuate insulin resistance.

4. Associated Knowledge Areas

KA Code	Knowledge Area
302	Nutrient Utilization in Animals
311	Animal Diseases

V(H). Planned Program (External Factors)

External factors which affected outcomes
- Competing Public priorities
- Competing Programmatic Challenges

Brief Explanation

V(I). Planned Program (Evaluation Studies)

Evaluation Results

UT and TSU Extension had a robust food safety education program that educated thousands of adults and youth on "preserving food at home" and "safe food handling practices" at home through a variety of workshops. The evaluation results after workshops showed the following impacts:

- 283 of 284 participants surveyed made a positive change in the attitude about cooking food to a safe internal temperature.
- 291 of 304 participants surveyed made a positive change in their attitude about how they thaw food.
- 333 of 354 participants surveyed made a positive change in their attitude about cleaning surfaces, utensils and equipment to prevent cross-contamination.
- 263 of 264 participants surveyed made a positive change in their attitude about eating/drinking foods from unsafe sources.
- 303 of 304 participants surveyed made a positive change in their attitude about keeping the temperature in the refrigerator at 40 degrees F or below.

Key Items of Evaluation

- 283 of 284 participants surveyed made a positive change in the attitude about

cooking food to a safe internal temperature.

- 291 of 304 participants surveyed made a positive change in their attitude about how they thaw food.
- 333 of 354 participants surveyed made a positive change in their attitude about cleaning surfaces, utensils and equipment to prevent cross-contamination.
- 263 of 264 participants surveyed made a positive change in their attitude about eating/drinking foods from unsafe sources.
- 303 of 304 participants surveyed made a positive change in their attitude about keeping the temperature in the refrigerator at 40 degrees F or below.

V(A). Planned Program (Summary)

Program # 9

1. Name of the Planned Program

Forestry, Wildlife, and Fishery 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
102	Soil, Plant, Water, Nutrient Relationships	0%	0%	3%	65%
112	Watershed Protection and Management	0%	0%	6%	0%
123	Management and Sustainability of Forest Resources	75%	75%	23%	10%
125	Agroforestry	10%	10%	0%	25%
133	Pollution Prevention and Mitigation	0%	0%	6%	0%
135	Aquatic and Terrestrial Wildlife	10%	10%	14%	0%
136	Conservation of Biological Diversity	0%	0%	9%	0%
203	Plant Biological Efficiency and Abiotic Stresses Affecting Plants	0%	0%	3%	0%
206	Basic Plant Biology	0%	0%	2%	0%
211	Insects, Mites, and Other Arthropods Affecting Plants	0%	0%	4%	0%
215	Biological Control of Pests Affecting Plants	0%	0%	8%	0%
311	Animal Diseases	0%	0%	2%	0%
312	External Parasites and Pests of Animals	0%	0%	3%	0%
605	Natural Resource and Environmental Economics	5%	5%	6%	0%
608	Community Resource Planning and Development	0%	0%	7%	0%
721	Insects and Other Pests Affecting Humans	0%	0%	2%	0%
722	Zoonotic Diseases and Parasites Affecting Humans	0%	0%	2%	0%
	Total	100%	100%	100%	100%

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2016	Extension		Research	
	1862	1890	1862	1890
Plan	9.0	2.0	45.0	8.0

Actual Paid	7.0	1.0	22.3	4.8
Actual Volunteer	2.0	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**
143359	10574	779773	232443
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
638493	12264	1909915	232443
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
50000	0	951622	128457

V(D). Planned Program (Activity)

1. Brief description of the Activity

UT and TSU Extension partnered with the Tennessee Forestry Association to plan and conduct group meetings to inform forest landowners of issues pertaining to forestry and wildlife. Topics included management and marketing. Volunteers were recruited and trained to present at group meetings, provide information, demonstrate equipment and provide materials for demonstrations. UT and TSU Extension provided education at local, regional and statewide events, such as the Tennessee Forest Festival to inform the general public about forest management issues. Demonstrations were provided for landowners and forestry workers. Extension Agents and Specialists educated attendees at County Forestry Landowners Associations. UT and TSU Extension worked closely with private consultants, Tennessee Wildlife Resources Agency employees, Tennessee Division of Forestry and others in forestry related industries to conduct educational programs and activities for professionals and landowners.

UT and TSU Extension continued one-on-one contacts with landowners throughout the year and used mass media and newsletters to inform the general public on issues and educational opportunities related to natural resources. Both UT and TSU Extension provided leadership for conducting programs that targeted limited resource landowners with TSU providing specialist leadership for this effort.

For Tennessee's forestry sector, UT AgResearch continues biological control of Hemlock Woolly Adelgid by known predators and new species and release technologies.We evaluate methods of increasing seedling success, and techniques for improving reforestation.We exploit genetic variation in nursery and field characteristics of native hardwood and coniferous forest tree species.We try novel strategies to address exotic forest tree pests and corresponding forest restoration. We establish collections of woody plants, including species and cultivars, and plants having potential commercial value as forest species or for landscape development, from which materials may be obtained for breeding/propagation.

For wood products manufacturing, UT AgResearch characterizes key parameters associated with the formation of durable, high-performance composite materials, and establish new statistical methods to advance intelligent manufacturing practices. We explore new methods to produce carbon fibers from low-quality raw materials and are developing a process for bonding plastic or polymer to lignocellulosic fibers (using ultrasonic vibration) as a replacement for toxic wood preservatives. We identify approaches and services to landowners that would enable them to realize a wide range of

landownership benefits while fostering stewardship and sustainability of private forest lands in Tennessee. Both qualitative (e.g., personal interviews and focus groups) and quantitative (e.g., survey responses) data are collected and analyzed to better understand landowners understanding of management.

Although manipulative studies of tree seedlings and saplings are cost effective and quick, recent research has shown that they may not allow for valid predictions on mature trees. Therefore, direct experiments on large trees or forested catchments have been developed. Experiments are being conducted on local forest research sites developed by the Department of Energy (DOE). Each are large-scale, multi-year, multi-investigator experiments.

TSU forestry research is developing production practices to optimize the production of woody biomass for energy production through intercropping and utilization of improved technology tools in mapping. UT AgResearch wildlife and fisheries research evaluates and quantifies the effects of deer on agricultural production and identifies associated land-use patterns and biological and ecological factors that could be used for reducing that impact.We monitor target avian species and relate specific population parameters to factors affecting forest health and sustainability, and develop new forest management prescriptions that promote sustainability.We develop prediction methods and evaluate selected aquatic species in existing and new production systems adapted to Tennessee's climate and geography.

2. Brief description of the target audience

The target audiences for this program are forest landowners, the professionals and volunteers who serve them, as well as those who enjoy the state's wildlife resources.

3. How was eXtension used?

This Forestry, Wildlife, and Fisheries planned program was enhanced through the service of:
• one Tennessee Extension professional on the "Climates, Forests, and Woodlands" CoP.
• one Tennessee Extension professional on the "Extension Wildfire Information Network" CoP.
• one Tennessee Extension professional on the "Feral Hogs" CoP.
• one Tennessee Extension professional on the "Wildlife Damage Management" CoP.
Tennessee Extension personnel shared implementation strategies and research results with their CoP colleagues.

V(E). Planned Program (Outputs)

1. Standard output measures

2016	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	22509	1129088	6965	0

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

Patent Applications Submitted

Year:	2016
Actual:	1

Patents listed
Wood adhesives containing reinforced additives for structural engineering products, Wang S. and C. Xing.

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2016	Extension	Research	Total
Actual	8	58	0

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Release of Hemlock Woolly Adelgid predators reared in Tennessee (Parkman, Grant)

Year	Actual
2016	1

Output #2

Output Measure

- Develop phytosanitary methods for disinfecting walnut logs that are currently under quarantine for walnut twig beetle (Taylor)
  Not reporting on this Output for this Annual Report

Output #3

Output Measure

- Number of logger preferences examined in emerging forest products industries.

Year	Actual
2016	0

Output #4

Output Measure

- Develop mobile apps for IPM (Fulcher, Windham, Hale)

Year	Actual
2016	1

Output #5

Output Measure

- Investigate importance of wildlife to plants (Kwit)

Year	Actual
2016	1

Output #6

Output Measure

- Population Dynamics of Fraser Fir in the GSMNP (Franklin)

Year	Actual
2016	1

Output #7

Output Measure

- Quantifying Impact of Forest Management (Zobel)

Year	Actual
2016	1

Output #8

Output Measure

- Wildlife Management Strategies Using Stable Isotope Analysis (Muller)

Year	Actual
2016	1

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Forest Landowner Education: Number of landowners who now understand the ecology of forest development and succession (using forest management plans or contacting a professional forester.)
2	Biomass Feedstock Availability and Assessment (Hodges, Young)
3	Thousand Cankers Disease on black walnut (Grant, Lambdin, Hadziabdic, Windham)
4	Suppression of Emerald Ash Borer (Grant, Wiggins)
5	Establishing shortleaf pine (Clatterbuck)
6	Predatory beetles against HWA (Lambdin, Grant, Wiggins)
7	Protecting amphibians from ranavirus (Gray)
8	Increase in efficiency of supply systems in Tennessee forest products. (Abbas)
9	Research to determine long term site improvement for biofuels production in intercropping systems through increased nutrient pools. (Haile)
10	Optimum switchgrass/pine intercropping combination to enhance soil carbon sequestration and minimize greenhouse gas production. (Haile)
11	Biomass mapping models to help plan a continuous supply of traditional forest products, and help generate revenue, and protect and restore supporting services in the forests in Tennessee. (Pokharel)
12	Tennessee Master Logger Program
13	Better Pressure-Treatment for Wooden Bridge Timbers (Taylor)
14	Environmental, Robust, Semitransparent Hydrophobic Coating (Wang)
15	Forestry Strategies to Protect Birds (Buehler)
16	Successful Reforestation for Mine Reclamation (Franklin)

Outcome #1

1. Outcome Measures

Forest Landowner Education: Number of landowners who now understand the ecology of forest development and succession (using forest management plans or contacting a professional forester.)

2. Associated Institution Types

- 1862 Extension
- 1890 Extension

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	166

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

What has been done

Results

4. Associated Knowledge Areas

KA Code	Knowledge Area
123	Management and Sustainability of Forest Resources

Outcome #2

1. Outcome Measures

Biomass Feedstock Availability and Assessment (Hodges, Young)

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	1

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

What has been done

Results

4. Associated Knowledge Areas

KA Code	Knowledge Area
123	Management and Sustainability of Forest Resources
125	Agroforestry
605	Natural Resource and Environmental Economics

Outcome #3

1. Outcome Measures

Thousand Cankers Disease on black walnut (Grant, Lambdin, Hadziabdic, Windham)

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	1

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

What has been done

Results

4. Associated Knowledge Areas

KA Code	Knowledge Area
123	Management and Sustainability of Forest Resources
125	Agroforestry
203	Plant Biological Efficiency and Abiotic Stresses Affecting Plants

Outcome #4

1. Outcome Measures

Suppression of Emerald Ash Borer (Grant, Wiggins)

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	1

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

What has been done

Results

4. Associated Knowledge Areas

KA Code	Knowledge Area
123	Management and Sustainability of Forest Resources
125	Agroforestry

605 Natural Resource and Environmental Economics

Outcome #5

1. Outcome Measures

Establishing shortleaf pine (Clatterbuck)

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	1

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

What has been done

Results

4. Associated Knowledge Areas

KA Code	Knowledge Area
123	Management and Sustainability of Forest Resources
125	Agroforestry
605	Natural Resource and Environmental Economics

Outcome #6

1. Outcome Measures

Predatory beetles against HWA (Lambdin, Grant, Wiggins)

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	1

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

What has been done

Results

4. Associated Knowledge Areas

KA Code	Knowledge Area
123	Management and Sustainability of Forest Resources
605	Natural Resource and Environmental Economics

Outcome #7

1. Outcome Measures

Protecting amphibians from ranavirus (Gray)

Not Reporting on this Outcome Measure

Outcome #8

1. Outcome Measures

Increase in efficiency of supply systems in Tennessee forest products. (Abbas)

Not Reporting on this Outcome Measure

Outcome #9

1. Outcome Measures

Research to determine long term site improvement for biofuels production in intercropping systems through increased nutrient pools. (Haile)

2. Associated Institution Types

- 1890 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	1

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Over the past few years, the demand for energy has significantly increased in the United States and most parts of the world. As a direct consequence of this increase, biofuels are being researched and promoted as an alternative energy source. As biofuel production increases, so will the demand for forests and other agricultural biomass in providing sources of biomass feedstock. The real challenge and opportunity, however, lies on how agricultural and forestry efforts can actually be integrated to meet the future renewable energy demand. For a long-term improvement and sustainability of biofuels production systems, bioenergy feedstock production has to seamlessly be integrated with existing agricultural production systems, available land, resources, economic systems, and community?s practice. Information on the ability of an agroforestry system of loblolly pine and switchgrass to produce biomass feedstock in flood prone sites will advance the limited knowledge in this area.

What has been done
The performance of agroforestry against monoculture systems based on land use and production yield were assessed and compared by measuring various efficiency indices.

Results
Results indicated biomass yield of switchgrass and loblolly pine grown in monoculture systems were consistently higher in comparison to those grown in agroforestry systems. An average increase of 2.27 Mg/ha year-1 and 2.50 Mg/ha year-1 were seen in switchgrass and loblolly monocultures respectively.
The combined analysis of land equivalent ratio (LER) for loblolly pine and switchgrass intercrops, however, was a ratio ranging 1.25?1.74, which shows that pure strand or monoculture systems would require 25?74% more land to produce the same amount of yield relative to an intercropping (agroforestry) system. An agroforestry system has great potential for producing biomass feedstock for bioenergy. Thus, using agroforestry intercropping of woody and perennial

herbaceous bioenergy crops enhances combined biomass yield, decreases the need for input, and therefore reduces the cost of biomass production.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
125	Agroforestry

Outcome #10

1. Outcome Measures

Optimum switchgrass/pine intercropping combination to enhance soil carbon sequestration and minimize greenhouse gas production. (Haile)

2. Associated Institution Types

- 1890 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	1

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Low-carbon systems are key criteria for long-term improvement and environmental sustainability of bioenergy feedstock production. The synergy of components in intercropping systems like agroforestry that combine energy crops and trees has the potential to enhance soil carbon sequestration and minimize greenhouse gas release from the system. Agroforestry systems may also produce much of the needed biomass for sustainable biofuel production in the near future, yet only few studies have been conducted regarding its overall performance in this regard. This study examines best management practices of integrating agroforestry systems of loblolly pine and switchgrass to enhance soil carbon sequestration and minimize greenhouse gas production

What has been done
Soil samples were collected from agroforestry feedstock systems that combines energy crops and trees and monoculture systems of energy crops and tree plantations. Total soil carbon content was determined in the lab for samples to assess and compare the three systems.

Results
Preliminary results shows that agroforestry systems of loblolly pine and switchgrass has potential to enhance the total soil carbon accumulation and reduce greenhouse gas production. Further analysis is needed to determine which components of the agroforestry system (tree or grass) is

the source of the different carbon fraction in the soil and the respective nature and longevity of soil carbon in the system.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
125	Agroforestry

Outcome #11

1. Outcome Measures

Biomass mapping models to help plan a continuous supply of traditional forest products, and help generate revenue, and protect and restore supporting services in the forests in Tennessee. (Pokharel)

2. Associated Institution Types

- 1890 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The perspectives and social values of the public regarding forests and forestry practices have changed the emphasis from traditional timber production to multiple-value forest management. To satisfy the multiple objectives of forest management, it requires timely and accurate information of forest conditions, at multiple scales and resolutions. With the advancement of computer and remote sensed technology, there is an opportunity to leverage geographically extensive data to develop predictive models of forest attributes, which offers synergistic benefits with field-based data collection to reduce cost, increase accuracy, and provide new opportunities in forest resources management and utilization through mapping of forest biomass across the state of Tennessee.

What has been done
A large amount of spatial and temporal data has been compiled that permit testing of the hypotheses in this project. There is a complex relationship between forest attributes such as a biomass and environmental, physiographic or structural variables, a traditional parametric approach may be inadequate to develop a predictive model of biomass without over-fitting the model. A predictive map model of biomass was developed using random forests with a machine

learning approach. The approach was employed to generate five thousand regression-trees from the fitting data set through a boot-strapped sampling procedure (selecting cases and predictor variables for each tree at random). It uses ensemble strategies to generate predictions for the out-of-bag fitting data (i.e. cases not selected for a given tree) and the targeted population (i.e. the forest area the model will be applied to).

Results
5000 trees were grown in an R statistical computing environment based on bootstrapped sampling using ?randomForest? package in the R statistical computing platform to develop predictive model for biomass per acre. The model explained 46.87% of variability for the biomass with RMSE of 17.14 tons per acre. Canopy cover percentage was one of the important variables while predicting biomass. We are in a process of developing a serious of continuous gridded layer of predicted total biomass across the state of Tennessee, and also planned to test the model against its intended use.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
123	Management and Sustainability of Forest Resources

Outcome #12

1. Outcome Measures

Tennessee Master Logger Program

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Training of loggers in best management practices is necessary in providing a non-regulatory approach to protecting water quality during forest harvesting operations in concordance with the Clean Water Act. The educational program is a cooperative effort between UT Extension, Tennessee Department of Agriculture Forestry Division, and the Tennessee Forestry Association.

What has been done

?18 continuing education logger workshops with 383 participants (loggers, foresters, landowners) were held in 2016 (8 hours each, 3,000+ contact hours).
?3 logger workshops of 5 days each for 51 participants (loggers) were held in 2016 (36 hours of instruction, 2,000+ contact hours).

Results
?Each participant increased their knowledge on best management practices to protect water quality during harvesting operations during the one-day continuing education workshop. Approximately 50% of the trained logging work force in Tennessee attended the workshops.
?The Tennessee Master Logger educational program has reached more than 1,200 loggers and 300 forestry professionals since 1983 or about 90 percent of the state logging workforce.

4. Associated Knowledge Areas

KA Code	Knowledge Area
123	Management and Sustainability of Forest Resources

Outcome #13

1. Outcome Measures

Better Pressure-Treatment for Wooden Bridge Timbers (Taylor)

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Wooden bridge timbers are a high-value component of the railway system and are very costly to replace due to down time. Unfortunately, their very large cross-section makes bridge timbers very difficult to treat with traditional pressure-applied preservatives.

What has been done

Results

Research at UT has demonstrated that drilling holes in these timber to provide a reservoir of diffusible preservative results in very well protected beams with acceptable strength properties. This simple, low-cost treatment has been adopted by Class 1 railroads. Timbers receiving this treatment are expected to last twice as long in service.

4. Associated Knowledge Areas

KA Code	Knowledge Area
125	Agroforestry
211	Insects, Mites, and Other Arthropods Affecting Plants
605	Natural Resource and Environmental Economics

Outcome #14

1. Outcome Measures

Environmental, Robust, Semitransparent Hydrophobic Coating (Wang)

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

What has been done
We have developed an environmentally friendly and robust semitransparent superhydrophobic coating through CVD modification for reducing surface free energy after a simple two-spraying process, which included initially spraying a commercial spray paint as adhesive onto substrate surfaces to support high-adhesion-stress and then spraying NFC ethanol suspension to build suitable roughness.

Results
The resulting NFC superhydrophobic coating showed good self-cleaning properties. In addition, the coating also exhibited outstanding abrasion resistance and durability and could retain superhydrophobic properties after sandpaper abrasion, finger-wipe, knife-scratch, long-time impregnation in water, UV radiation, and long-time staying at low temperature. So, in addition to being suitable for coating both wood and glass, the NFC superhydrophobic coating can potentially

be used on many different substrate surfaces, such as plastic, floors and fabrics.

4. Associated Knowledge Areas

KA Code	Knowledge Area
125	Agroforestry

Outcome #15

1. Outcome Measures

Forestry Strategies to Protect Birds (Buehler)

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The Cerulean Warbler is a species of conservation concern in the eastern United States because of significant population declines. It has been petitioned to be listed and protected under the Endangered Species Act. The Cumberland Mountains of eastern Tennessee host the largest and most productive breeding population across the range of the species.

What has been done
Our research since 2006 has documented the significance of this population in terms of supporting the overall population viability of the species.

Results
As a result of our cerulean habitat model that delineated high-priority habitat in the Cumberlands, Tennessee Wildlife Resources Agency partnered with the U. S. Fish and Wildlife Service to develop a Habitat Conservation Plan for the species in the Cumberlands to ensure the long-term sustainability of breeding habitat. Furthermore, based on our research on the ceruleans and other environmental concerns, the U. S. Department of the Interior in 2016 signed off on a Lands Unsuitable for Mining petition developed by the state of Tennessee to protect an additional 75,000 acres of prime cerulean breeding habitat from surface coal mining.

4. Associated Knowledge Areas

KA Code	Knowledge Area
112	Watershed Protection and Management
123	Management and Sustainability of Forest Resources
135	Aquatic and Terrestrial Wildlife
608	Community Resource Planning and Development

Outcome #16

1. Outcome Measures

Successful Reforestation for Mine Reclamation (Franklin)

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Thousands of acres of mined land reclaimed in the 1970's through 2010 have failed to develop into functional forests, demonstrating that the capacity of the land to produce timber products and other services had been greatly reduced. Early efforts to plant trees on these lands were unsuccessful due to competitive pasture grasses.

What has been done
We studied how these factors influence the establishment and growth of trees native to Tennessee. We treated and reforested 30 acres of this land, and tested herbicide and seeding treatments.

Results
We showed that the selection of herbaceous species is important for the early success of reforestation, in part by influencing deer damage to trees. Because we were able to demonstrate successful reforestation of reclaimed mine sites and transfer this technology to industry, all new coal mining permits in TN have designated forestry as the end land use.

4. Associated Knowledge Areas

KA Code	Knowledge Area

112	Watershed Protection and Management
123	Management and Sustainability of Forest Resources
125	Agroforestry
133	Pollution Prevention and Mitigation
605	Natural Resource and Environmental Economics
608	Community Resource Planning and Development

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

Brief Explanation

V(I). Planned Program (Evaluation Studies)

Evaluation Results

For forestry and intercropping research,the planned evaluation includes:
Ex ante which includes internal research proposal screening at proposal stage. The basic dimensions of evaluation of a development research project ex ante are :Relevance for state of Tennessee, in accordance with the local political strategies; Scientific quality; Valorization; Performance; Expected impact on development; Innovation, originality; Cost effectiveness; Feasibility and Expected sustainability.
Ex post: The basic dimensions of evaluation of a development research project ex post are : Relevance for development; Scientific quality; Valorization; Performance and Impact on development.
Our **Forestry, Wildlife and Fisheries** planned program was modified over the past two years to focus on the an integrated research and Extension shortleaf pine initiative. Even though shortleaf pine is a native to Tennessee, the species has been discriminated against by industry in favor of loblolly pine, resulting in a generation of landowners and natural resource professionals who know very little about shortleaf pine, much less mixed pine-hardwood stands that historically occurred. UT installed a 60-acre research/demonstration project at each of two UT AgResearch Stations: Cumberland Forest in Morgan County and Highland Rim Forest in Franklin County. More than 100 Tennesseans learned about the establishment of mixed hardwood-pine stands and management of shortleaf pine in existing stands. More shortleaf pine seedlings have been sold and planted in the last 2 years than in the last 10 years combined as reported by the Tennessee Department of Agriculture Division of Forestry Nursery near Delano, TN. More interest in planting shortleaf pine has also been exhibited in the number of landowners using federal cost share funding

according to the NRCS.

Key Items of Evaluation

Our **Forestry, Wildlife and Fisheries** planned program was modified over the past two years to focus on the an integrated research and Extension shortleaf pine initiative. Even though shortleaf pine is a native to Tennessee, the species has been discriminated against by industry in favor of loblolly pine, resulting in a generation of landowners and natural resource professionals who know very little about shortleaf pine, much less mixed pine-hardwood stands that historically occurred. UT installed a 60-acre research/demonstration project at each of two UT AgResearch Stations: Cumberland Forest in Morgan County and Highland Rim Forest in Franklin County. More than 100 Tennesseans learned about the establishment of mixed hardwood-pine stands and management of shortleaf pine in existing stands. More shortleaf pine seedlings have been sold and planted in the last 2 years than in the last 10 years combined as reported by the Tennessee Department of Agriculture Division of Forestry Nursery near Delano, TN. More interest in planting shortleaf pine has also been exhibited in the number of landowners using federal cost share funding according to the NRCS.

V(A). Planned Program (Summary)

Program # 10

1. Name of the Planned Program

Health and Safety

☑ 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
402	Engineering Systems and Equipment	5%	5%	0%	0%
511	New and Improved Non-Food Products and Processes	5%	5%	0%	0%
724	Healthy Lifestyle	70%	70%	0%	0%
805	Community Institutions, Health, and Social Services	20%	20%	0%	0%
	Total	100%	100%	0%	0%

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2016	Extension		Research	
	1862	1890	1862	1890
Plan	20.0	1.0	0.0	0.0
Actual Paid	18.0	2.0	0.0	0.0
Actual Volunteer	4.0	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**
358397	82632	0	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
1596233	95833	0	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
150000	0	0	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

Dining with Diabetes was a three-session course which was offered throughout the state. This course was taught by Extension Family and Consumer Sciences Agents who coordinated with local health officials to target people with diabetes and/or their caregivers.

Arthritis Self-Help was a program delivered in six sessions. Each session was two-hours in length. Participants were provided with the book, The Arthritis Helpbook, written by Kate Lorig and James Fries. This evidence-based program was designed to increase the self-confidence of participants to manage their arthritis. It was delivered by Extension, in partnership with the Tennessee Chapter of the Arthritis Foundation, the Tennessee Department of Health's Arthritis Control Program, and the University of Tennessee Medical Center's Department of Family Medicine. Specific efficacy-enhancing strategies used in this program included:

- Contracting: Weekly contracting helped participants master something new.
- Feedback: Opportunity was provided to report and record progress and explore different behaviors.
- Modeling: People learn more and try harder when they are motivated by people whom they perceive to be like themselves. Program participants and the trainer serve as models. The course had an emphasis on modeling.
- Reinterpreting Symptoms and Changing Beliefs: People are pretty rational. They acted based on beliefs. If people believed arthritis is a wear and tear disease, then they may not have thought to exercise. If they thaught that nothing could be done for their arthritis, they were probably right. Throughout this program, there was a great emphasis on changing such beliefs.
- Persuasion: By seeing others in the class contract and succeed, even the most reluctant participant often chose to take part. It is usually hard not to go along with others. The facilitator urged participants to do a little more than they were doing now, such as walking four blocks instead of two.

Living Well with Chronic Conditions targeted citizens living with chronic health issues such as asthma, arthritis, and heart disease. Extension helped those individuals to manage their pain and engage in daily activities.

2. Brief description of the target audience

The target audience is inclusive of consumers and limited resource individuals and families. The Dining with Diabetes program targets individuals with this chronic disease and the caregivers, health professionals and volunteers who serve them.

3. How was eXtension used?

- Tennessee Extension personnel annually address hundreds of Frequently Asked Questions through eXtension, including health and safety questions.
- In 2016, Tennessee Extension professionals served on the Home Energy Community of Practice.
- In 2016, Tennessee Extension professionals served on the Creating Healthy Communities Community of Practice.

V(E). Planned Program (Outputs)

1. Standard output measures

2016	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	72680	40251200	8977	0

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

Patent Applications Submitted

Year:	2016
Actual:	0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2016	Extension	Research	Total
Actual	8	0	0

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number of exhibits built and displayed to promote program awareness and participation.

Year	Actual
2016	171

Output #2

Output Measure

- Number of research-based publications distributed as part of this program.

Year	Actual
2016	474

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Arthritis Self-Help Course: Number of participants surveyed who have less pain from their arthritis.
2	Arthritis Self-Help Course: Number of participants surveyed who take fewer medications for their arthritis pain.
3	Dining with Diabetes: Number of participants surveyed who reduced weight.
4	Dining with Diabetes: Number of participants surveyed who eat at least five servings of fruits and vegetables each day.
5	Dining with Diabetes: Number of participants surveyed who use spices and other seasonings to cut back on fat, sugar, and salt.
6	Living Well with Chronic Conditions: Number of participants controlling their anger and frustration caused by their condition by using positive thinking techniques six months after completing the program.
7	Living Well with Chronic Conditions: Number of participants making healthy food decisions six months after completing the program.
8	Living with Chronic Conditions: Number of participants who have had fewer doctor visits and/or emergency room visits six months after completing the program.
9	Clean and Healthy Homes
10	Tennessee's Household and Structural Integrated Pest Management (IPM) Program

Outcome #1

1. Outcome Measures

Arthritis Self-Help Course: Number of participants surveyed who have less pain from their arthritis.

2. Associated Institution Types

- 1862 Extension
- 1890 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	999

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

What has been done

Results

4. Associated Knowledge Areas

KA Code	Knowledge Area
724	Healthy Lifestyle
805	Community Institutions, Health, and Social Services

Outcome #2

1. Outcome Measures

Arthritis Self-Help Course: Number of participants surveyed who take fewer medications for their arthritis pain.

2. Associated Institution Types

- 1862 Extension
- 1890 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	132

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

What has been done

Results

4. Associated Knowledge Areas

KA Code	Knowledge Area
724	Healthy Lifestyle
805	Community Institutions, Health, and Social Services

Outcome #3

1. Outcome Measures

Dining with Diabetes: Number of participants surveyed who reduced weight.

2. Associated Institution Types

- 1862 Extension
- 1890 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	103

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

What has been done

Results

4. Associated Knowledge Areas

KA Code	Knowledge Area
724	Healthy Lifestyle
805	Community Institutions, Health, and Social Services

Outcome #4

1. Outcome Measures

Dining with Diabetes: Number of participants surveyed who eat at least five servings of fruits and vegetables each day.

2. Associated Institution Types

- 1862 Extension
- 1890 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	954

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

What has been done

Results

4. Associated Knowledge Areas

KA Code	Knowledge Area
724	Healthy Lifestyle
805	Community Institutions, Health, and Social Services

Outcome #5

1. Outcome Measures

Dining with Diabetes: Number of participants surveyed who use spices and other seasonings to cut back on fat, sugar, and salt.

2. Associated Institution Types

- 1862 Extension
- 1890 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	1758

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

What has been done

Results

4. Associated Knowledge Areas

KA Code	Knowledge Area
724	Healthy Lifestyle
805	Community Institutions, Health, and Social Services

Outcome #6

1. Outcome Measures

Living Well with Chronic Conditions: Number of participants controlling their anger and frustration caused by their condition by using positive thinking techniques six months after completing the program.

2. Associated Institution Types

- 1862 Extension
- 1890 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	466

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

What has been done

Results

4. Associated Knowledge Areas

KA Code	Knowledge Area
724	Healthy Lifestyle
805	Community Institutions, Health, and Social Services

Outcome #7

1. Outcome Measures

Living Well with Chronic Conditions: Number of participants making healthy food decisions six months after completing the program.

2. Associated Institution Types

- 1862 Extension
- 1890 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	106

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

What has been done

Results

4. Associated Knowledge Areas

KA Code	Knowledge Area
724	Healthy Lifestyle

Outcome #8

1. Outcome Measures

Living with Chronic Conditions: Number of participants who have had fewer doctor visits and/or emergency room visits six months after completing the program.

2. Associated Institution Types

- 1862 Extension
- 1890 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	107

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

What has been done

Results

4. Associated Knowledge Areas

KA Code	Knowledge Area
724	Healthy Lifestyle

Outcome #9

1. Outcome Measures

Clean and Healthy Homes

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Research clearly documents the ways in which our home environment impacts our health. Areas of primary concern are lead poisoning, asthma and unintentional injuries. While these issues are detrimental to all residents in the home, infants, young children, the elderly, those with chronic medical conditions, and those with limited resources are disproportionately affected.

What has been done
Our Health and Safety planned program was strengthened by formalizing our UT Extension Healthy Homes Partnership. Representatives on this advisory group come from 21 organizations including the City of Memphis City Code Enforcement, Tennessee Commission on Children and Youth, and Tennessee Housing Development Agency. This partnership has expanded Extension programming to improve indoor air quality and to reduce indoor health hazards. In 2016, the Extension Clean and Healthy Homes programs were provided in 38 counties, up from 27 in 2015.

Results
The following outcomes were achieved:
-163 participants surveyed increased their knowledge on how regular cleaning can help reduce environmental health hazards.
-167 participants surveyed increased their knowledge on safer house cleaning techniques.
-187 participants surveyed increased their knowledge on the importance of moisture control in their home.
-1995 participants surveyed increased their knowledge of the health effects of environmental tobacco smoke on children.
-1894 participants surveyed increased their knowledge on how to minimize their child?s exposure to environmental tobacco smoke.

4. Associated Knowledge Areas

KA Code	Knowledge Area
724	Healthy Lifestyle
805	Community Institutions, Health, and Social Services

Outcome #10

1. Outcome Measures

Tennessee's Household and Structural Integrated Pest Management (IPM) Program

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
UT Extension?s Urban Integrated Pest Management program has developed successful management strategies for pests found in and around structures. This success has brought our program national recognition. Bed bugs are now considered the most difficult pest to manage inside United States homes.

What has been done
In 2016, nine bed bug presentations were given to more than 365 housing managers, residents, public health professionals, entomologists, graduate students, and pest management professionals to share our research results, to help assuage concerns about bed bugs, and to inform them of their pest management role. Research on bed bug monitoring device type and number has been conducted in low-income, multi-family housing and an IPM program implemented. Cooperators from three other universities (Rutgers, Virginia Tech and Cornell) joined with UT research and Extension experts to conduct a bed bug meeting for 116 housing managers and service providers organized by UT and held in Knoxville, Tennessee.

Results
Evaluation results indicate that 98% of participants are now using recommended protocols to protect themselves from bed bugs when visiting clients and 68% plan to use bed bug monitors because of the Extension program.

4. Associated Knowledge Areas

KA Code	Knowledge Area
805	Community Institutions, Health, and Social Services

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Competing Public priorities
- Competing Programmatic Challenges

Brief Explanation

V(I). Planned Program (Evaluation Studies)

Evaluation Results

Evaluation of Poison Prevention programs in 12 counties demonstrated the following:

- 1291 participants will contact the Tennessee Poison Center if they suspect a poisoning or have a question about a product.
- 587 participants will keep medications out of the reach of children.
- 531 participants will keep products in their original containers.
- 847 participants will post the Tennessee Poison Center toll free number by a phone and in their cell phone address book.
- 590 participants will read the label before using a product.

Key Items of Evaluation

Evaluation of Poison Prevention programs in 12 counties demonstrated the following:

- 1291 participants will contact the Tennessee Poison Center if they suspect a poisoning or have a question about a product.
- 587 participants will keep medications out of the reach of children.
- 531 participants will keep products in their original containers.
- 847 participants will post the Tennessee Poison Center toll free number by a phone and in their cell phone address book.
- 590 participants will read the label before using a product.

V(A). Planned Program (Summary)

Program # 11

1. Name of the Planned Program

Horticultural 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
102	Soil, Plant, Water, Nutrient Relationships	0%	0%	6%	0%
201	Plant Genome, Genetics, and Genetic Mechanisms	0%	0%	13%	0%
205	Plant Management Systems	60%	60%	11%	0%
211	Insects, Mites, and Other Arthropods Affecting Plants	10%	10%	0%	30%
212	Pathogens and Nematodes Affecting Plants	10%	10%	39%	30%
213	Weeds Affecting Plants	10%	10%	0%	10%
215	Biological Control of Pests Affecting Plants	0%	0%	2%	10%
216	Integrated Pest Management Systems	10%	10%	5%	10%
601	Economics of Agricultural Production and Farm Management	0%	0%	0%	10%
702	Requirements and Function of Nutrients and Other Food Components	0%	0%	12%	0%
721	Insects and Other Pests Affecting Humans	0%	0%	12%	0%
	Total	100%	100%	100%	100%

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2016	Extension		Research	
	1862	1890	1862	1890
Plan	36.0	5.0	25.0	11.0
Actual Paid	29.0	8.0	25.1	13.0
Actual Volunteer	7.0	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**
582395	198497	1018161	629534
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
2593879	230209	1521115	629534
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
100000	21688	1449194	347904

V(D). Planned Program (Activity)

1. Brief description of the Activity

UT AgResearch variety evaluation of several different vegetable crops will be conducted to determine suitability to climate, soils and cultural practices for state producers. Yields, quality and market potential will be evaluated to assess potential production by growers seeking additional crops or alternative crops. Crops suitable for greenhouse production in farmers tobacco transplant greenhouses will be evaluated for profitability and product quality with respect to local and state markets.

UT AgResearch efforts determine the effectiveness of various control technologies, develop new genetic cultivars of plants from in-house breeding programs or, in some cases, find naturally resistant populations of plants by searching the southeast U.S. (i.e. for anthracnose resistant dogwoods). Research is conducted at selected Research and Education Centers across Tennessee, and at several farmer-cooperator locations in key areas of horticultural production in Tennessee. Substantial investments have just been made in construction and renovation of greenhouse facilities on campus and at certain Research and Education Centers. These will be utilized extensively in the conduct of our research.

Research conducted by TSU will a) identify new pesticide, biopesticide, and treatment methodologies for container and field-grown nursery stock to manage disease and insect problems.
Determine the lowest effective rates for synthetic petroleum-based pesticides and develop new reduced rate insecticide / biopesticide combinations; b) Identify new biopesticides that can substitute for synthetic petroleum-based pesticides and reduce worker exposure risk and environmental impact; c) release phorid-decapitating flies in Tennessee to provide imported fire ant biological control; d) provide extension training and literature to producers on imported fire ant and Japanese beetle management and train students in pest management and research techniques; e) provide data to support new treatments in the Domestic Japanese Beetle Harmonization Plan and the Federal Imported Fire Ant Quarantine, as well as data to support new insecticide label amendments; and f) assess labor use and optimization on small farms.

2. Brief description of the target audience

- Farmers/producers who have traditional livestock and tobacco operations, but are looking to improve income through the Green Industry.
- Master Gardeners who volunteer to provide community service through horticulture.
- Business owners who need research-based information to start, maintain or expand their greenhouse, landscaping, or nursery business.

- Regulatory agencies (e.g., U.S. Environmental Protection Agency, USDA-APHIS, Tennessee

Department of Agriculture).

- Agrochemical manufacturers

3. How was eXtension used?

Information on control of Imported Fire Ant was disseminated via webinars and and other postings on eXtension.

V(E). Planned Program (Outputs)

1. Standard output measures

2016	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	225690	12297660	17488	5600

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

Patent Applications Submitted

Year: 2016

Actual: 0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2016	Extension	Research	Total
Actual	29	51	0

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Horticultural workshops and conferences.

Year	Actual
2016	0

Output #2

Output Measure

- Number of exhibits displayed to teach best practices in horticultural systems.

Year	Actual
2016	206

Output #3

Output Measure

- Number of research-based publications distributed as part of this program.

Year	Actual
2016	21677

Output #4

Output Measure

- Factsheets about alternative methods to control disease and insects in nursery production.

Year	Actual
2016	4

Output #5

Output Measure

- Develop drought- and temperature-tolerant grapes (Cheng)
  Not reporting on this Output for this Annual Report

Output #6

Output Measure

- Employ nematodes for biological pest control (An)

Year	Actual
2016	0

Output #7

Output Measure

- Genetic Influences on Nutritionally Important Bioactive Components (Kopsell)

Year	Actual
2016	1

Output #8

Output Measure

- GPR Modifications to Image Fibrous Citrus Roots (Freeland)

Year	Actual
2016	1

Output #9

Output Measure

- Willingness to Pay for Tennessee Muscadine Wine (Jensen)

Year	Actual
2016	1

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Consumer Horticulture: Number of consumers who applied fewer fertilizers and pesticides due to a better understanding of landscape best management practices.
2	Consumer Horticulture: Number of consumers who learned about plant selection and proper planting to save money and time in the landscape.
3	New trap designs and strategies for Ambrosia beetle available to growers. (Addesso)
4	Assessing and reintroducing Pityopsis ruthii (Trigiano, Wadl)
5	Gentic diversity in dogwood cultivars (Windham, Windham, Trigiano, Wadl)
6	Downy mildew control (Lamour, Trigiano)
7	Greenhouse production (Deyton, Sams)
8	Molecular Markers for Horticultural Traits (Trigiano, Ownley, Wadl)
9	Using genetics against Phytophthora blight (Lamour)
10	Oliver Improved understanding of pest management treatment options and reduced-risk pest control options by end-user nursery growers. (Oliver)
11	Development of new treatment options, reduced costs, lower environmental pesticide inputs, or reduced risk from lower rates or new chemistries with less acute toxicity. (Oliver)
12	Research to develop changes to quarantine guidelines for Japanese beetle and imported fire ant. (Oliver)
13	Determine the current labor use by small Tennessee farmers and the degree of off-farm employment by small farmer. (Tegegne)
14	Development of Best Management Practices for labor use by small farmers in Tennessee. (Tegegne)
15	Enhancing sustainable plant health through identification and characterization of microbes with bioactivity against diverse fungal diseases, insects and environmental stress for use as microbial pesticides for pathogens, and in improving plant growth. (Mmbaga)
16	Identification of new nursery crop production practices to reduce the use of synthetic pesticides. (Witcher)
17	Enhance nursery production efficiency through readily-adopted chemical, biorational and cultural techniques to reduce soil-borne disease. (Baysal-Gurel)

18	Residential and Consumer Horticulture Extension
19	Producing Hydrangeas Profitably
20	Tennessee Master Nursery Producer Program
21	A Regional Food Hub to Aggregate Local Food? (Velandia)
22	Battling Rose Rosette Virus (Windham)
23	Bringing Back a Native Endangered Sunflower (Trigiano)
24	Resistant Flower Cultivars (Trigiano, Windham)
25	Using Plant Extracts to Protect from Cold Temperatures and UV Light (Kopsell)
26	Wine industry forecast in Tennessee (Hughes)

Outcome #1

1. Outcome Measures

Consumer Horticulture: Number of consumers who applied fewer fertilizers and pesticides due to a better understanding of landscape best management practices.

2. Associated Institution Types

- 1862 Extension
- 1890 Extension

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	999

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

What has been done

Results

4. Associated Knowledge Areas

KA Code	Knowledge Area
205	Plant Management Systems
211	Insects, Mites, and Other Arthropods Affecting Plants
212	Pathogens and Nematodes Affecting Plants
213	Weeds Affecting Plants
216	Integrated Pest Management Systems

Outcome #2

1. Outcome Measures

Consumer Horticulture: Number of consumers who learned about plant selection and proper planting to save money and time in the landscape.

2. Associated Institution Types

- 1862 Extension
- 1890 Extension

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	4645

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

What has been done

Results

4. Associated Knowledge Areas

KA Code	Knowledge Area
205	Plant Management Systems

211	Insects, Mites, and Other Arthropods Affecting Plants
212	Pathogens and Nematodes Affecting Plants
213	Weeds Affecting Plants
216	Integrated Pest Management Systems

Outcome #3

1. Outcome Measures

New trap designs and strategies for Ambrosia beetle available to growers. (Addesso)

2. Associated Institution Types

- 1890 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	2

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Ambrosia beetles are serious pests of trees and shrubs in nursery production. The beetles tunnel into the bark and excavate galleries which can girdle the tree and kill it. The beetles feed on symbiotic fungus they inoculate into the bark tissue which can cause diseases in some plants.

What has been done
An ethanol blocker product that was piloted last year as a trunk application was further tested with different adjuvants and in a push-pull management approach. A new method for detecting ethanol production in stressed trees was piloted and a field chamber developed and tested. A fungicide product was tested to prevent establishment of ambrosia beetle galleries in stressed trees.

Results
The ethanol blocker product for ambrosia beetle management was tested in multiple experiments. The limiting factor of the product is that it easily washes off of trunk surfaces with rain events. The 'sticker' adjuvants tested were not sufficient to prevent washing off of product. Future work with this product will depend on identifying a sticker agent that can hold the adsorbent onto the tree trunks for a longer period of time. Studies will continue in 2017 to test the ethanol detector system to see if it can be used by growers to monitor trees in field. The fungicide product successfully prevented beetle attacks on flood stressed trees when applied as a drench prior to flooding. Work in 2017 will continue testing the fungicide as a preventative as well as test whether the product will work as a rescue treatment for previously stressed trees.

4. Associated Knowledge Areas

KA Code	Knowledge Area
211	Insects, Mites, and Other Arthropods Affecting Plants

Outcome #4

1. Outcome Measures

Assessing and reintroducing Pityopsis ruthii (Trigiano, Wadl)

Not Reporting on this Outcome Measure

Outcome #5

1. Outcome Measures

Gentic diversity in dogwood cultivars (Windham, Windham, Trigiano, Wadl)

Not Reporting on this Outcome Measure

Outcome #6

1. Outcome Measures

Downy mildew control (Lamour, Trigiano)

Not Reporting on this Outcome Measure

Outcome #7

1. Outcome Measures

Greenhouse production (Deyton, Sams)

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual

2016 1

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

What has been done

Results

4. Associated Knowledge Areas

KA Code	Knowledge Area
205	Plant Management Systems
211	Insects, Mites, and Other Arthropods Affecting Plants
212	Pathogens and Nematodes Affecting Plants
215	Biological Control of Pests Affecting Plants
216	Integrated Pest Management Systems

Outcome #8

1. Outcome Measures

Molecular Markers for Horticultural Traits (Trigiano, Ownley, Wadl)

Not Reporting on this Outcome Measure

Outcome #9

1. Outcome Measures

Using genetics against Phytophthora blight (Lamour)

Not Reporting on this Outcome Measure

Outcome #10

1. Outcome Measures

Oliver Improved understanding of pest management treatment options and reduced-risk pest control options by end-user nursery growers. (Oliver)

2. Associated Institution Types

- 1890 Extension
- 1890 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	2

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Ornamental nurseries grow a more diverse mixture of plant genera and species than typical of other monoculture farming systems like traditional row crops. Consequently, many nursery producers must deal with multiple pest and disease issues at any given time. In addition, a large number of non-indigenous species have been introduced into the U.S. and the invasive nature of many of these species and the costly quarantine programs often associated with them pose a constant challenge to nursery operations. With the complexity of pest issues in nursery agroecosystems, it is important to provide producers and stakeholders with current research information to maximize their knowledge on successful, sustainable, and profitable control tactics via workshops and field days, educational materials like factsheets, and other outlets like webinars and one-on-one training.

What has been done
Research has been performed on improved management of multiple key nursery pests like imported fire ant, Japanese beetle, granulate ambrosia beetle, camphor shot borer, blackstem borer, and flatheaded borers. Producers and other agricultural stakeholders received training and educational knowledge on pest management research via workshops and field days, new factsheets, and one-on-one communications in-person or via email.

Results
Workshops provided producers and stakeholders with research results on management of nursery-related pests, and all workshops had evaluations to gauge educational benefit of trainings and to identify areas of needed improvement. Total number of nursery growers and agricultural stakeholders educated at workshop and field day trainings during this reporting period was about 324 (direct) and 539 (indirect). In addition, the project had about 102 (direct) and (70,126) indirect producer and stakeholder contacts outside of workshops. Producers have reported savings of several thousand dollars in knowledge gained and changed practices.

4. Associated Knowledge Areas

KA Code	Knowledge Area
211	Insects, Mites, and Other Arthropods Affecting Plants
216	Integrated Pest Management Systems

Outcome #11

1. Outcome Measures

Development of new treatment options, reduced costs, lower environmental pesticide inputs, or reduced risk from lower rates or new chemistries with less acute toxicity. (Oliver)

2. Associated Institution Types

- 1890 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	2

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Numerous insect pests in nurseries require frequent insecticide treatments to reduce levels of plant damage or to meet mandatory quarantine requirements. Examples include trunk damaging borers like ambrosia beetle and flatheaded borers, which can destroy the marketability of a tree, and cryptic quarantine pests that are easily transported in nursery plant soils like Japanese beetle larvae and imported fire ants.
The development of new product alternatives, especially reduced-risk treatments, and better treatment methodologies, is important for protecting agricultural workers, the environment, and ensuring treatments remain viable and available to agricultural producers.

What has been done
Multiple trials have been performed evaluating new options and insecticide products for important nursery pests.

Results
For research previously described, we have determined that:
Injection solution moves minimally in B&B soil after the initial injection and probe number and placement are important in maximizing internal root ball area that is effectively treated.
An imidacloprid rate that is half the current labeled rate will effectively manage flatheaded borers for about three years and herbicide-treated plots have higher borer attack rates (probably from less tree trunk camouflage).
Imidacloprid longevity against JB larvae will not be completed until fall 2017, but past tests have shown that a full rate applied in the first summer and followed by a quarter rate in the second summer can potentially manage JB, thus avoiding the currently required full rate application in the second summer.
Compost levels are directly related to JB infestation of containers, but that current quarantine

treatments still worked against JB and IFA even at the highest compost levels. Wasp lures evaluated caught a very diverse mixture of Polistes species. Biofungicide studies have shown some promise for repelling ambrosia beetles from nursery trees.

4. Associated Knowledge Areas

KA Code	Knowledge Area
211	Insects, Mites, and Other Arthropods Affecting Plants
216	Integrated Pest Management Systems

Outcome #12

1. Outcome Measures

Research to develop changes to quarantine guidelines for Japanese beetle and imported fire ant. (Oliver)

2. Associated Institution Types

- 1890 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	1

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Imported fire ants (IFA) and Japanese beetle (JB) populations continue to spread into new areas in the United States. Both of these pests require expensive nursery certification protocols involving insecticide treatments to ensure insects are not shipped to new areas. Management of these pests has been particularly challenging in Tennessee because our nursery industry has the most field-grown acres in the nation. Most of the current IFA and JB quarantine protocols for field-grown nurseries are expensive, rely extensively on one of only three active ingredients, and have potential worker exposure issues from repeated site reentries or post-treated plant handling. More options are needed with lower cost, reduced-risk to farm labor, and greater efficacy to ensure these pests are not shipped to new areas.

What has been done
Data from IFA and JB research continues to be shared with agencies involved in decisions regarding quarantine programs and modifications to existing protocols. Example agencies include the USDA-APHIS-PPQ, National Plant Board, and Tennessee Department of Agriculture. In addition, cooperative research with USDA-APHIS Soil Inhabiting Pests Section (Biloxi, MS)

(SIPS), USDA-ARS Center for Medical, Agricultural, and Veterinary Entomology (Gainesville, FL) (CMAVE), and USDA-ARS Horticultural Insects Research Laboratory (Wooster, OH) has leveraged the impact value of some of our research on these two pests. The PI of this project also is a member of the National Plant Board JB Harmonization Plan (JBHP) Regulatory Treatments Review Committee and also recently served on the JBHP Revision Committee. We currently have a cooperative project with SIPS and CMAVE to determine if non-traditional container substrates like whole pine tree or high compost still have acceptable efficacy with current IFA and JB quarantine treatments.

Results

No current changes have occurred to JB or IFA quarantine guidelines from our research. However, our cooperative testing with SIPS and CMAVE has determined that alternative container substrates do not appear to inhibit JB or IFA quarantine treatment efficacy. We also have determined that high compost container substrates do increase the risk of JB infestations. Testing also has determined that anthranilic diamides like cyantraniliprole and chlorantraniliprole were quite effective on JB and with additional support data may be potential substitutes for imidacloprid and other neonicotinoid insecticides. Finally, previous testing (now being repeated) with approved JBHP dip treatments during fall, winter, and spring indicates treatments may work in colder periods of the year, thus allowing growers to meet certifications when soil temperatures are below 50F. Based on our past success with getting multiple modifications to JB and IFA quarantine regulations, we anticipate research results listed above also will lead to new regulation modifications.

4. Associated Knowledge Areas

KA Code	Knowledge Area
211	Insects, Mites, and Other Arthropods Affecting Plants
216	Integrated Pest Management Systems

Outcome #13

1. Outcome Measures

Determine the current labor use by small Tennessee farmers and the degree of off-farm employment by small farmer. (Tegegne)

2. Associated Institution Types

- 1890 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	1

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Labor is an important input in agriculture in general, and in small farms in particular. The issue becomes critical in light of the growing ageing population of farmers.

What has been done
A survey instrument was developed, pre-tested, and administered to 200 randomly selected farmers in middle and west Tennessee. Seventy four completed surveys (representing a 34% response rate) were received. SPSS-PC was used to analyze the data. The findings could be useful to stakeholders including Extension educators and policy makers.

Results
It was found that small farmers use both hired and family labor. The operators are engaged in on-farm labor approximately 24 hours per week. Off-farm labor supply is influenced both by the level of farm income at a given time and attractiveness of non-farm wage level. Off-farm employment was found to contribute to farm household income.

4. Associated Knowledge Areas

KA Code	Knowledge Area
601	Economics of Agricultural Production and Farm Management

Outcome #14

1. Outcome Measures

Development of Best Management Practices for labor use by small farmers in Tennessee. (Tegegne)

2. Associated Institution Types

- 1890 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	1

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
It is important to realize that agricultural activities are seasonal and labor supply is influenced by this seasonality. Thus it is necessary to focus on efficient use of labor during the peak season.

What has been done

Different sources of labor supply were identified. Family labor provides more labor supply compared to hired labor (85% to 60%, respectively).

Results
It was found that the vast majority of those working off-farm reside in metro and metro-adjacent counties. This shows the competition that exists between off farm jobs such as construction or service-based and on-farm employment. Best management strategies seek to adopt farm management practices such as this with appropriate modification(s). Income enhancement is a key result.

4. Associated Knowledge Areas

KA Code	Knowledge Area
601	Economics of Agricultural Production and Farm Management

Outcome #15

1. Outcome Measures

Enhancing sustainable plant health through identification and characterization of microbes with bioactivity against diverse fungal diseases, insects and environmental stress for use as microbial pesticides for pathogens, and in improving plant growth. (Mmbaga)

2. Associated Institution Types

- 1890 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	6

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Diseases caused by fungi have detrimental effects on agricultural productivity and reduce crops yields. The use of chemical pesticides to control such diseases is a common practice, but there is increasing concern over toxicity hazards from accidental exposures to the users and environmental contamination. It is therefore important to develop alternative products that are effective and safer to the users and the environment. Microbial pesticides are deemed safer and more precise and may provide alternative products to chemical pesticides.

What has been done
Microbes that grow inside plants without causing harm their host plant are thought to have beneficial effects in helping the host plants fight against pathogens. Isolation of the microorganisms and evaluation of their effect on diverse fungal pathogens have been completed.

Identification of the microbial isolates has not been initiated but is not complete. Evaluations of the microbial isolates for biological activity in suppressing fungal pathogens were performed in the lab and some have been confirmed in greenhouse and field environments, this action is continuous and is being repeated.

Results

Out of 197 microorganisms isolated from healthy plants, six organisms suppressed growth of fungal pathogens in the lab. Out of 197 microbes isolated, several isolates are known to be pathogens but they did not express their pathogenicity on plants from which they were isolated. Evaluation of their pathogenicity is continuous and evaluation of isolates known to be pathogens have not been completed; a question remains whether non-pathogenic isolates impacted (suppressed) the pathogenic ones from expressing their pathogenicity. The role of the non-pathogenic microbes in suppressing disease development from the pathogenic fungi is being evaluated.

4. Associated Knowledge Areas

KA Code	Knowledge Area
212	Pathogens and Nematodes Affecting Plants
216	Integrated Pest Management Systems

Outcome #16

1. Outcome Measures

Identification of new nursery crop production practices to reduce the use of synthetic pesticides. (Witcher)

2. Associated Institution Types

- 1890 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Nursery producers of container-grown crops are increasingly utilizing alternative organic components (such as compost and wood-based materials) for container substrates, yet the effectiveness of insecticides has not been evaluated in these alternative substrates. Adequate insect control is critical especially for nursery stock shipped from areas labeled as quarantined or restricted for insects such as imported fire ants and Japanese beetles.

What has been done
In two studies, bifenthrin insecticide was applied (multiple rates) to wood-based substrates and compost-amended substrates to evaluate efficacy on imported fire ants compared with a standard pine bark substrate (control). Each study will be carried out for 18 months to determine maximum longevity. In a third study, bifenthrin and imidacloprid insecticides were applied to compost-amended substrates to evaluate efficacy on Japanese beetle grubs.

Results
Bifenthrin provided control of imported fire ant in wood-based (through 12 months) and compost-amended substrates (through 3 months), equally or more effective compared with the control substrate. Data for the Japanese beetle study will be collected in March 2017.

4. Associated Knowledge Areas

KA Code	Knowledge Area
211	Insects, Mites, and Other Arthropods Affecting Plants
213	Weeds Affecting Plants

Outcome #17

1. Outcome Measures

Enhance nursery production efficiency through readily-adopted chemical, biorational and cultural techniques to reduce soil-borne disease. (Baysal-Gurel)

2. Associated Institution Types

- 1890 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	2

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Soil-borne diseases can be a major limitation to field grown nursery production of woody ornamentals, particularly for propagation-field ground bed systems. In addition, based on nursery inspections and disease samples received at the Tennessee State University Nursery Research Center, soil-borne pathogens were documented as most economically important pathogens. Soil-borne diseases are often difficult to control, and cannot be managed solely through the use of crop rotations, improved disease resistant varieties and chemical control. Therefore, providing improved, efficacious, cost-effective, sustainable and environmentally friendly recommendations for soil-borne disease management to the nursery industry is very important.

What has been done
Chemical and biorational products were evaluated for ability to control Phytophthora root rot in hydrangea and Rhizoctonia solani in Viburnum. Biofumigation cover crops in the Brassicaceae family were evaluated for susceptibility to Rhizoctonia solani and Phytophthora nicotiane.

Results
Results indicated that biopesticides, RootShield WP and RootShield Plus, should be considered to reduce the risk of Phytophthora root rot on container-grown plants in the nursery. Other studies showed that the treatments most effective in reducing Phytophthora root rot severity on field grown plants were Segovis, Empress Intrinsic, Subdue Maxx and MBI110 and the treatments most effective in reducing Rhizoctonia root rot on field grown viburnum were Mural, Empress Intrinsic, Pageant Intrinsic and TerraClean 5.0 + TerraGrow. Among the 15 cover crops, Oilseed Radish, Mustard, Amara Mustard Green Seed, Oriental Mustard and Dwarf Essex Rape showed the highest seed germination rates in both of Rhizoctonia solani and Phytophthora nicotiane trials. Future research will be conducted using selected cover crops with higher germination rates to evaluate its ability in controlling soil borne diseases in woody ornamental nurseries.

4. Associated Knowledge Areas

KA Code	Knowledge Area
212	Pathogens and Nematodes Affecting Plants

Outcome #18

1. Outcome Measures

Residential and Consumer Horticulture Extension

2. Associated Institution Types

- 1862 Extension
- 1890 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
UT Extension's needs assessment activities demonstrated that educational needs for homeowners, consumers, and garden enthusiasts were effective and sustainable fertilizer and pesticide application in home landscapes; installation and management of home gardens; and

implementation of practices that conserve and protect the state?s valuable soil, water, and plant resources.

What has been done
UT and TSU Extension conducted numerous programs to reach the state's citizens with education in residential and consumer horticulture. In addition to Master Gardener meetings and events, activities included workshops, demonstrations, and on-site visits. Indirect methods used in this program were print, TV, radio, social media, and other methods.

Results
-3976 consumers learned how to properly take a soil test and interpret the results.
-3906 consumers learned how to apply landscape fertilizers and pesticides safely.
-3376 consumers learned how to conserve and protect water quality in the landscape.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
205	Plant Management Systems
216	Integrated Pest Management Systems

Outcome #19

1. Outcome Measures

Producing Hydrangeas Profitably

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Hydrangeas are a critical crop for nursery producers. They generate the second highest revenue of all deciduous flowering shrubs in the nation - over $91 million annually for 10 million plants produced.

What has been done

To help commercial growers in the Southeast U.S. produce this crop more efficiently and profitably, a multi-state collaboration was formed in 2016 between Extension in Tennessee, Virginia, and North Carolina. 106 growers attended the multistate workshop where they heard from national experts, participated in hands-on demonstrations, observed hydrangea crops grown under different production treatments, such as lime and fertilizer rates and pruning techniques, as well as signs and symptoms of plant diseases.

Results
Following the workshop the 106 growers estimated they will save a total of $636,954 ($6,009 average savings per person) from information gained and anticipated practice changes.

4. Associated Knowledge Areas

KA Code	Knowledge Area
205	Plant Management Systems

Outcome #20

1. Outcome Measures

Tennessee Master Nursery Producer Program

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Tennessee nursery producers did not have an opportunity to compete for higher levels of cost share through the Tennessee Ag Enhancement Program funding (a state cost-share program that directly benefits producers), nor was there an active professional development program for nursery producers. Both of these situations stifled the economic potential of nursery production.

What has been done
The UT Extension nursery specialist formed a committee that proposed to develop the Tennessee Master Nursery Producer program (and in 2016, the Advanced Tennessee Master Nursery Program) to the Tennessee Department of Agriculture as a qualifier for this funding.

Furthermore, this committee prepared two proposals for Specialty Crops Block grants to fund the programs and used the grant funding to develop the Tennessee Master Nursery Producer program.

Results

The Tennessee Master Nursery Program launched as an online course in 2014. By 2016, 36 graduates estimated saving on average $6,457 per person due to knowledge gained and practices changed and estimated increasing plant inventory value by an average of $5,551 as a result of participating in the online program for a total of $432,324 in direct benefits. In addition, graduates of the online program who enrolled in the Tennessee Agricultural Enhancement Program qualified for 50% rather than 35% in cost share, saving an additional $55,384. In 2016, the total economic value of the Tennessee Master Nursery Program was estimated at $487,672.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
205	Plant Management Systems
601	Economics of Agricultural Production and Farm Management

Outcome #21

1. Outcome Measures

A Regional Food Hub to Aggregate Local Food? (Velandia)

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

The market for local foods is constrained by lack of infrastructure and the difficulties faced by local food producers in penetrating conventional markets. Efforts to address these constraints recently focus on the development of food hubs. Food hubs address many of the difficulties confronting local food producers by: 1) facilitating producer access to retail or wholesale local food markets

that would otherwise be difficult to enter because of their inability to meet requirements of consistent volume and quality, as well as product liability coverage and food safety standards; 2) resolving transport and distribution problems; 3) providing brokering services between farmers and market; 4) increasing market share by bundling products or extending product life; 5) providing technical assistance to build production and/or marketing capacity among producers; and (6) ensuring fair prices to producers by using product differentiation strategies. Knoxville does not currently have a food hub aggregating local food.

What has been done

We collected information on potential supply and demand and potential barriers and opportunities for the development of a food hub in the region through interviews; focus groups; and surveys of (a) food hubs in other cities, (b) local producers, (c) local restaurants, (d) local chefs, institutions, and groceries, and (e) local organizations.

Results

Through a food hub feasibility study, workshops, and meetings with policy makers we provided information that helped East Tennessee policy makers make the decision of not initiating a full-service food hub in this region. This decision allowed them to re-allocate resources from private and public sources of at least $200,000 to be invested in other initiatives and projects that could better help the development and sustainability of local food systems in East Tennessee.

4. Associated Knowledge Areas

KA Code	Knowledge Area
601	Economics of Agricultural Production and Farm Management

Outcome #22

1. Outcome Measures

Battling Rose Rosette Virus (Windham)

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Rose rosette is a virus disease that has destroyed hundreds of thousands of roses in the mid-south in the last 10 years. Since there are not management plans for this disease, rose rosette often destroys whole gardens or planting of roses once it is found in a garden.

What has been done
Seven miticide treatments were evaluated for preventing development of symptoms of Rose Rosette.

Results
Four of the miticide treatments when used as preventatives, resulted in complete control of this disease.

4. Associated Knowledge Areas

KA Code	Knowledge Area
211	Insects, Mites, and Other Arthropods Affecting Plants
212	Pathogens and Nematodes Affecting Plants
601	Economics of Agricultural Production and Farm Management

Outcome #23

1. Outcome Measures

Bringing Back a Native Endangered Sunflower (Trigiano)

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Helianthus vericillatus is a native endangered sunflower species only indigenous to three locations in Tennessee, Georgia and Alabama. There are very few plants remaining in the population sites. These population are sufficiently distant from each other to preclude any exchange (hybridization) of genetic information. Breeding efforts between plants from two of the three populations apparently has been successful, although, genetic testing is required for confirmation of hybridization.

What has been done
We have developed two rudimentary tissue culture propagation systems for the species that will allow us (or commercial companies) to produce large number of copies of selected genotypes, including (probably) those hybrids from breeding experiments. The number of plants that can be produced far exceeds that of normal asexual reproduction by rhizomes and from limited observation, sexual reproduction.

Results
Tissue culture is the means to build populations and reestablish this plant species. Several diseases, which may have impacts on commercial production, have been identified and control measures are available.

4. Associated Knowledge Areas

KA Code	Knowledge Area
201	Plant Genome, Genetics, and Genetic Mechanisms
205	Plant Management Systems
212	Pathogens and Nematodes Affecting Plants
601	Economics of Agricultural Production and Farm Management

Outcome #24

1. Outcome Measures

Resistant Flower Cultivars (Trigiano, Windham)

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Hydrangea is one of the hottest crops in the ornamental market. Unfortunately end-user (homeowners and landscapers) enthusiasm for these products has waned due to foliar diseases that make the plants unattractive in summer months.

What has been done

Results
We have screened 88 hydrangea cultivars for disease resistance and have identified 8 cultivars that are highly resistant to foliar diseases.

4. Associated Knowledge Areas

KA Code	Knowledge Area
205	Plant Management Systems
211	Insects, Mites, and Other Arthropods Affecting Plants
212	Pathogens and Nematodes Affecting Plants

Outcome #25

1. Outcome Measures

Using Plant Extracts to Protect from Cold Temperatures and UV Light (Kopsell)

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The application of natural plant products for crop protection is increasing is the agri-chemical sector. Natural plant extracts can provide protection against abiotic and biotic stressors.

What has been done

Results
We have demonstrated positive crop protection impacts of natural plant extracts for protection against cold temperatures and UV-light for several specialty and agronomic crops. This work has resulted in a provisional patent application and a commercial licensing agreement.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships

205 Plant Management Systems

Outcome #26

1. Outcome Measures

Wine industry forecast in Tennessee (Hughes)

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Assessment based on industry growth trends, budgets, and demand indicates that the wine industry has a bright future. Data has been provided to UTIA leadership regarding study results. Results were presented at the Tennessee Farm Wine Growers Association Annual meeting, at the TAAA&S Eastern Region Meeting, and to the leadership of the Tennessee Farm Bureau.

What has been done

Results
As a result of these efforts, information provided in the report was used to support successful applications for three out of the four value-added producer grants awarded by the USDA in the state of Tennessee in 2016.

4. Associated Knowledge Areas

KA Code	Knowledge Area
601	Economics of Agricultural Production and Farm Management

V(H). Planned Program (External Factors)

External factors which affected outcomes

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

Brief Explanation

V(I). Planned Program (Evaluation Studies)

Evaluation Results

Evaluation studies utilize focus groups and post test survey to assess impacts. Both are qualitative measures and use representative sample of operators for assessment. Feedback received from farm operators at outreach conferences has been positive. Suggestions provided will be incorporated in future applied research. Visits to different farm operations will be used to assess project impact. Results will be documented and disseminated to stakeholders including policy makers and in developing a database maintained at the university. The program will also be closely involved in identification and recognition of small farmers that adopt best management practices. Research impact and program relevance were measured primarily by the number of instances when our program was solicited or utilized for research information by stakeholders. Evaluation surveys also were given during educational trainings to obtain research impact feedback from nursery and agricultural stakeholders, to guide future research efforts, and to measure educational knowledge gain.

Specific documentation of program impacts, evaluation studies, and realization of program successes include quarantine regulation changes that are providing continuous multi-year impacts to nursery growers.

UT and TSU Extension's evaluation of the Tennessee Extension Master Gardener Program showed high levels of volunteerism and results. UT and TSU Extension worked to recruit, train, and coordinate these volunteers for residential and consumer horticulture programs. In 2016, the state had 2,394 Master Gardener volunteers reporting service hours, with 671 of those reporting participating in initial training and receiving 40 hours of education in a broad range of horticultural topics. Together, these volunteers donated 172,466 hours of volunteer service to Tennessee last year that is valued at $3.6 million. Impact from these service hours follow. In 2016, Tennessee Extension Master Gardeners:

- Managed 124 landscape and ornamental gardens to demonstrate sustainable practices
- Managed 49 food gardens that contributed 58,080 pounds of produce to local citizens and communities
- Taught or conducted 598 educational presentations that delivered information to 22,329 residents
- Assisted 2218 people to control pests through integrated pest management
- Assisted 2287 people to identify symptoms of plant disease
- Assisted 2806 people to improve soil through soil test results
- Assisted 2366 people in turf selection or management

Key Items of Evaluation

UT and TSU Extension's evaluation of the Tennessee Extension Master Gardener Program showed high levels of volunteerism and results. UT and TSU Extension worked to recruit, train, and coordinate these volunteers for residential and consumer horticulture programs. In 2016, the state had 2,394 Master Gardener volunteers reporting service hours, with 671 of those reporting participating in initial training and receiving 40 hours of education in a broad range of horticultural topics. Together, these volunteers donated 172,466 hours of volunteer service to Tennessee last year that is valued at $3.6 million. Impact from these service hours follow. In 2016, Tennessee Extension Master Gardeners:

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V(A). Planned Program (Summary)

Program # 12

1. Name of the Planned Program

Human Development

☑ 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
802	Human Development and Family Well-Being	100%	100%	0%	0%
	Total	100%	100%	0%	0%

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2016	Extension		Research	
	1862	1890	1862	1890
Plan	17.0	2.0	0.0	0.0
Actual Paid	14.0	2.0	0.0	0.0
Actual Volunteer	3.0	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**
286717	50757	0	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
1276986	58866	0	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
200000	0	0	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

This program involved professionals, parents, child care providers, older adults, and community leaders. The target audiences were child care providers, adolescents, and parents who are divorced or

incarcerated, court-ordered parents and relatives as caregivers.

The following was used to help the target audience gain awareness: displays, exhibits, community events, newspaper articles, radio programs, TV shows and newsletters. In addition, fact sheets and resource lists for parents, teachers and professionals were created and disseminated. Extension Family and Consumer Sciences Agents in over 60 of Tennessee's 95 counties offered the four-hour class Parenting Apart: Effective Co-Parenting, an information and skills-based program that utilizes lecture, class discussion, videos, and handouts to inform parents about the potential effects of divorce on their children and provides them with strategies for minimizing those effects.

In 2016, the TSU Extension Family and Community Health programs placed emphasis on "Healthy Aging" for the mind, body and spirit. The ultimate goal is to increase knowledge and education relating to healthy aging. Tennessee is getting older. Various assessments have shown that the percentage of Tennessee's population over the age of 65 will grow to 20% by 2025 (up from about 12% at the beginning of the 21st Century). TSU Extension produced and distributed resource materials and educational programs on a variety of topics for interested individuals, caregivers, and professionals. Various methods were employed, including inter-generational connections.

2. Brief description of the target audience

The target audiences for this planned program was Tennessee child care providers, parents, and adolescents. While all parents of infants and young children were targeted for literacy programs, parents seeking a divorce were especially targeted for parenting instruction because of the added demands of co-parenting. Tennessee child care providers working full-time are required to have 18 hours and child care center directors are required to have 24 hours of instruction annually. Tennessee parents seeking a divorce are directed by the courts to a four-hour co-parenting class. In many communities in the state, Extension continues to be the only provider of this instruction.

3. How was eXtension used?

In 2016, Tennessee personnel served on three eXtension Communities of Practice in implementing this program: Parenting, Child Care, and Family Caregiving. eXtension resources were used to inform and improve Extension human development programs in Tennessee.

V(E). Planned Program (Outputs)

1. Standard output measures

2016	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	96815	7012461	37508	0

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

Patent Applications Submitted

Year:	2016
Actual:	0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2016	Extension	Research	Total
Actual	3	0	0

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number of exhibits displayed to promote program awareness and participation.

Year	Actual
2016	195

Output #2

Output Measure

- Number of research-based publications distributed as part of this program.

Year	Actual
2016	39171

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Child Care/Parenting: Number of parents and childcare providers who report using suggested guidance techniques more often.
2	Child Care/Parenting: Number of parents and child care providers who report putting down or blaming their child less.
3	Child Care/Parenting: Number of parents and child care providers who report talking, singing and playing more with their children than before the program.
4	Divorcing Parents: Number of parents who plan to decrease exposure of their children to parental conflict.
5	Caregiving Education: Number of caregivers who report the Extension program helped them to minimize stress.

Outcome #1

1. Outcome Measures

Child Care/Parenting: Number of parents and childcare providers who report using suggested guidance techniques more often.

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	64

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

What has been done

Results

4. Associated Knowledge Areas

KA Code	Knowledge Area
802	Human Development and Family Well-Being

Outcome #2

1. Outcome Measures

Child Care/Parenting: Number of parents and child care providers who report putting down or blaming their child less.

Not Reporting on this Outcome Measure

Outcome #3

1. Outcome Measures

Child Care/Parenting: Number of parents and child care providers who report talking, singing and playing more with their children than before the program.

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	37

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

What has been done

Results

4. Associated Knowledge Areas

KA Code	Knowledge Area
802	Human Development and Family Well-Being

Outcome #4

1. Outcome Measures

Divorcing Parents: Number of parents who plan to decrease exposure of their children to parental conflict.

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	1546

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

What has been done

Results

4. Associated Knowledge Areas

KA Code	Knowledge Area
802	Human Development and Family Well-Being

Outcome #5

1. Outcome Measures

Caregiving Education: Number of caregivers who report the Extension program helped them to minimize stress.

2. Associated Institution Types

- 1890 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	1171

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

What has been done

Results

4. Associated Knowledge Areas

KA Code	Knowledge Area
802	Human Development and Family Well-Being

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Government Regulations

Brief Explanation

{No Data Entered}

V(I). Planned Program (Evaluation Studies)

Evaluation Results

In eight counties in 2016, a UT Extension program was offered to provide education to teenagers who provide child care (babysitters). The program was evaluated through surveys and observations that demonstrated 100% of the 44 participants:

- feel more confident when taking care of young children.
- feel more equipped to facilitate activities with the children they babysit.
- increased their knowledge on health and safety topics when babysitting young children.
- reported they feel more prepared to handle emergencies while babysitting.

Key Items of Evaluation

In eight counties in 2016, a UT Extension program was offered to provide education to teenagers who provide child care (babysitters). The program was evaluated through surveys and observations that demonstrated 100% of the 44 participants:

- feel more confident when taking care of young children.
- feel more equipped to facilitate activities with the children they babysit.
- increased their knowledge on health and safety topics when babysitting young children.
- reported they feel more prepared to handle emergencies while babysitting.

V(A). Planned Program (Summary)

Program # 13

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
101	Appraisal of Soil Resources	0%	0%	7%	0%
102	Soil, Plant, Water, Nutrient Relationships	0%	0%	4%	13%
121	Management of Range Resources	0%	0%	7%	0%
132	Weather and Climate	0%	0%	0%	25%
201	Plant Genome, Genetics, and Genetic Mechanisms	0%	0%	19%	12%
202	Plant Genetic Resources	0%	0%	3%	0%
205	Plant Management Systems	0%	0%	7%	25%
212	Pathogens and Nematodes Affecting Plants	0%	0%	4%	0%
215	Biological Control of Pests Affecting Plants	0%	0%	3%	0%
402	Engineering Systems and Equipment	0%	0%	7%	0%
404	Instrumentation and Control Systems	0%	0%	4%	0%
511	New and Improved Non-Food Products and Processes	0%	0%	34%	0%
512	Quality Maintenance in Storing and Marketing Non-Food Products	80%	80%	1%	0%
601	Economics of Agricultural Production and Farm Management	0%	0%	0%	25%
603	Market Economics	10%	10%	0%	0%
605	Natural Resource and Environmental Economics	10%	10%	0%	0%
	Total	100%	100%	100%	100%

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2016	Extension		Research	
	1862	1890	1862	1890
Plan	5.0	1.0	65.0	8.0
Actual Paid	5.0	1.0	59.7	5.3

Actual Volunteer	1.0	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**
89599	39481	773331	256656
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
399058	45789	3892017	256656
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
0	23402	4884167	141838

V(D). Planned Program (Activity)

1. Brief description of the Activity

UT AgResearch is developing national ethanol, biodiesel, electric, and bioproduct demand quantities and incorporating them into an existing dynamic agricultural sector econometric simulation model (POLYSYS). Regional feedstock supply curves necessary to meet national bioenergy and bioproduct demand quantities are being estimated by modifying POLYSYS to include cellulosic feedstock in addition to existing agricultural grain and oilseed crops. Regional bioenergy and bioproduct supply curves are being developed using regional feedstock supply curves, representative transportation costs, and representative costs for each feedstock-technology-product combination considered. A national expansion curve for the bioenergy and bioproduct industry is being estimated. Key indicators of agricultural sector performance including net farm income, agricultural prices, and government cost in meeting national bioenergy and bioproduct demand quantities are being evaluated.
As part of UT AgResearch's engineering work, we are documenting drying rates and methods for corn stover, and quantifying the distribution and quality of the above ground biomass.For existing biomass densification systems, we areidentifying relations between particle size, biomass type, final density, compression pressures and energy, and other engineering factors. We are determining optimum particle sizes based on a balance between expended energy, final density, and integrity of compressed pellet or wafer. We are using these optimum particle sizes to identify or invent technologies to achieve the size based on theoretical cutting lengths due to feed speed, cutter speed, and other engineering factors. We are applying the developed technologies in laboratory-scale granulation tests to verify sizes using laser, image analyzer, sieve, and manual methods. We are comparing the developed methods in particle size reduction to existing technologies.
In terms of downstream processing, UT AgResearch is conducting fundamental studies on the fractionation of various free fatty acid (FFA) mixtures to test whether the mathematical modeling approach used by us for rapeseed oil is more widely applicable.Additionally, the food safety of the purified FFA products is being assessed. We will then complete the cost analysis of this fractionation process using results predicted by the mathematical model using chemical plant design software. A bench-scale continuous reactor is being assembled and we will attempt to maintain the same productivity (moles of product per time per mass of enzyme) as achieved for batch-mode experiments from previous experiments.We are also attempting the further development of microemulsion-based protein extraction as a rapid low-cost and scalable means of selectively isolating and purifying proteins of interest from aqueous media.

From a production perspective, research is optimizing the production and performance of alternative fuel biostocks using renewable resources. Additionally, molecular regulation of stress tolerance factors in biofuel crops are being identified for exploitation in new varieties adapted to changing environmental conditions.

2. Brief description of the target audience

This planned program is targeted to Tennessee farmers. Secondary audiences include consumers of both basic and applied research and the general public.

3. How was eXtension used?

.

V(E). Planned Program (Outputs)

1. Standard output measures

2016	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	370	40000	1189	0

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

Patent Applications Submitted

Year:	2016
Actual:	3

Patents listed

Method of producing carbon fibers and carbon fiber composites from plant derived lignin and its blends, D. P. Harper, A. McCall, D. Webb, J. Bozell, D. Penumadu, N. Meek, N. Labbe´, T. Rials, D. Naab, O. Housseinaei, S. Young

Method of Synthesizing Carbon Materials, D. P. Harper, D. Keffer, V. Garcia-Negron, J. Li, C. Daniel, A. Johs, O. Rios.

Oil borne preservative removal by torrefaction, J. Lloyd, J. Kim, P. Kim, N Labbe.

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2016	Extension	Research	Total
Actual	1	73	0

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number of research-based publications distributed as part of Extension biofuels programs. Not reporting on this Output for this Annual Report

Output #2

Output Measure

- Number of underrepresented students trained in bioenergy and climate change research

Year	Actual
2016	0

Output #3

Output Measure

- Develop bio-based agricultural mulches (Hayes)

Year	Actual
2016	1

Output #4

Output Measure

- Increase control of thermal properties of lignin polymers (Chmely)

Year	Actual
2016	1

Output #5

Output Measure

- Produce platform chemicals from hemicellulose (Chmely)

Year	Actual
2016	1

Output #6

Output Measure

- Adding Value to Used Railroad Ties and Utility Poles (Labbe)

Year	Actual
2016	1

Output #7

Output Measure

- Carbon Nanofibers from Cellulose Nanofibers (Wang)

Year	Actual
2016	1

Output #8

Output Measure

- Co-firing Switchgrass with Coal (English)

Year	Actual
2016	1

Output #9

Output Measure

- Improving Switchgrass Genetics (Bhandari, Allen)

Year	Actual
2016	1

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Switchgrass pathogens and diseases (Ownley, Zale, Gwinn, Windham)
2	Switchgrass logistics and handling (Womac)
3	Biorefinery coproducts (Bozell)
4	Insects to help with biofuel production (Jurat-Fuentes, Klingeman, Oppert)
5	Switchgrass biomass yield improvement (Bhandari, Allen)
6	Switchgrass extractives as bioactive compounds (Canaday, Gwinn, Labbe, Ownley)
7	Improved understanding of mechanisms of biofuel crop responses to agricultural practices and climate change. (Hui)
8	Improved process-based ecosystem models to forecast biofuel productivity and greenhouse gas emission under future climate conditions. (Hui)
9	Document the growth performance, environmental conditions, and agronomy practices for alternative biomass production in the Southeast. (Illukpitiya)
10	Determine the economic benefits, factors that inhibit adaptation, and cost of short rotation woody biomass crops for bioenergy production. (Illukpitiya)
11	Research to provide insight into factors responsible for regulating stress tolerance traits that are inherited via seeds or genome imprinting in stock plants. (Zhou)
12	Stabilize bio-oil by deoxygenation (Chmely)
13	Genetic Improvement of Poplar (Cheng)
14	Influencing the Chemical Composition of Switchgrass (English)
15	Producing Carbon Fibers from Lignin (Harper)
16	Reinforcing Composites with Natural Fibers (Wang)
17	Replacing Graphite in Battery Anodes with Lignin-based Carbon (Harper)

18	Unique Densification for Bulk-format Biomass (Womac)

Outcome #1

1. Outcome Measures

Switchgrass pathogens and diseases (Ownley, Zale, Gwinn, Windham)

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	1

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

What has been done

Results

4. Associated Knowledge Areas

KA Code	Knowledge Area
212	Pathogens and Nematodes Affecting Plants
215	Biological Control of Pests Affecting Plants

Outcome #2

1. Outcome Measures

Switchgrass logistics and handling (Womac)

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	1

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

What has been done

Results

4. Associated Knowledge Areas

KA Code	Knowledge Area
402	Engineering Systems and Equipment
404	Instrumentation and Control Systems
511	New and Improved Non-Food Products and Processes
601	Economics of Agricultural Production and Farm Management
603	Market Economics

Outcome #3

1. Outcome Measures

Biorefinery coproducts (Bozell)

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual

2016	1

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

What has been done

Results

4. Associated Knowledge Areas

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

Outcome #4

1. Outcome Measures

Insects to help with biofuel production (Jurat-Fuentes, Klingeman, Oppert)

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	1

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

What has been done

Results

4. Associated Knowledge Areas

KA Code	Knowledge Area

511 New and Improved Non-Food Products and Processes

Outcome #5

1. Outcome Measures

Switchgrass biomass yield improvement (Bhandari, Allen)

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	1

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

What has been done

Results

4. Associated Knowledge Areas

KA Code	Knowledge Area
201	Plant Genome, Genetics, and Genetic Mechanisms
202	Plant Genetic Resources

Outcome #6

1. Outcome Measures

Switchgrass extractives as bioactive compounds (Canaday, Gwinn, Labbe, Ownley)

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	1

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

What has been done

Results

4. Associated Knowledge Areas

KA Code	Knowledge Area
215	Biological Control of Pests Affecting Plants
511	New and Improved Non-Food Products and Processes
601	Economics of Agricultural Production and Farm Management

Outcome #7

1. Outcome Measures

Improved understanding of mechanisms of biofuel crop responses to agricultural practices and climate change. (Hui)

2. Associated Institution Types

- 1890 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	1

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
This project improves our understanding how biofuel crops respond to biochar and nutrient applications.

What has been done
Field experiments with biochar and N fertilization. Experiments considered biochar application (10 tonne /ha) and without biochar, and four N applications (0, 15, 30, and 60 lbs N /acre) with a total of 8 treatments. For experiment II, we considered three biochar levels, and two N applications, and both switchgrass and gamagrass were considered. We have purchased biochar and nitrogen fertilizer and will start the measurement in the growing season of 2017. For experiment I, we have collected field measurement for one growing season. Leaf photosynthesis was using a Li-6400 Portable Photosynthesis System (Li-Cor Inc., Lincoln, NE, USA). Soil temperature, moisture and soil respiration (CO_2 emission) were monitored biweekly.

Results
The response of soil respiration to biochar addition varied with different N-fertilized levels. Biochar addition significantly decreased soil respiration at low N application. Both fertilization and biochar addition did not change soil temperature and moisture. The findings from this study are useful to optimize N fertilization by the amendment of biochar in the switchgrass fields for maintaining highly productive corn yield while reducing greenhouse gas emissions.

4. Associated Knowledge Areas

KA Code	Knowledge Area
132	Weather and Climate
205	Plant Management Systems

Outcome #8

1. Outcome Measures

Improved process-based ecosystem models to forecast biofuel productivity and greenhouse gas emission under future climate conditions. (Hui)

2. Associated Institution Types

- 1890 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	1

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
This project improves our understanding how biofuel crops respond to climate change and agricultural practices.

What has been done
We have established field precipitation facility and used the process-based model (DNDC) to simulate greenhouse gas N2O emission in a cornfield and switchgrass field. For field study, we have established a 20-plot field precipitation facility with five treatments (ambient precipitation, +-33% and +-50% of ambient precipitation) and replicated five times. Field measurements including plant growth, physiology and soil CO2 emission have been conducted for the 2015 growing seasons. For modeling study, we have parameterized the DNDC model and applied to the cornfield.

Results
Results indicated that the DNDC model could adequately simulate N2O emissions as well as soil properties under different agricultural management practices. The modeled emissions of N2O significantly increased by 35% with tillage, and decreased by 24% with the use of nitrification inhibitor, compared with no-tillage and normal N fertilization. Sensitivity analysis showed that N2O emission was sensitive to mean annual precipitation, mean annual temperature, soil organic carbon, and the amount of total N fertilizer application. Our model results provide valuable information for determining agricultural best management practice to maintain highly productive corn yield while reducing greenhouse gas emissions.

4. Associated Knowledge Areas

KA Code	Knowledge Area
132	Weather and Climate
205	Plant Management Systems

Outcome #9

1. Outcome Measures

Document the growth performance, environmental conditions, and agronomy practices for alternative biomass production in the Southeast. (Illukpitiya)

2. Associated Institution Types

- 1890 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual

2016	1

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Small-scale on-farm bioenergy production is relatively new for farmers. Information on reliable crop varieties, field operations and management are are essential to attract growers for energy crop farming. This information is needed for long term investment decisions.

What has been done
Evaluate bioenergy feedstock, growth performance, fertilizer responses, harvesting, yield and response to environmental conditions (freezing and snow damage).

Results
There are superior plants with high yield that can be adopted in the region. Some varieties are susceptible to freezing and snow kill hence need further field trials to identify appropriate planting date and management.

4. Associated Knowledge Areas

KA Code	Knowledge Area
601	Economics of Agricultural Production and Farm Management

Outcome #10

1. Outcome Measures

Determine the economic benefits, factors that inhibit adaptation, and cost of short rotation woody biomass crops for bioenergy production. (Illukpitiya)

2. Associated Institution Types

- 1890 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	1

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Producers have concerns over net return from growing and marketing feedstock and the economic benefits to their operation. In terms of production of short rotation woody biomass, producers are willing to know the economic benefits of new production methods including capital

and operational costs and potential economic returns. Producers also need information to compare economic benefits of the potential investment.

What has been done
Benefits:costs of producing paulownia and sweetgum, Monti Carlo risk analysis of range of potential income and how yield, price and production costs effect net profit.

Results
Dry matter yield of both Paulownia and sweetgum are high compared to conventional short rotation woody biomass. Both provide positive net return to farmers. Simulation results shows less risk of growing these feedstock.

4. Associated Knowledge Areas

KA Code	Knowledge Area
601	Economics of Agricultural Production and Farm Management

Outcome #11

1. Outcome Measures

Research to provide insight into factors responsible for regulating stress tolerance traits that are inherited via seeds or genome imprinting in stock plants. (Zhou)

2. Associated Institution Types

- 1890 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	1

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The understanding if and how tillers and seeds of perennial herbs utilize the inheritable epigenetics mechanisms to adapt to environmental stress is an important issue for breeders and growers as they choose a ?smart? way to propagate better adapted plants under certain circumstances. Tillers deriving directly from the parent plants should be able to carry on all the mitotically transmitted information which includes the stress-induced DNA methylation patterns (also named intra-generational epigenetics). Many of the stress-activated changes in genome are reset during the gametogenesis process.

What has been done

Drought treatments were applied to Panicum hallii seedlings and leaf tissues were harvested. After brief processing, ChIP-Seq sequencing and genome mapping were completed on these samples. Only one sample was completed, the tiller samples will be done in the coming year as funding becomes available.

Results

More than 33-44 million raw reads per sample were obtained, which is about 93% mapping ration to Panicum hallii genome (panhal2). Primary blast result of the annotated peaks with Phytozome database shows that there are some protein super families and enzymes like Glutathione S Transferase (GST domain containing), Endo-1,4-beta-xylanase, Phosphotransferase enzyme family (APH), auxin responsive protein (auxin inducible), Zink Finger CCHC domain containing protein etc. are present in the stressed genome. The blast results with Uniprot KB database also shows that the annotated peak associated gene locus has profound similarities retrotransposon protein and putative gag-pol protein. These mobile elements may have some function in regulating the genome expression pattern which will be further investigated.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
201	Plant Genome, Genetics, and Genetic Mechanisms

Outcome #12

1. Outcome Measures

Stabilize bio-oil by deoxygenation (Chmely)

Not Reporting on this Outcome Measure

Outcome #13

1. Outcome Measures

Genetic Improvement of Poplar (Cheng)

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Populus (or poplar tree) is one of the leading candidates for woody bioenergy. But its complicated cell wall chemistry makes its commercialization very challenging.

What has been done
Plants interact in nature with variety of microorganisms. I am involved in a project with DOE-ORNL to generate transgenic poplar lines that contains a gene from a microorganism to improve nutrient use efficiency.

Results
We have generated many plants and are in the process of multiplying these plants for further analysis. The anticipated outcome will help us to understand how plants interact with natural microorganisms in utilizing nutrients.

4. Associated Knowledge Areas

KA Code	Knowledge Area
121	Management of Range Resources
201	Plant Genome, Genetics, and Genetic Mechanisms
202	Plant Genetic Resources
511	New and Improved Non-Food Products and Processes

Outcome #14

1. Outcome Measures

Influencing the Chemical Composition of Switchgrass (English)

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

What has been done

Gaining understanding and controlling biomass chemical composition contributes to an efficient biofuel generation. We presented a principal component analysis (PCA) that shows the influence and relevance of selected controllable factors over the chemical composition of switchgrass and, therefore, in the generation of biofuels. The study introduces the following factors: (1) storage days; (2) particle size; (3) wrap type; and (4) weight of the bale.

Results

Results show that all the aforementioned factors have an influence in the chemical composition. The number of days that bales have been stored was the most significant factor regarding changes in chemical components. The storage days are followed by the particle size, the weight of the bale and the type of wrap utilized to enclose the bale. An increment in the number of days in storage decreases the percentage of carbohydrates while content of ash increases.

4. Associated Knowledge Areas

KA Code	Knowledge Area
205	Plant Management Systems
402	Engineering Systems and Equipment
512	Quality Maintenance in Storing and Marketing Non-Food Products
601	Economics of Agricultural Production and Farm Management
605	Natural Resource and Environmental Economics

Outcome #15

1. Outcome Measures

Producing Carbon Fibers from Lignin (Harper)

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Lignin-based carbon fibers have low strength when tested in single fiber test compared to commercial fiber tests.

What has been done

Utilization of biorefinery lignin as feedstocks for carbon fiber production can make biorefining economically feasible and contribute an additional $4 billion annually to rural economies. We developed carbon fibers from switchgrass and hardwoods that we manufactured into carbon fiber composites.

Results
We developed carbon fiber composites where the interfacial shear strength exceeded that of commercial fiber without the need for added sizing (adhesion promoting) agents. Lignin carbon fibers can realize the full strength in much shorter fiber composites than current commercial fibers. This will have an advantage in processes such as additive manufacturing. A patent is pending and a paper has been published with another forthcoming.

4. Associated Knowledge Areas

KA Code	Knowledge Area
402	Engineering Systems and Equipment
511	New and Improved Non-Food Products and Processes
601	Economics of Agricultural Production and Farm Management

Outcome #16

1. Outcome Measures

Reinforcing Composites with Natural Fibers (Wang)

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

What has been done

Results
We received a US patent ?Wood adhesives containing reinforced additives for structural engineering products?, which is using cellulose nanofibers as main reinforcing agent. The patent has been licensed to a company for commercialization.

4. Associated Knowledge Areas

KA Code	Knowledge Area
402	Engineering Systems and Equipment
511	New and Improved Non-Food Products and Processes
601	Economics of Agricultural Production and Farm Management

Outcome #17

1. Outcome Measures

Replacing Graphite in Battery Anodes with Lignin-based Carbon (Harper)

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

What has been done
We developed a method to convert kraft and biorefinery lignin into nano-phase carbon-carbon composite battery anodes that can replace flake graphite in Li-ion batteries with theoretically higher performance.

Results
We produced lignin based Li-ion batteries with stability and capacity on par with and exceeding that of flake graphite under the right conditions. A patent is pending and a paper has been published based on these results.

4. Associated Knowledge Areas

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

Outcome #18

1. Outcome Measures

Unique Densification for Bulk-format Biomass (Womac)

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

What has been done
A method unique to biomass densification in bulk format was identified, tested, and published.

Results
A solid waste compactor and ejector transfer system provided alternative bulk compaction and hauling for switchgrass (SG) either field chopped with a forage harvester (FC) or with bales size reduced with a tub grinder as coarse (CTG) and fine (FTG) materials. Though bulk density values were less than that reported for bales, advantages were noted with bulk loading and ejection unloading, such that loading a full over-the-road semi-trailer required a minimum of 24 min, as limited by the supply system, and unloading only required 5 min. Low energy requirements for bulk compaction and ejection indicated an economy of scale.

4. Associated Knowledge Areas

KA Code	Knowledge Area
402	Engineering Systems and Equipment
511	New and Improved Non-Food Products and Processes
512	Quality Maintenance in Storing and Marketing Non-Food Products
601	Economics of Agricultural Production and Farm Management
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
- Other (International conflict)

Brief Explanation

{No Data Entered}

V(I). Planned Program (Evaluation Studies)

Evaluation Results

Research has clearly defined objectives, methodology and work plan. We work on each objective and collected data and analyze where appropriate to generate results.
Impact of the research documented based on publications (if any), oral and poster presentations, field work, number of persons participated in presentations, informal requests and discussions about the research
Mendeley profile shows over 1,152 and 1,248 views of recent articles on feedstock development in 11 citations on recent articles; increased number of graduate students interest in working on bioenergy research and students actually working on thesis research; undergraduate students interest in developing business plans; and various informal request on the research and invitations for conference presentations and publish work in journals.
TSU Extension provided a biomass energy training curriculum through a Southern SARE grant. The curriculum was used to train 18 professionals such as Extension agents and Soil Conservation District official. Based on evaluation results, participants involved in the biomass energy in-service training identified an increase in knowledge related to on-farm, small-scale bio-diesel production, the economics of growing biomass energy crops and the Rural Energy for America Program (REAP). They also indicated that the training increased their capacity to provide programs related to sustainability and biomass energy.

Key Items of Evaluation

TSU Extension provided a biomass energy training curriculum through a Southern SARE grant. The curriculum was used to train 18 professionals such as Extension agents and Soil Conservation District official. Based on evaluation results, participants involved in the biomass energy in-service training identified an increase in knowledge related to on-farm, small-scale bio-diesel production, the economics of growing biomass energy crops and the Rural Energy for America Program (REAP). They also indicated that the training increased their capacity to provide programs related to sustainability and biomass energy.

VI. National Outcomes and Indicators

1. NIFA Selected Outcomes and Indicators

Childhood Obesity (Outcome 1, Indicator 1.c)	
3012	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 whit climate adaptive traits.
Global Food Security and Hunger (Outcome 1, Indicator 4.a)	
1422	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.