2015 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 6.4 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 2015, 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 $511 million for FY 2015. It was estimated that for every $1 in public funds invested in Extension, $8.25 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 the United States Department of Defense 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 $200 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 5.2 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 (2006-2015), 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 2015 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. New support buildings at our main campus that provide convenient, modern facilities for processing and acquiring data on harvests were completed using NIFA funding; faculty in the area of integrated pest management, remote sensing, GIS, and agribusiness have been added.
We have a talented faculty who have dedicated themselves to improving the lives of others.
Examples of research accomplishments include:

- Introducing technology-based tools to help limited resource land owners employ multi-function land management techniques to optimize the return on their land
- Development of new methods for managing an invasive insect (ambrosia beetles) in nursery production
- Producers of alternative poultry who have adopted practiced defined as a result of our research have experienced a 20%. savings in feed cost by replacing expensive turkey rations with specific rations for the Guinea fowl.
- Development of new types of fiber-enriched breads to combat obesity .
- Research analysis provided our limited-resource biofuel producers with estimations of indicators such as break-even prices, feedstock costs per gallon, and breakeven price of ethanol which is vital for decision making of feedstock producers as well as ethanol processors.
- Advanced detection techniques for the food-borne pathogen Salmonella, and new techniques for sterilizing liquid-based consumer products.
- Research to use environmentally-friendly microorganisms to reduce the toxicity of energy production by-products in contaminated soils.
- Documenting ways to optimize biofuel production under future climate conditions
- New vegetable cultivars identified as suitable for organic management systems

The review of our TSU Research Annual Report last year cited some concerns that some outcomes seemed to lean toward Extension rather than research. We have undertaken a process to re-work all of our outcomes, a process reflected in this year's Plan of Work. Results from some of new outcomes have been added to 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: 2015	Extension		Research	
	1862	1890	1862	1890
Plan	450.0	62.0	340.0	63.0
Actual	450.0	96.0	316.9	71.0

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 six 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 2015.
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 in February 2014. 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 2015.
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. Tennessee Organic Growers Association, Tennessee Nursery and Landscape Association, Professional Grounds Maintenance 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 2015, UT and TSU Extension made 5,866 contacts for needs assessment purposes, and 309 (5%) were young people under 18 years of age. Statewide needs assessment methods included:

• 246 advisory committee meetings
• 87 focus group meetings
• 693 interviews with key informants

Both TSU and UT Extension administrators meet with the State Extension Advisory Council 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 2015, Extension conducted 87 different focus groups and 693 interviews with key informants. Regarding interviews with key informants, 51% 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 trainin g 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, an d 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 fro m 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 or via survey instruments. Each of these methods are effective. The face-to-face discussions are often held with 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.

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 2015, stakeholder input was used to identify volunteer leaders, identify new audiences, and identify and secure locations for Extension programs. In FY 2015, stakeholder input was used to modify these Extension programs:

- Our **Childhood Obesity** program was redirected to family-based approaches to combat obesity, diabetes, heart disease, and stroke in four West Tennessee counties (Lake, Lauderdale, Haywood, and Humphreys Counties) identified by the Centers for Disease Control and Prevention as four of the unhealthiest counties in the United States. This was the second year for this collaborative approach among UT and TSU Extension and 48 community and state-level organizations and agencies.
- Our **Agritourism and Community Economic Development** efforts were increased as Tennessee agritourism operators look to Extension for education regarding budgeting, safety, customer service, technical assistance, and additional topics. Estimated sales increased among 200

operators participating in Extension programs by a combined $7.5 million. Other Extension community economic development programs produced an estimated $2.1 million in increased revenue and capital purchases such as assisting local charities to obtain grant funds and providing assistance to small businesses.

• In 2015, 337 Tennesseans completed the **UT Extension Beemaster** program. This program was re-tooled and provided in response to stakeholder requests. Tennessee beekeepers learned how to save honeybee colonies from various catastrophes, including parasitic mites, with an estimated 11,500 bee colonies saved (valued at $700 per hive for bees, hive parts, medications, and honey production). The total value of the saved colonies, hive parts, and honey production is valued at $7.5 million.

• The **Tennessee Value-Added Beef Program** was a new initiative developed by Extension specialists in the Center for Profitable Agriculture, Animal Science, and Food Science and Technology in response to Tennessee cattle producers asking an increasing number of questions about developing business enterprises beyond traditional cow-calf production systems. The program has provided a range of educational programming and materials including conferences, workshops, webinars, and publications. Beef consumer market research was conducted, and educational programs were focused on all aspects of marketing value-added beef. Outreach included 20 professionals from five agencies and 30 Tennessee Extension agents. Over the past four years, the Tennessee Value-Added Beef Program has helped Tennessee farms to greatly expand their value-added beef marketing. Specifically, the number of farm-based retail meat permits issued by the Tennessee Department of Agriculture from December 2011 to May 2015 (from 57 to 142) has increased 149%.

• 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 nursery research programs. In our quest to increase the efficacy of insecticide treatments for the invasive insect, Xylosandrus germanus (Ambrosia Beetle) treatments were developed that had good efficacy, but low residual effects. Our stakeholders communicated that as this insect first emerges during the busy spring shipping season, they were willing to accept a treatment with lower efficacy but a longer residual, to avoid tying up labor with repeated sprays. Alternative treatments are being examined. 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

In FY 2015, stakeholder input was used to modify a number of Extension programs with these programs selected for illustration:

• Our **Childhood Obesity** program was redirected to family-based approaches to combat obesity, diabetes, heart disease, and stroke in four West Tennessee counties (Lake, Lauderdale, Haywood, and Humphreys Counties) identified by the Centers for Disease Control and Prevention as four of the unhealthiest counties in the United States. This was the second year for this collaborative approach among UT and TSU Extension and 48 community and state-level organizations and agencies.

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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
8921886	2904030	6077762	3380111

2. Totaled Actual dollars from Planned Programs Inputs				
	Extension		Research	
	Smith-Lever 3b & 3c	1890 Extension	Hatch	Evans-Allen
Actual Formula	8921886	2904030	6278217	3384226
Actual Matching	38349784	3760745	19890866	3384226
Actual All Other	7244080	1513305	12762688	0
Total Actual Expended	54515750	8178080	38931771	6768452

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

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: 2015	Extension		Research	
	1862	1890	1862	1890
Plan	144.0	17.0	0.0	0.0
Actual Paid	153.0	32.0	0.0	0.0
Actual Volunteer	36.0	32.0	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**
3033441	1028026	0	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
13038929	1331304	0	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
100000	0	0	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

• **Clubs/Project Groups -** In FY 2015, 65 Tennessee counties organized over 2,500 4-H clubs where workforce preparation was the major emphasis. Project work was emphasized, and the experiential learning model was used to highlight jobs and careers aligned with 4-H projects. Curriculum emphasized practical skills which align with jobs and careers.

• **School Enrichment -** Various school enrichment programs in 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 2015, 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 goal was to increase science literacy among the state's young people. TSU Extension reached 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 organized and taught in public schools.

3. How was eXtension used?

This 4-H Positive Youth Development Planned 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

2015	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	369533	19287070	1646987	19287070

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

Patent Applications Submitted

Year:	2015
Actual:	0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2015	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
2015	6394

Output #2

Output Measure

- Number of exhibits produced.

Year	Actual
2015	7435

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.
12	Developing the STEM Workforce
13	4-H Develops Strong Leaders

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
2015	5777

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
2015	6395

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
2015	4638

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
2015	8110

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
2015	6127

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
2015	6206

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
2015	13528

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
2015	16394

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
2015	14626

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
2015	11601

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
2015	4736

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

Outcome #12

1. Outcome Measures

Developing the STEM Workforce

2. Associated Institution Types

- 1862 Extension
- 1890 Extension

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The need for science and engineering graduates in Tennessee and nationwide will continue to grow. The National Science Foundation (NSF) report indicates that total employment in occupations that NSF classifies as science and engineering will increase at more than double the overall growth rate for all occupations.

What has been done
UT and TSU Extension made 144,388 direct educational contacts to help youth gain new knowledge, acquire new skills and increase aspirations regarding 4-H STEM. Programs were delivered through 4,894 group meetings including organized clubs, camps, project groups and school enrichment by Extension 4-H Agents and volunteers. Educational programs were reinforced by 27 exhibits, 54 news articles, seven radio programs and two television programs.

Results
Of the youth who participated in 4-H STEM programs:
__5,227 youth can use specific scientific knowledge to form a question.
__5,751 youth can ask a question that can be answered by collecting data.

__5,488 youth can record data accurately.
__5,475 youth can analyze the results of a scientific investigation.
__1,520 youth can communicate a scientific procedure to others.
__1,311 youth can use data to create a graph for presentation to others.
__1,426 youth can create a display to communicate scientific data and observations.
__1,319 youth can use science terms to share scientific results.
__1,359 youth can use models to explain scientific results.
__1,636 youth can use the results of their investigation to answer the question they had asked.

4. Associated Knowledge Areas

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

Outcome #13

1. Outcome Measures

4-H Develops Strong Leaders

2. Associated Institution Types

- 1862 Extension
- 1890 Extension

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The need for leadership-type skills extends beyond the workforce and reaches into areas of basic ideal citizens. Research from the Appalachian Regional Commission indicates a growing need for leadership training to ensure young people are prepared to participate in political and civic life.

What has been done
The UT-TSU Extension 4-H Leadership program used 4-H club meetings and demonstrations, direct and e-mail, and personal telephone calls for program activities. Special emphasis was placed on teen leadership. A total of 114,813 youth were involved in programs focused on leadership skills.

Results

Completed questionnaires were obtained from 42,582 youth (37% of the total program participants). Impacts included:
__57% (2,658) reported that as a member of a committee, they take their job seriously.
__58% (2,717) reported that they help to ensure that everyone gets an opportunity to say what they think.
__100% (4,663) believed that they could cooperate and work in a group.
__77% (3,604) indicated that they know how to set goals and use them when leading a group.

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

- Public Policy changes
- Competing Public priorities

Brief Explanation

V(I). Planned Program (Evaluation Studies)

Evaluation Results

The need for leadership-type skills extends beyond the workforce and reaches into areas of basic ideal citizens. Research from the Appalachian Regional Commission indicates a growing need for leadership training to ensure young people are prepared to participate in political and civic life.
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Key Items of Evaluation

The need for leadership-type skills extends beyond the workforce and reaches into areas of basic ideal citizens. Research from the Appalachian Regional Commission indicates a growing need for leadership training to ensure young people are prepared to participate in political and civic life.
The UT-TSU Extension 4-H Leadership program used 4-H club meetings and demonstrations, direct and e-mail, and personal telephone calls for program activities. Special emphasis was placed on teen leadership. A total of 114,813 youth were involved in programs focused on leadership skills. Completed questionnaires were obtained from 42,582 youth (37% of the total program participants). Impacts included:

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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%	14%	12%
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%	15%	20%
202	Plant Genetic Resources	0%	0%	16%	20%
203	Plant Biological Efficiency and Abiotic Stresses Affecting Plants	0%	0%	7%	0%
204	Plant Product Quality and Utility (Preharvest)	0%	0%	2%	0%
205	Plant Management Systems	50%	50%	7%	12%
211	Insects, Mites, and Other Arthropods Affecting Plants	5%	5%	5%	12%
212	Pathogens and Nematodes Affecting Plants	5%	5%	14%	12%
213	Weeds Affecting Plants	0%	0%	5%	12%
402	Engineering Systems and Equipment	0%	0%	5%	0%
511	New and Improved Non-Food Products and Processes	0%	0%	3%	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: 2015	Extension		Research	
	1862	1890	1862	1890
Plan	4.0	1.0	65.0	11.0
Actual Paid	50.0	0.0	70.3	13.0

Actual Volunteer	12.0	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**
981407	278787	1119418	611041
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
4218477	361032	5011442	611041
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
100000	0	3041181	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

The Extension portion of this plan 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 also highlighted 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 taught specific practices to and lead discussions with producers.

Implementation: On-farm demonstrations were conducted, particularly in the 31 West Tennessee counties, to highlight research-based practices. Integrated research and extension projects 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.

The research portion of this program improved disease and insect resistance mechanisms in crops, developed new varieties, increased yields, discovered new markets, improved production practices, and reduced production inputs.

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 was Tennessee row crop producers, and the secondary audience were the professionals, business owners/cooperatives, and government officials who served row crop producers.

3. How was eXtension used?

This Agronomic Crop Systems Planned Programs was enhanced through the service of three Tennessee Extension personnel and one stakeholder on the "Cotton" CoP and one Extension professional and one stakeholder on the "Pesticide Environmental Stewardship" 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

2015	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	95669	12588699	8517	35

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

Patent Applications Submitted

Year:	2015
Actual:	1

Patents listed

U.S. Plant Variety Protection (PVP) for 'Ellis' soybean. Application filed in 2015 by UT Research Foundation. Pantalone, V.R. 2015.

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2015	Extension	Research	Total
Actual	15	103	118

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
2015	38

Output #2

Output Measure

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

Year	Actual
2015	1957

Output #3

Output Measure

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

Year	Actual
2015	1

Output #4

Output Measure

- Evaluate treatments for soilborne fungal pathogens of snapbeans and soybeans. (Canaday)

Year	Actual
2015	1

Output #5

Output Measure

- Number of workshops held on use of specialized fertilizer formulations to reduce environmental nutrient contamination.

Year	Actual
2015	14

Output #6

Output Measure

- Number of molecular markers identified for improved cotton genetic mapping.

Year	Actual
2015	16

Output #7

Output Measure

- Number of soil quality parameters evaluated under pigeon pea cultivation.

Year	Actual
2015	0

Output #8

Output Measure

- Combat glyphosate-resistant pigweed (Steckel)

Year	Actual
2015	1

Output #9

Output Measure

- Provide ongoing irrigation recommendations for cotton and soybeans (Verbree)
  Not reporting on this Output for this Annual Report

Output #10

Output Measure

- Develop new cereal varieties (West)

Year	Actual
2015	1

Output #11

Output Measure

- Test drought tolerant soybeans (Cheng)

Year	Actual
2015	1

Output #12

Output Measure

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

Year	Actual
2015	1

Output #13

Output Measure

- Genetically improve soybean yields (Pantalone)

Year	Actual
2015	1

Output #14

Output Measure

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

Year	Actual
2015	1

Output #15

Output Measure

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

Output #16

Output Measure

- Understand Soybean Mosaic Virus Virulence (Hajimorad)

Year	Actual
2015	1

Output #17

Output Measure

- Evaluate New Crop Varieties (Allen)

Year	Actual
2015	1

Output #18

Output Measure

- Completed field work for the barrier fabric experiment and the biocontrol objective for brown marmorated stink bug (BMSB) (Moore)

Year	Actual
2015	2

Output #19

Output Measure

- Results provide corn producers with enhanced information about the effects of risk exposure on choices among corn rotations and N fertilizer rates. (Larson)

Year	Actual
2015	1

Output #20

Output Measure

- The confidence intervals for the expected profit-maximizing planting dates for soybean overlap, suggesting that Tennessee producers have a long period for planting. (Larson)

Year	Actual
2015	1

Output #21

Output Measure

- We compared no cover crop to both single species and mixed species cover and have found no yield benefit from covers on corn, cotton or soybeans. Cover crops serve the purpose of additional erosion protection and enhanced carbon storage but have not been shown to increase crop yield. (Tyler)

Year	Actual
2015	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	Producers will adopt use of specialized fertilizer formulations to reduce environmental nutrient contamination (Enhanced capacity of a sustainable global food system including new/improved plans, animals, technologies and management systems).
5	Producers will realize reduction in crop loss through the use of specialized fertilizer formulations to reduce environmental nutrient contamination.
6	Number of crops producing pathogen-inducer chemicals that can be used to screen germplasm.
7	Increased breeding efficiency in upland cotton through improved genetic maps.
8	Improved knowledge of the utility of pigeon pea as a soil improving cover crop, source of forage and source of soil nitrogen
9	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).
10	Continued adoption of automatic section control on planters (Velandia, Larson, Buschermohle)
11	Create genetic mapping populations of soybean (Pantalone)
12	Investigate insect resistance to biopesticides (Jurat-Fuentes)
13	Identify Molecular and Genomic Plant Defense Mechanisms (Chen, Grant)
14	Explore Nematode and Arthropod Biodiversity (Bernard)
15	Attack the Soybean cyst Nematode (Hewezi)
16	Increase soybean genetic diversity (Taheri).
17	Identify vegetable cultivars suitable for organic management system and to improve efficiency of organic farming by proper allocation of inputs.

18	Improve amaranth as an alternative crop and increase profitability of farming in small acreages through the production of alternative crops.
19	Cotton farmers' interest in no-till or cover cropping (Jensen)
20	Post glyphosate-resistant weed management in cotton (Lambert)
21	Economic Impact of Crop Variety Testing
22	Row Crops IPM Extension in Tennessee

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
2015	1450

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

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
2015	2746

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
2015	1043

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

What has been done

Results

4. Associated Knowledge Areas

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

Outcome #4

1. Outcome Measures

Producers will adopt use of specialized fertilizer formulations to reduce environmental nutrient contamination (Enhanced capacity of a sustainable global food system including new/improved plans, animals, technologies and management systems).

2. Associated Institution Types

- 1862 Extension
- 1890 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	3

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Some of the challenges of cultural practices include water and fertility management for healthy seed and stand establishment.

What has been done
An examination of specific nutrient utilization was conducted. Several options of organic fertilizer nutrient sources such as compost, green manure etc. as a source of NPK in organic seedling establishment were determined as beneficial.

Results
Research outcomes were communicated across the scientific community, extension specialists, extension agents, graduate students, undergraduate students and growers. The disseminated information improved nutrient management in food crops, soil fertility and minimized losses. Alternative nutrient sources may also represent a cost savings factor in small sized farm production of food crops.

4. Associated Knowledge Areas

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

Outcome #5

1. Outcome Measures

Producers will realize reduction in crop loss through the use of specialized fertilizer formulations to reduce environmental nutrient contamination.

2. Associated Institution Types

- 1862 Extension
- 1890 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	12

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Insufficient information is available to growers concerning site and crop specific fertilizer application techniques for production for specialized crops, i.e. blueberry production, Romaine

lettuce, Broccoli, Cucumber etc.

What has been done
Research in nutrient availability under different forms of production was conducted. Workshops were conducted to highlight the 1) impact of nitrogen forms, source and rate and pH levels for crops such as blueberry, 2) High tunnel crop production system, 3) Transition to organic farming and 4) Growing crops under soilless system.

Results
Producers realized reduction in crop loss through the use of site and crop specific fertilizers used in their farms. They realized the importance of monitoring and managing soil and water pH and EC. Growers began to apply site specific fertilizers and adjust the root zone pH appropriately for efficient nutrient uptake. Growers could identify macro and micronutrient deficiency symptoms at early stage to rectify it immediately to minimize crop yield losses. Growers and master gardeners, blueberry producers, beginning farmers gained knowledge on production techniques and specifically on fertilizer stewardship - source, rate, and application protocols.

4. Associated Knowledge Areas

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

Outcome #6

1. Outcome Measures

Number of crops producing pathogen-inducer chemicals that can be used to screen germplasm.

2. Associated Institution Types

- 1890 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	10

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
With over 80 crops susceptible to soft rot, identification of a molecule that serves to induce virulence of soft rot pathogens even in segment of these host crops will significantly impact many the production of many crops and thereby improve American agriculture.

What has been done
Using the tools of analytical and preparatory chemistry, we have developed a method of purifying the inducer from two host crops: celery and potato. The level of purity is being determined after which we shall determine the chemical identify of the inducer.

Results
The inducer is extractable from the crude material with water and in a dialysis bag with MWCO of 1kDa. The bioactivity (induction of exoenzyme production in Pectobacterium carotovorum) is consistently retained in the aqueous fraction following organic solvent extraction under neutral, acidic or basic conditions. Reverse Phase-HPLC analysis on a C8 column shows a single peak eluting very early (before the injection peak), indicating that the compound is very hydrophilic. Size exclusion chromatography shows a single peak with a retention time corresponding to the lower exclusion limit, indicating the compound is of low molecular mass. The UV-Vis spectrum shows absorbance in the lower UV range (200-220nm) and very little absorbance above 230nm. The combination of FT-IR and NMR scans of the extract and some other results indicate the active ingredient is of carbohydrate nature.

4. Associated Knowledge Areas

KA Code	Knowledge Area
212	Pathogens and Nematodes Affecting Plants

Outcome #7

1. Outcome Measures

Increased breeding efficiency in upland cotton through improved genetic maps.

2. Associated Institution Types

- 1890 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	16

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Improved seed oil and protein traits are important in cotton. Verified molecular markers facilitate the use Upland cotton (Gossypium hirsutum) lines with chromosome or segment substituted from Pima cotton (G. barbadense) in breeding trials for improving cotton seed oil and protein traits for food/feed usage.

What has been done
Molecular marker- based profiling of Upland cotton, Pima cotton and their 17 chromosome substitution progeny lines was conducted. In addition, lipid and protein secondary structures were calculated for mature cottonseeds from above lines using a Fourier Transform Infrared Spectrometer.

Results
Secondary structures for the two most important nutritional components, i.e. lipids and proteins, were non-destructively detected from mature cotton seeds of the select lines. Hydrated and dehydrated lipids as well as a-helices, b-sheets, turns and random coils were separately profiled for cotton hulls and kernels. Along with molecular markers this tool is useful in selecting breeding candidates for better nutritional quality in seeds.

4. Associated Knowledge Areas

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

Outcome #8

1. Outcome Measures

Improved knowledge of the utility of pigeon pea as a soil improving cover crop, source of forage and source of soil nitrogen

2. Associated Institution Types

- 1890 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The faculty member that was leader in this program is no longer with the university. Priorities for this program are being re-examined.

What has been done

Results

4. Associated Knowledge Areas

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

Outcome #9

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).

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	778

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 #10

1. Outcome Measures

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

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

What has been done
We analyzed the adoption patterns among cotton farmers for remote sensing, yield monitors, soil testing, soil electrical conductivity, and other precision agriculture technologies.

Results
The propensity to adopt technology bundles was greater for producers managing relatively larger operations who used a variety of information sources to learn about precision farming, irrigated cotton, practiced crop rotation, and participated in working land conservation programs.

4. Associated Knowledge Areas

KA Code	Knowledge Area
133	Pollution Prevention and Mitigation
204	Plant Product Quality and Utility (Preharvest)
205	Plant Management Systems
601	Economics of Agricultural Production and Farm Management

Outcome #11

1. Outcome Measures

Create genetic mapping populations of soybean (Pantalone)

Not Reporting on this Outcome Measure

Outcome #12

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
2015	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The kudzu bug is an invasive insect that has expanded its distribution throughout the southeast.

What has been done
We initiated a research program to assess the status, seasonality and natural enemies of kudzu bug to inform development of a management program to reduce numbers of kudzu bug.

Results
A fungus, Beauveria bassiana, infecting ca. 90% of kudzu bugs in some areas, was discovered. This fungus may be an important mortality factor of kudzu bugs. Further research will address the role of this fungus (and other natural enemies) in maintaining kudzu bug populations below damaging levels.

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 #13

1. Outcome Measures

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

Not Reporting on this Outcome Measure

Outcome #14

1. Outcome Measures

Explore Nematode and Arthropod Biodiversity (Bernard)

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Nematodes, springtails, millipedes, and other invertebrates play an indispensable role in the maintenance of healthy plant communities, as well as in some cases causing economic damage to crops and ornamentals.

What has been done
The general theme of my research efforts is the understanding of soil biodiversity, as both a means of assessing soil health and monitoring the environment in the future for species and population shifts due to climate change.

Results
The presence of high reniform nematode populations in cotton and soybean fields in Tennessee indicates a serious problem on the horizon, which at this point can only be met very partially with resistant germplasm.

4. Associated Knowledge Areas

KA Code	Knowledge Area

102	Soil, Plant, Water, Nutrient Relationships
205	Plant Management Systems
211	Insects, Mites, and Other Arthropods Affecting Plants

Outcome #15

1. Outcome Measures

Attack the Soybean cyst Nematode (Hewezi)

Not Reporting on this Outcome Measure

Outcome #16

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
2015	0

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 modify soybeans for better oil profile. 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 grown to full maturity. Seeds were harvested from these plants and about 10 seeds will be planted from each M1 plant in the second growing season for phenotypic evaluation and DNA examination. The data generated from this germplasm enhancement will be used in fishing out mutations in reported genes involved in beneficial traits.

Results

In 2015, soybeans were grown for the first time in our greenhouses which were not optimized for this crop due to lack of lighting. LED lighting will be installed for the following season. Also it was determined that under out conditions that soybeans in 6in. pot is not recommended as the plants outgrow these pots quickly; larger pots will be used in future years.

4. Associated Knowledge Areas

KA Code	Knowledge Area
202	Plant Genetic Resources

Outcome #17

1. Outcome Measures

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

2. Associated Institution Types

- 1890 Extension
- 1890 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	65

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
Variety trials of tomato, leafy greens, and sweetpotato crops grown in organic management practices during 2015 growing season at TSU certified organic farm. Various mulch treatments applied in organic sweetpotato variety trial to manage weed populations and control.

Results
Analysis of sixty five new cultivars of organic tomato (26), leafy greens (25) and sweetpotato (14) for improved agronomic characteristics, higher yields, resistance to pest and diseases, and palatability. Mulch products were evaluated to provided lower occurrence of weeds in sweetpotato fields.

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 #18

1. Outcome Measures

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

2. Associated Institution Types

- 1890 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	1

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 are applying plant breeding and germplasm screening to improve grain amaranth and test the crop for adaptation to growing conditions in Tennessee.

What has been done
Evaluation plots were established for 260 Amaranth accessions from the USDA as well as a group of 34 lines from Seed Savers Exchange (SSE) plus the first semi dwarf grain amaranths developed in the nation. In addition to agronomic testing in both the greenhouse and field using a new in vitro seedling growth method plus transplanting, we also performed molecular analysis of the plants. DNA extracted for 96 individuals. Part of the agronomic evaluation is via drones and aerial images while the other part has been done with yield trials and biomass/grain measurements.

Results
Results include the identification of best-bet amaranth varieties and the development of DNA and in vitro culture techniques for amarnath. For our laboratory goals, we plan to continue marker

development, DNA extraction, germplasm assembly and the study of tissue culture techniques for amaranths. For breeding goals, we plan to plant the F1 seed to rogue out self-pollinated seedlings and then produce F2 families for each cross and from each individual plant. We will also test the F2 derived F3 families produced from the herbicide resistant x cultivar cross. This research program also facilitated the instruction of 15 graduate and undergraduate students from Tennessee State University and six high school students in molecular techniques.

4. Associated Knowledge Areas

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

Outcome #19

1. Outcome Measures

Cotton farmers' interest in no-till or cover cropping (Jensen)

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Adoption of no-till and cover cropping are proven methods for protecting and enhancing the agricultural environment.

What has been done
We conducted a study of cotton farmers' interest in participating in a pilot program that would incentivize adoption of no-till or cover cropping along with risk management through a STAX federal crop insurance policy.

Results
Results showed that about 28 percent of farmers would be interested in enrolling acreage in such a program at $10 per acre above current EQIP payment levels for no-till and 34.7 percent were interested in participating in a program for cover cropping. These results suggest interest in

participating in a voluntary program to incentivize dual participation in environmental management practices and crop insurance.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
104	Protect Soil from Harmful Effects of Natural Elements
133	Pollution Prevention and Mitigation
205	Plant Management Systems
601	Economics of Agricultural Production and Farm Management

Outcome #20

1. Outcome Measures

Post glyphosate-resistant weed management in cotton (Lambert)

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Growers rapidly adopted glyphosate-resistant crops because the technology provides a cost effective system for managing weeds. However, increased reliance on glyphosate for weed control and a decline in the use of other weed management practices contributed to the rapid evolution of glyphosate-resistant weeds.

What has been done
We used a survey of upland US cotton producers to determine the factors contributing to changes in weed management costs after the identification of herbicide-resistant weeds. Estimated cost transition probabilities were used to determine the effects of adopting practice combinations on weed management cost and the cotton area affected.

Results

The analysis indicates that the most important determinants of post-resistance cost increases are initial weed management costs, the adoption of labor-intensive remedial practices, and wick application of herbicides. Other cultivation and mechanical/chemical-intensive practices did not increase post-resistance weed management costs. Post-resistance weed management costs increase less quickly with combinations of practices that exclude manual weeding and wick applications of chemicals.

4. Associated Knowledge Areas

KA Code	Knowledge Area
204	Plant Product Quality and Utility (Preharvest)
205	Plant Management Systems
213	Weeds Affecting Plants
601	Economics of Agricultural Production and Farm Management

Outcome #21

1. Outcome Measures

Economic Impact of Crop Variety Testing

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
University of Tennessee crop variety testing data is used extensively by 80% of Tennessee farmers to select the seed that they use to plant their oilseed, grain and cotton crops.

What has been done
Results from the variety testing program have helped farmers increase yields by identifying the varieties that will perform best in their farming operations.

Results
In 2015, the higher yields resulted in approximately $102.4 million in additional income to Tennessee farmers.

4. Associated Knowledge Areas

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

Outcome #22

1. Outcome Measures

Row Crops IPM Extension in Tennessee

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Insects and other pests cost many millions of dollars annually in cotton, corn, soybean, wheat and sorghum. IPM education, demonstration and applied research programs are critical to reduce pest related losses and prevent unnecessary use of pesticides that increase production costs and may have negative effects on the environment. The IPM program targets extension agents, growers, private crop consultants, retailers and other agricultural professionals who make management recommendations on these crops.

What has been done
Over 2,000 agricultural clients were directly trained in IPM strategies for field crops at various production meetings, including over 200 individuals trained at cotton or soybean scout schools. The UTcrops News Blog had over 52,000 visits by 28,675 users with 84,000 pages of content viewed. UTcrops.com had over 32,000 visits by 18,931 unique users with 67,000 pages of content viewed.

Results
Savings to row crops producers in Tennessee via reduced insect control costs and yield loss in field crops due to their increased understand of IPM are conservatively estimated at $15 million in 2015.

4. Associated Knowledge Areas

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

V(H). Planned Program (External Factors)

External factors which affected outcomes

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

Brief Explanation

The 2015 growing season started with a wet spring which led to more late planted corn, but temperatures and rainfall were adequate for the majority of the growing season for high corn yields and many growers reporting good yields in non-irrigated fields. The final state average yield was 160 bushels/acre (Jan 2015 NASS Quick stats). Corn prices were lower than in recent years due to the large U.S. crop with producers receiving closer to $3.50 per bushel for their crop on average. Projected cash receipts for 2015 corn grain in Tennessee are estimated at more than $380 million. Soybeans were planted and harvested on more than 1.6 million acres in Tennessee in 2015. Moderate temperatures and adequate rainfall created good to excellent yields in most counties across the state and there was a final state average yield of 46 bushels/acre (Jan 2015 NASS quick facts). Soybean prices were mediocre and most producers received close to $9.00 per bushel for their crop. Projected cash receipts for soybeans in 2015 are more than $660 million.

V(I). Planned Program (Evaluation Studies)

Evaluation Results

The University of Tennessee, Pesticide Safety Education Program (PSEP) provides training and training materials for individuals who want to become certified and/or licensed.

- Five Extension personnel received pesticide certification training for category 10 and Core.
- 822 commercial applicators received training in various pesticide categories provided monthly.
- 95 private applicators received initial certification through online training.
- 1,131 individuals received initial certification training through county offices which used materials developed by the state PSEP program.
- 693 workers and handlers received Worker Protection Standard training through efforts made available through the PSEP Program.

Young and Ramsay (2011) estimated that the annual value of certified applicator training programs was $6,787 for initial certification and $13,366 for re-certification per trainee. For example, training improves gross revenues by improving crop yield and quality, and it also reduces labor costs since producers who are certified applicators do not have to hire private contractors.

Using the Young and Ramsay (2011) research, the economic impact of Tennessee's

Extension PSEP in 2015 was estimated at $10.9 million.
Young, D. & Ramsay, C. (2011). What is the value of Extension training for certified pesticide applicators? Journal of Pesticide Safety Education, 13: 14-23.

Key Items of Evaluation

The University of Tennessee Extension's Pesticide Safety Education Program had 1266 certifications, and research has estimated annual benefits of $10.9 million.

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%	12%	16%
302	Nutrient Utilization in Animals	0%	0%	24%	23%
303	Genetic Improvement of Animals	10%	10%	0%	23%
304	Animal Genome	0%	0%	4%	0%
305	Animal Physiological Processes	0%	0%	11%	0%
306	Environmental Stress in Animals	0%	0%	5%	0%
307	Animal Management Systems	60%	60%	0%	38%
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%	14%	0%
402	Engineering Systems and Equipment	0%	0%	2%	0%
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: 2015	Extension		Research	
	1862	1890	1862	1890
Plan	44.0	5.0	30.0	9.0
Actual Paid	45.0	8.0	23.9	8.0
Actual Volunteer	11.0	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**
892188	261363	547536	376025
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
3834979	338467	2943207	376025
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
200000	0	106094	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

The Master Beef Producer Program was led by a team of University of Tennessee 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. Master Beef Producer programs were taught by agents who completed the comprehensive training curriculum. During this training, agents were exposed to each session of the program, and were provided on-screen presentations, speaker notes, evaluation instruments, and instructions about the most effective strategies for teaching this curriculum. Industry professionals, veterinarians, and other local industry leaders were included as a part of the teaching team. The Master Beef Producer Program:

1. Included a series of 12 educational sessions that focused on cow-calf production and issues facing the beef industry. These were conducted at various off-campus locations accessible to Tennessee beef producers. These sessions included hands-on demonstrations, mini-lectures, discussions, question and answer sessions, etc.

2. Enhanced the profitability and competitiveness of cow-calf operations by providing essential, technical information.

3. Provided participants with a beef production reference manual that covers in detail the educational information presented in the sessions.

4. Allowed producers to interact with trained facilitators and encourage sharing of ideas with other producers.

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. 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.

2015 marked the ninth year for the Tennessee Browsing Academy, an extensive four day hands-on training for producers, educators, and other professionals interested in the biological and environmentally sound practices of vegetative management with small ruminants (specifically goats). This class was

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.

Additionally, research is conducted on the longitudinal survival and reproductive output of meat goat does and on expanding the meat goat market to new consumers/ethnic groups/communities.

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 UT 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.

Alternative poultry production is the benefit of research on nutritional requirements for Guinea fowl and genome mapping of important production qualities in Guinea fowl.

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 composed 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?

This Animal Systems Planned Program was enhanced through the service of:

- 13 Tennessee Extension personnel on the "Beef Cattle" CoP;
- two Tennessee Extension personnel on the "Goat Industry" CoP; and
- two Tennessee Extension personnel on the "HorseQuest" CoP.

Tennessee Extension professionals shared program implementation strategies, outcome measurement, and evaluation protocols with their CoP colleagues.

V(E). Planned Program (Outputs)

1. Standard output measures

2015	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	374845	7929252	316637	55

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

Patent Applications Submitted

Year:	2015
Actual:	1

Patents listed

Edwards, J.L. L.A. Rispoli and F.N. Schrick. UTRF Utility Patent Antibody for skewing sex ratio and methods of use thereof. U.S. Patent Application Serial No. 14/626,401. February 2015. Filed February 19, 2015. Rispoli, L.A., Edwards, J.L. and F.N. Schrick. 2015

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2015	Extension	Research	Total
Actual	4	87	91

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
2015	84

Output #2

Output Measure

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

Year	Actual
2015	673

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

- Producer workshops to improve animal production in small farm and limited resource populations.

Year	Actual
2015	5688

Output #5

Output Measure

- Dietary recommendations for improved Guinea fowl production.

Year	Actual
2015	1

Output #6

Output Measure

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

Output #7

Output Measure

- Improve Reproductive Efficiency in Cattle (Rispoli)
  Not reporting on this Output for this Annual Report

Output #8

Output Measure

- Promote Native Grasses in Forage Systems (Keyser)

Year	Actual
2015	1

Output #9

Output Measure

- Validated in vivo models in both beef and dairy cattle to predict late embryonic mortality. (Pohler)

Year	Actual
2015	1

Output #10

Output Measure

- While a pre-partum supplemental feeding program was not necessary to improve livestock producers' profits, retained ownership is a valuable marketing alternative for Tennessee cattle producers. (Lewis)

Year	Actual
2015	1

Output #11

Output Measure

- Research examined why consumers support laws such as mandatory country of origin labeling (MCOOL) for beef. Since MCOOL is at the center of several policy debates between the U.S., Canada and Mexico, this research is helpful to policy makers. (Lewis)

Year	Actual
2015	1

Output #12

Output Measure

- Given the offer of a cost-share, 816 of 1,153 respondents indicated they would adopt or expand prescribed grazing for greenhouse gas reduction (Clark, English, Jensen, Lambert, Yu)

Year	Actual
2015	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	Direct contact meat goat producers will have increased knowledge of altered doe selection techniques (Enhanced capacity of a sustainable global food system including new/improved plants, animals, technologies and management systems).
9	Goat producer doe non-recorders will have knowledge of the advantages of doe record keeping (Enhanced capacity of a sustainable global food system including new/improved plants, animals, technologies and management systems).
10	Percentage of meat goat producers and researchers with a better understanding of how maternal genetics can affect meat goat carcass yield (Enhanced capacity of a sustainable global food system including new/improved plants, animals, technologies and management systems).
11	Guinea fowl producers will have knowledge of calcium and phosphorus recommendations for optimal nutrition (Enhanced capacity of a sustainable global food system including new/improved plants, animals, technologies and management systems).
12	Guinea fowl producers will have knowledge of lysine recommendations for optimal nutrition.
13	Guinea fowl producers will experience increased profitability of production (More sustainable, diverse, and resilient food systems across scales).
14	Goat producers will have an increased knowledge of meat goat marketing channels.
15	Consumers will be aware of the healthy benefits of goat meat consumption.
16	Develop Diagnostic Devices for Animal/Human Diseases (Eda)

17	Exploit Pathways for Leanness in Poultry/Humans (Voy)
18	Supplement Nutrients for Improved Reproduction (Mulliniks)
19	Willingness-to-Pay for Carbon-friendly Beef Practices (Clark, Jensen, Lambert)
20	Identify Cattle Resistant to Tall Fescue Toxicosis (Kojima)
21	The Tennessee Value-Added Beef Program

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
2015	84

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
2015	3171

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
2015	4129

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 #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
2015	3553

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
2015	201418

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
2015	174

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
To remain viable in a competitive marketplace, livestock and forage producers must improve their management efficiency, sustainability and productivity. Tennesseans need education in maintaining or improving production efficiency, marketing, product quality and food safety. The Tennessee State University Goat Extension Program serves the agricultural industry of Tennessee by providing meaningful educational programs in efficient production of animals and wholesome animal products. These programs are directed through TSU/UT Extension staff.

What has been done
The Tennessee Goat Extension program provides Master Goat Producer Training, Dairy Goat Production Training, Browsing Academies, Small Ruminants Hot Topics and technical assistance to small ruminant producers across the state of Tennessee each year. It also provides training and assistance to 4-H youth involved in livestock showing and judging contests as well. 10,988 direct contacts were made over the course of 2015 by extension personnel and volunteers.

Results
As a result of the Goat Extension Program:

-174 goat producers have implemented practices related to genetic improvement, nutrition, health, reproduction and other information as a result of the Master Goat Program.
-653 goat producers have improved knowledge about genetic improvement, nutrition, health, reproduction and other information as a result of the Master Goat Program.
-429 goat producers report improved production efficiency due to practices implemented from their Master Goat Program participation.

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

Direct contact meat goat producers will have increased knowledge of altered doe selection techniques (Enhanced capacity of a sustainable global food system including new/improved plants, animals, technologies and management systems).

2. Associated Institution Types

- 1890 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	500

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.

What has been done
Research on improving herd strength via doe selection techniques was performed and results

were disseminated to producers at industry and university events.

Results
Research outcomes have allowed 500 new and experienced producers to gain a better understanding of the benefits of informed breed selection for use in commercial meat goat herds.

4. Associated Knowledge Areas

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

Outcome #9

1. Outcome Measures

Goat producer doe non-recorders will have knowledge of the advantages of doe record keeping (Enhanced capacity of a sustainable global food system including new/improved plants, animals, technologies and management systems).

2. Associated Institution Types

- 1890 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	20

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Meat goat producers recognize the need to properly evaluate breeding females for enhanced herd fitness and production efficiency.

What has been done
Research was conducted to develop an evaluation protocol for doe herd evaluation. The protocol has been offered to producers for objective performance testing.

Results
As demonstrated by our research findings, producers have begun to reconsider the need to record performance to improve the genetic and economic status of their meat goat breeding programs.

4. Associated Knowledge Areas

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

Outcome #10

1. Outcome Measures

Percentage of meat goat producers and researchers with a better understanding of how maternal genetics can affect meat goat carcass yield (Enhanced capacity of a sustainable global food system including new/improved plants, animals, technologies and management systems).

2. Associated Institution Types

- 1890 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	80

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The meat goat industry has been directed towards the production of market kids over the last 10-15 years under the assumption that Boer germplasm is superior for carcass yield among goat breeds.

What has been done
Research was performed to evaluate the impact of maternal genetics on carcass yield. Results were provided to producers giving new insight on relative sire and dam breed evaluations for carcass yield traits and general herd economic returns.

Results
Reconsideration of breed selection approaches for carcass traits is occurring in the meat goat industry.

4. Associated Knowledge Areas

KA Code	Knowledge Area
303	Genetic Improvement of Animals

307 Animal Management Systems

Outcome #11

1. Outcome Measures

Guinea fowl producers will have knowledge of calcium and phosphorus recommendations for optimal nutrition (Enhanced capacity of a sustainable global food system including new/improved plants, animals, technologies and management systems).

2. Associated Institution Types

- 1890 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	2

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
While the guinea fowl industry is growing in the United States, there are constraints in developing a thriving and sustainable industry because of lack of established nutrient requirements to guide the formulation of least-cost rations. Information on the required dietary levels of calcium, phosphorus and lysine, a limiting amino acid that would ensure optimum performance of these birds, is limited.

What has been done
Dietary calcium (Ca) and phosphorus requirement for optimum growth performance of the Pearl Grey guinea fowl replacement pullets and laying hens were evaluated.
Dietary Lysine requirement for both the French and Pearl grey varieties of the Guinea Fowl were evaluated.

Results
Pearl Grey guinea fowl replacement seems to utilize more efficiently diets containing 0.8% Ca and 0.32-0.48% available phosphorus. Pearl Grey Guinea Fowl laying hens utilized more efficiently diets containing 3.25 to 3.75% calcium and 0.35 to 0.40% available phosphorus. Number of producers with knowledge of these values has not yet been calculated. The French guinea fowl broilers be fed diets containing 1.10 % lysine during the exponential growth phase seems to provide optimum growth performance. Findings from this research also suggest that Pearl grey guinea fowl replacement pullets (females) and males be fed diets containing 1.16% and 0.98-1.22% lysine, respectively.
Results were presented at conferences and workshops and also shared with guinea fowl producers.

4. Associated Knowledge Areas

KA Code	Knowledge Area
302	Nutrient Utilization in Animals

Outcome #12

1. Outcome Measures

Guinea fowl producers will have knowledge of lysine recommendations for optimal nutrition.

2. Associated Institution Types

- 1890 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	2

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The costs associated with the production of Guinea fowl need to minimized for producers to realize maximum profit as this species becomes more accepted in American diets.

What has been done
Research to determine the optimum levels of lysine is complete and the information is being disseminated to stake holders. One paper was published and one more is being developed for publication this year.

Results
Optimum levels are being communicated to producers, thus no opportunity for producer knowledge/adoption of optimized levels yet.

4. Associated Knowledge Areas

KA Code	Knowledge Area
302	Nutrient Utilization in Animals

Outcome #13

1. Outcome Measures

Guinea fowl producers will experience increased profitability of production (More sustainable, diverse, and resilient food systems across scales).

2. Associated Institution Types

- 1890 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Feeding constitutes more than 65% of the total cost of poultry production. Minimizing this cost by establishing the lysine requirement will minimize this cost and encourage participation in guinea fowl production.

What has been done
Research to determine the optimum levels of lysine has been completed and recommendations being disseminated to stakeholders for adoption.

Results
Adequate feedback has not been received as yet on the profitability of the guinea fowl production as a result of recommended dietary changes. This information will be sought from producers and documented.

4. Associated Knowledge Areas

KA Code	Knowledge Area
302	Nutrient Utilization in Animals

Outcome #14

1. Outcome Measures

Goat producers will have an increased knowledge of meat goat marketing channels.

2. Associated Institution Types

- 1890 Extension
- 1890 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Goat producers need to know what consumers are looking for in their goat meat and goat products. Consumers are looking for information on alternative to red meets to meet nutritional and cultural needs with goat meat. Processors want connection with producers and consumers to maximize the use of facilities. Researchers seek opportunities to gain new knowledge about meat goat and goat meat. Students desire to learn about goat meat marketing research, how to conduct survey, and analyze data. Goats are important in the economy of Tennessee and relatively little is known about this industry.

What has been done
Team conducted research, training and education that enhanced producer skills and understanding of issues in marketing goat meat channels, processing capacity, and industry complexity in Tennessee. Project continued mentoring, training and supervising 10 students (7 graduate students and 3 undergraduate students) in conducting research and marketing. These students were involved with literature review, survey design, data collection, data coding, data entry and analysis using IBM SPSS statistics, Microsoft office and the internet. Project team collaborated in designing and implementing educational activities for the target audiences (meat goat producers, consumers, researchers, students and stakeholders). Education and outreach included: local seminars and symposiums for students and researchers; producer related expos, field days and tours or outreach.

Results
Research found few custom slaughtered facilities sparingly located were insufficient to support local meat goat production and demand in Tennessee. However these facilities were certified, in good sanitary condition and have the capacity to process goat meat. Furthermore, results also showed that it cost less to process large volume of animals at reduced cost, saving both the

consumer money in per unit cost and producer in transportation, maximizes facility efficiency for processor. These findings support the theory that facility size plays an important role in processing larger volumes with efficiency, lowering the average fixed costs per animal.

4. Associated Knowledge Areas

KA Code	Knowledge Area
307	Animal Management Systems

Outcome #15

1. Outcome Measures

Consumers will be aware of the healthy benefits of goat meat consumption.

2. Associated Institution Types

- 1890 Extension
- 1890 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Health conscious consumers seeking alternative to red meat or reduce their cholesterol tend to choose goat meat. Immigrants who have a taste for goat meat, or want to satisfy nutritional needs and first time eaters also may enjoy eating goat meat. These individuals need education and information about availability of meat goat and goat products in Tennessee. Many consumers are looking for information on alternative to red meets to meet nutritional and cultural needs. An opportunity exists to fill their demand with the abundant supply of goat meat by Tennessee producers.

What has been done
Project provided consumer education on healthy aspects to enhance market connections. Seminars, symposium, meetings, posters and tour were used in discussing the nutritional value and benefits of consuming goat meat.

Results
Secondary data showed that goat meat is low in saturated fat and cholesterol, rich in protein compared to other red meats. Sixty four percent of the respondents said that advertising the

product in grocery stores and restaurants, consumer education, taste sampling at fairs, festivals and local food stores, product packaging, better market conditions and among others were listed as viable factors influencing the popularity of goat meat among Americans.

4. Associated Knowledge Areas

KA Code	Knowledge Area
307	Animal Management Systems

Outcome #16

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
2015	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Annual economic impact of Johne's disease to the US diary industry was estimated to be more than $200 million. In 2012, it was estimated that more than 90% of dairy herds in the United States are contaminated with the causative agent of Johne's disease.

What has been done
We developed a new diagnostic test, named EVELISA test, which showed much higher sensitivity (approximately 90%) compared to that of current ELISA tests in detecting animals with Johne's disease. The new ELISA test was shown to be effective also in diagnosis of bovine tuberculosis.

Results
The new test for Johne's disease was commercialized in 2015.

4. Associated Knowledge Areas

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

Outcome #17

1. **Outcome Measures**

Exploit Pathways for Leanness in Poultry/Humans (Voy)

Not Reporting on this Outcome Measure

Outcome #18

1. **Outcome Measures**

Supplement Nutrients for Improved Reproduction (Mulliniks)

Not Reporting on this Outcome Measure

Outcome #19

1. **Outcome Measures**

Willingness-to-Pay for Carbon-friendly Beef Practices (Clark, Jensen, Lambert)

2. **Associated Institution Types**

- 1862 Extension
- 1862 Research

3a. **Outcome Type:**

Change in Knowledge Outcome Measure

3b. **Quantitative Outcome**

Year	Actual
2015	0

3c. **Qualitative Outcome or Impact Statement**

Issue (Who cares and Why)
The cattle industry contributes the majority of U.S. agricultural greenhouse gas (GHG) emissions.

What has been done
We examine a hypothetical third party certified labeling program for beef, ?Raised Carbon Friendly? (RCF). The RCF label is applied if the beef is from cattle raised on farms using prescribed grazing. Willingness to support and pay for an RCF label is estimated using a survey of U.S. consumers.

Results
We estimate that 65% of U.S. beef consumers support the use of grazing practices to reduce greenhouse gas emissions associated with cattle production. Among supporters, annual average household WTP is $210, while WTP for beef consuming households is $55 annually.

4. Associated Knowledge Areas

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

Outcome #20

1. Outcome Measures

Identify Cattle Resistant to Tall Fescue Toxicosis (Kojima)

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Fescue Toxicosis is one of the most costly obstacles producers of beef cattle face in the southeastern United States. The availability of a genetic marker that would identify animals who were genetically resistant to the effects of fescue toxicosis would be most helpful.

What has been done
Over the last three years, two manuscripts, 4 abstracts, and 2 theses have been published from my lab identifying and characterizing the DRD2 genetic marker.

Results
This technology has been commercialized by a small startup company.

4. Associated Knowledge Areas

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

Outcome #21

1. Outcome Measures

The Tennessee Value-Added Beef Program

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The Tennessee Value-Added Beef Program was a new initiative developed by Extension specialists in the Center for Profitable Agriculture, Animal Science, and Food Science and Technology in response to Tennessee cattle producers asking an increasing number of questions about developing business enterprises beyond traditional cow-calf production systems.

What has been done
The program has provided a range of educational programming and materials including conferences, workshops, webinars, and publications. Beef consumer market research was conducted, and educational programs were focused on all aspects of marketing value-added beef. Outreach included 20 professionals from five agencies and 30 Tennessee Extension agents.

Results
Over the past four years, the Tennessee Value-Added Beef Program has helped Tennessee farms to greatly expand their value-added beef marketing. Specifically, the number of farm-based retail meat permits issued by the Tennessee Department of Agriculture from December 2011 to May 2015 (from 57 to 142) has increased 149%.

4. Associated Knowledge Areas

KA Code	Knowledge Area
307	Animal Management Systems

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 livestock programs fluctuates from year-to-year depending on a number of factors including commodity prices, input costs, and land value. However, these programs continue to enhance the lives and livelihood of Tennessee livestock producers by providing timely, research based information designed to increase overall profitability.
In 2015 beef producers began to experience a decline in what had been record prices for feeder cattle, cull breeding animals and finished cattle. Prices also continued to be volatile and sensitive to news both on the domestic and international fronts. Stocker operators, especially because they are margin operators, must manage their risk for both cattle and purchased inputs. Cow calf producers must manage not only production risk by improved health and nutrition management but also price risk.

V(I). Planned Program (Evaluation Studies)

Evaluation Results

Meat goat research produced the following evaluation:
A primary aim of the outreach effort is educating producers of the importance of performance recording and evaluation. This program has a website with one page dedicated to performance recording. Over the last year, the performance page averaged 3 to 4 visitors per week. Most of the impact has been seen within the Kiko breeder group. There were a dozen producers that enrolled in the initial web-based herd evaluation system. This web component is somewhat hindered by fragmentation within the breeder group that requires resolution.
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 outreach activities from this lab.
Kiko goats are starting to be offered for sale with performance data, some actual and some relative. This was not evident before the push for performance recording. The proportion of animals sold with performance data is still low, although many producers may be using the data for internal selection only. In the upcoming year an effort will be made to determine the extent to which producers are using the performance data collected.
Optimizing Animal Production

Extension agents emphasized quality assurance, reproductive management, nutrition, and marketing with Tennessee beef producers 2015, 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.

Forage Systems

UT Extension educated farmers on the benefits of warm-season grasses, clover, and stockpiling tall fescue. Extension also demonstrated hay storage, feeding methods to reduce waste and spoilage, and broadleaf weed control. Tennessee farmers saved more than $17.8 million from better forage production, including following fertilizer recommendations, storage, and feeding practices.

Key Items of Evaluation

Optimizing 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%	15%
701	Nutrient Composition of Food	5%	5%	0%	8%
702	Requirements and Function of Nutrients and Other Food Components	0%	0%	0%	9%
703	Nutrition Education and Behavior	95%	95%	0%	38%
724	Healthy Lifestyle	0%	0%	0%	15%
806	Youth Development	0%	0%	0%	15%
	Total	100%	100%	0%	100%

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2015	Extension		Research	
	1862	1890	1862	1890
Plan	75.0	8.0	0.0	8.0
Actual Paid	68.0	8.0	0.0	7.0
Actual Volunteer	16.0	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**
1338282	406564	0	329022
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
5752468	526504	0	329022
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
5986105	100000	0	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

UT and TSU Extension used the Power U curriculum in Tennessee schools and afterschool programs. Extension personnel and volunteers used the curriculum to teach diet quality to young adolescents. The program was delivered through 10 interactive lessons. 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 TSU Youth Active and Media Savvy (YAMS) program was used to facilitate media literacy research and education.
TSU research is conducting programs to develop alternative foods for improved nutrition and identify naturally occurring compounds to supplement human nutrition.

2. Brief description of the target audience

Tennesseans targeted included consumers and youth. Because of the prevalence of obesity in the state, all consumers are potentially members of the target audience. However, the TNCEP and EFNEP programs were targeted to the state's limited resource population. In addition, the TSU Food Nutrition Education Program was targeted to eligible food stamp recipients.

3. How was eXtension used?

This 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

2015	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	220504	3770891	305018	52

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

Patent Applications Submitted

Year: 2015

Actual: 0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2015	Extension	Research	Total
Actual	1	25	26

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

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

Year	Actual
2015	1352

Output #2

Output Measure

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

Year	Actual
2015	193387

Output #3

Output Measure

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

Year	Actual
2015	0

Output #4

Output Measure

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

Year	Actual
2015	0

Output #5

Output Measure

- Number of parameters examined comparing the physiological effects of soy fiber to other fiber sources.

Year	Actual
2015	0

Output #6

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
2015	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	Target youth attending summer camp sessions (Children Engage in Healthy Levels of Physical Activity).
7	Target youth with increased self-efficacy and self-esteem
8	Target youth maintaining healthy behaviors 12 months post-intervention (Children Engage in Healthy Levels of Physical Activity).
9	Increase in the number of flavanoid compounds that can be used for supplemental nutrition.
10	Public acceptance of soy fiber fortified breads for increased fiber consumption.
11	Establish the fundamental mechanism by which cost-effective, naturally available compounds can promote health and extend lifespan in humans.
12	Farmers' Market Fresh

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
2015	1587

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
2015	2473

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
2015	3893

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
2015	3722

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
2015	2678

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

Target youth attending summer camp sessions (Children Engage in Healthy Levels of Physical Activity).

2. Associated Institution Types

- 1890 Extension
- 1890 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	25

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
African-Americans have disproportionately higher rates of obesity and reportedly watch more television than other Americans. Although many social, cultural, and environmental factors influence childhood and adolescent risk for obesity, marketing may have an especially powerful impact on food and beverage consumption. Using a summer camp setting, YAMS was developed to combat the influences of media, insufficient nutrient intake and excess caloric consumption, and inactivity on childhood obesity through media literacy, nutrition education, and physical activity, respectively.

What has been done
One, 3-week long camp was held with a total of 25 youth ages 8-13 attending. Three high school peer educators volunteered and served as mentors. Four undergraduate college students, one graduate student, and the peer educators were trained on the Youth Active and Media Savvy and the Cooking Matters curricula. Participants prepared their lunches after receiving nutrition education and food safety lessons beforehand. Each day, campers were involved in 60-minutes of physical activity. Campers participated in cultural and self-esteem empowering activities in gender specific social circles daily. Field trips taken include a trip to a grocery store, the local farmers market, Tennessee State University's campus radio station, Wave Country Water Park, a local farm and the Challenge Course at the Tennessee State University Agriculture Research and Education Center in Ashland City.

Results
Youth created and presented various forms of media and artistic expressions (i.e. posters, songs, raps, poems and videography) concerning deceitful food marketing, healthy habits, the YAMS camp, and positive self-images of their culture. Observations and self-reports from camp participants and their parents/guardians affirm that campers were motivated to implement and share healthier food alternatives at home.

4. Associated Knowledge Areas

KA Code	Knowledge Area
703	Nutrition Education and Behavior

Outcome #7

1. Outcome Measures

Target youth with increased self-efficacy and self-esteem

2. Associated Institution Types

- 1890 Extension
- 1890 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	25

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Self-esteem is important to building self-efficacy needed to read food labels, prepare healthy meals, and implement anti-obesogenic behaviors.

What has been done
Delivered thirty-six sessions that involved cultural and self-esteem empowering activities in gender-specific groups according to and influenced by, the principles of Kwanzaa (unity, self-determination, collective work and responsibility, cooperative economics, purpose, creativity, faith, legacy/heritage, beauty, personal hygiene, respect) and Ubuntu (?I am because you are?).

Results
Repeat campers report sustaining behaviors such as reading food labels and increasing water intake, and limiting the number of sodas and other unhealthy snack foods.

4. Associated Knowledge Areas

KA Code	Knowledge Area
703	Nutrition Education and Behavior
724	Healthy Lifestyle
806	Youth Development

Outcome #8

1. Outcome Measures

Target youth maintaining healthy behaviors 12 months post-intervention (Children Engage in Healthy Levels of Physical Activity).

2. Associated Institution Types

- 1862 Extension
- 1890 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	25

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
It is important that programs that target youth show that the behavior change is sustainable and can be maintained after leaving the camp.

What has been done
A 12-month post-intervention has not been captured.

Results
A 12-month post-intervention for 2015 has not been captured, however the analysis of data from 2012-2014 show approximately 85% of the respondents report increased physical activity and improved dietary habits 12 months after attending YAMS camp.

4. Associated Knowledge Areas

KA Code	Knowledge Area
703	Nutrition Education and Behavior
724	Healthy Lifestyle
806	Youth Development

Outcome #9

1. Outcome Measures

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

2. Associated Institution Types

- 1890 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	1

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The promotion of healthy eating can reduce the incidence of diseases associated with oxidative damage especially in youth the ages of 13-20.

What has been done
Examined ways to condense the beneficial properties of flavonoids into a more easily consumable product.
Biochemical research of flavanoids.
Research into how quercetin, genistein and kaempferol modulate adipocyte cells differentiation in 3T3-L1 cells.

Results
Flavonoids inhibited the differentiation of the 3T3-L1 preadipocytes to adipocyets suggesting the possible molecular mechanisms by which these flavonoids may both inhibit and induce apoptosis in preadipocytes. Quercetin, genistein and kaempferol do prevent oxidative damage, thereby lowering the oxidative damage through the metabolic syndrome.
Specifically the studies have shown that the above mentioned flavonoids can enhance the cell?s capabilities to better cope with oxidative damage induced by obesity by enhancing the levels of the cell?s glutathione (GSH, a natural antioxidant in cells), and its antioxidative through the glutathione peroxidase (GSH-PX), glutathione reductase (GSH-Rx), superoxide dismutase (SOD), and glucose-6-phosphate dehydrogenase (G-6-PDH) pathways.

4. Associated Knowledge Areas

KA Code	Knowledge Area
502	New and Improved Food Products

703 Nutrition Education and Behavior

Outcome #10

1. Outcome Measures

Public acceptance of soy fiber fortified breads for increased fiber consumption.

2. Associated Institution Types

- 1890 Extension
- 1890 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Due to the increasing chronic disease issues, the general public are 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 fibers. 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 the dough quality when 5% and 10% soy fiber was added. Soluble fiber could significantly lower the glucose releasing profile in intestinal tract by using an in vitro digestion model. The obesity cell accumulated less fat droplet 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.

4. Associated Knowledge Areas

KA Code	Knowledge Area
502	New and Improved Food Products
703	Nutrition Education and Behavior

Outcome #11

1. Outcome Measures

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

2. Associated Institution Types

- 1890 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	0

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 processes and decrease of quality of life.

What has been done
Animal tissues have been collected and analyzed. Aging-reduced actin protein expression in the muscle was reversed by treatment. This reduced protein is the major contributor of skeletal muscle dysfunction.

Results
Results indicate aging-reduced actin protein expression in the muscle was reversed by treatment. This reduced protein is the major contributor of skeletal muscle dysfunction. Epicatechin intake may delay aging process by improving muscle function and therefore possibly improve quality of life. One peer-reviewed journal article on this work will be published in 2016, results have been presented on 44th American Aging Association Annual Meeting, and one PhD student will graduate in 2016.

4. Associated Knowledge Areas

KA Code	Knowledge Area
701	Nutrient Composition of Food

702 Requirements and Function of Nutrients and Other Food Components

Outcome #12

1. Outcome Measures

Farmers' Market Fresh

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Limited-resource individuals consume disproportionally fewer fruits and vegetables. Increasing fruit and vegetable consumption among this population continues to be of paramount importance. To help facilitate increased consumption, limited resource consumers need access to fresh, high-quality fruit and vegetables. Additionally, education on selecting and preparing fresh fruits and vegetables is needed.

What has been done
In 2015, UT Extension developed and implemented Farmers? Market Fresh, a social marketing campaign engaging limited-resource consumers. The primary objective of this campaign was to promote fruit and vegetable consumption through farmers? markets accepting SNAP/EBT benefits. This program was implemented at 15 farmers? markets in 12 Tennessee counties. Extension agents conducted 121 food demonstrations resulting in 29,071 educational contacts.

Results
__3,198 participants reported increased consumption of locally-grown fruits.
__5,523 participants reported increased consumption of locally-grown vegetables.
__In 2015, SNAP redemption at the Farmers' Market Fresh pilot markets increased by over $3,600 from $13,032 to $16,653.

4. Associated Knowledge Areas

KA Code	Knowledge Area
703	Nutrition Education and Behavior

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

V(I). Planned Program (Evaluation Studies)

Evaluation Results

YAMS summer camp intervention was evaluated using a triangulation of methods. Baseline surveys captured household, socioeconomic, psychosocial, and behavioral information from parents and youth campers. Campers were also given pre-and post-assessments regarding media usage, physical activity, and nutrition education level on the first and last day of camp. Campers were also given a evaluation booklet that allowed them to record their thoughts about the daily activities during "ReKinection" sessions held at the end of the day. The camp facilitators were required to document and record their thoughts and observances daily as well. Daily and at the end of each camp session, debriefings were held to discuss and document the process of developing the YAMS camp curriculum. Focus groups of parents and campers were held during the month of December each year to access behaviors approximately 6-months after the camp intervention. The pre- and post-assessments are currently being analyzed based on session, year, and aggregately as this project used an adaptive intervention design to explore culturally acceptable methods to:
1) Counteract negative media influences, unhealthy dietary behaviors, and sedentary lifestyles; 2) Increase media literacy and improve the food choices, dietary intake, and nutrition related attitudes of youth in our communities; 3) Use findings to incorporate culturally empowering health behaviors and messages into a summer camp intervention; and 4) Pilot test and refine the summer camp curriculum.

Key Items of Evaluation

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%	7%	0%
601	Economics of Agricultural Production and Farm Management	30%	30%	25%	50%
602	Business Management, Finance, and Taxation	5%	5%	0%	0%
603	Market Economics	5%	5%	0%	0%
604	Marketing and Distribution Practices	30%	30%	0%	50%
605	Natural Resource and Environmental Economics	0%	0%	31%	0%
606	International Trade and Development	5%	5%	7%	0%
607	Consumer Economics	10%	10%	0%	0%
608	Community Resource Planning and Development	15%	15%	17%	0%
610	Domestic Policy Analysis	0%	0%	13%	0%
	Total	100%	100%	100%	100%

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2015	Extension		Research	
	1862	1890	1862	1890
Plan	32.0	7.0	35.0	3.0
Actual Paid	32.0	4.0	30.4	2.0
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**
624532	116161	972525	94006
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
2684485	150430	1784050	94006
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
77000	155133	844128	0

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 Extension MANAGE program helps families analyze their total farming business so they can make informed decisions regarding their future. Extension staff trained in farm and financial management help 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 is will offer hundreds of workshops to help farmers improve their financial situation. For example, workshops will be offered in improved marketing, goal-setting, and strategic planning.

Although the MANAGE program will not remove uncertainty of the future, it will provide farm families with a clear understanding of their current financial situation and help them evaluate their alternatives for the future. Making informed decisions today may be the best way to prepare for tomorrow's opportunities. The educational program is 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" will continue to be conducted to make landowners aware of resources that are available to them for land retention and crop

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

Leadership development workshops will focus 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.

The economics of commerce and the subsequent impact on the lives of Americans will be examined through research on food distribution practices as they relate to the health and well-being of Americans, particularly in the South.

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?

Economic Infrastructure and Commerce Planned Program was enhanced through the service of:

- 10 Tennessee Extension personnel on the "Entrepreneurs and Their Communities" CoP, and
- four Tennessee Extension personnel on the "Network Literacy" CoP.

V(E). Planned Program (Outputs)

1. Standard output measures

2015	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	48714	982091	4256	0

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

Patent Applications Submitted

Year:	2015
Actual:	0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2015	Extension	Research	Total
Actual	5	64	69

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

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

Year	Actual
2015	50

Output #2

Output Measure

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

Year	Actual
2015	52

Output #3

Output Measure

- Number of venues to inform stakeholders about characteristics, trends, and significant changes in supply distribution of produce commodities in the U.S.

Year	Actual
2015	4

Output #4

Output Measure

- Agriculture, with multiplier effects, accounted for 9.0 percent of the state?'s economy and generated $52.6 billion in output and employed close to 254,000 Tennesseans, with over 109,000 (both full?- and part?-time) in agricultural production. (Jensen)

Year	Actual
2015	1

Output #5

Output Measure

- Consolidating the Ocmulgee National Monument in central Georgia with areas of surrounding public lands and a portion of the Ocmulgee River waterway into a National Park and Preserve could add as much as $226 million annually by 2031 to the area?s economy compared with no national park formation. (Jensen)

Year	Actual

2015	1

Output #6

Output Measure

- Conservation organizations need to better account for acquisition costs. Acquisition costs for protected areas in our survey show pronounced economies of scale; specifically ten times the area can be purchased for seven times the cost of a smaller site. (Cho)

Year	Actual
2015	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	Producers and businesses in the produce industry and policy makers will have increased knowledge of characteristics, trends, and significant changes in supply distribution of produce commodities in the U.S. (more sustainable, diverse, and resilient food systems across scales).
8	Students will have increased knowledge of characteristics, trends, and significant changes in supply distribution of produce commodities in the U.S. (more sustainable, diverse, and resilient food systems across scales).
9	Producers and businesses in the produce industry, consumers, educators, researchers, and policy makers will have increased knowledge about current issues on fruit and vegetable consumption/demand and its relationship with overweight/obesity in the U.S.
10	Students will have increased knowledge about current issues on fruit and vegetable consumption/demand and its relationship with overweight/obesity in the U.S.
11	Assess the Local Food System/the Knoxville Foodshed (Hellwinckel)
12	US sugar policy (Lewis)
13	Willingness to Purchase Tennessee Steak (Jensen)

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
2015	30

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.

Not Reporting on this Outcome Measure

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
2015	16

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
2015	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
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

2015	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
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

Producers and businesses in the produce industry and policy makers will have increased knowledge of characteristics, trends, and significant changes in supply distribution of produce commodities in the U.S. (more sustainable, diverse, and resilient food systems across scales).

2. Associated Institution Types

- 1890 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	20

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

An evaluation of trends and significant changes in farm and supply distribution of produce commodities will provide empirical evidence and perspectives for policy makers, producers and businesses to evaluate needs and opportunities, and to effectively design and implement policies and programs that create market access and opportunities for fresh produce farmers and businesses. Research on these issues, though invaluable to various stakeholders, is very limited or not up to date. This study provides the most up-to-date empirical evaluation of the recent developments in the fresh produce market.

What has been done

Combining the studies and findings from trends of produce industries and needs and demand of consumers for fresh produce, the project draws implications for building and strengthening local food systems and increasing affordable and accessible product for consumers. The analysis suggests that there are opportunities and growth potential for small farms, specialty-crop farms, many forms of direct-to-consumers sales, in particular in the South.

Results

The analysis also suggests the south has a larger share of small farms but accounted much less in direct-to-consumer sales compared with the rest of the nation. These may suggest potential growth of direct-to-consumer sales, especially for small farms and in the South, and it may meet the needs to increase access to healthy foods where obesity rates are high and consumption of healthy foods is low.

About twenty producers and business people increased knowledge of characteristics, trends, and significant changes in supply distribution of produce commodities in the U.S.

4. Associated Knowledge Areas

KA Code	Knowledge Area
601	Economics of Agricultural Production and Farm Management
604	Marketing and Distribution Practices

Outcome #8

1. Outcome Measures

Students will have increased knowledge of characteristics, trends, and significant changes in supply distribution of produce commodities in the U.S. (more sustainable, diverse, and resilient food systems across scales).

2. Associated Institution Types

- 1890 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	10

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Skilled personnel are vital to sustainable growth in the produce industry and increasing supply of healthy foods for consumers. It is important to inform and educate students of critical issues, recent developments, current situation, and future perspectives and opportunities in the produce industry. Knowledge gained will help them make informed decisions on their careers and beyond and encourage them to make contributions to communities.

What has been done
Activities include teaching and training for students at TSU. Many students were minority students such as African American, African, Asian, and Middle-eastern students.

Results
Ten students enrolled in two courses were introduced to background, literature, needs, critical and emerging issues, data sources, methodologies, and findings and implications. The study has directly increased the knowledge of at least ten students about characteristics, trends, and changes in the U.S. fresh produce industry, and is estimated to impact even more people as the students spread the knowledge. This will have a spillover and long-term impact on the labor force in the fresh produce industry.

4. Associated Knowledge Areas

KA Code	Knowledge Area
601	Economics of Agricultural Production and Farm Management
604	Marketing and Distribution Practices

Outcome #9

1. Outcome Measures

Producers and businesses in the produce industry, consumers, educators, researchers, and policy makers will have increased knowledge about current issues on fruit and vegetable consumption/demand and its relationship with overweight/obesity in the U.S.

2. Associated Institution Types

- 1890 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	30

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The analysis of demand for fruits and vegetables and related issues is critical to study the future development of the produce industry. This study examines the relationship between fruit and vegetable consumption and adult obesity prevalence. The study also investigates whether and how obesity rates differ among various demographic and socioeconomic groups and factors that affect the propensity for consuming more fruits and vegetables.

What has been done
Examined factors associated with demand, needs and issues, and hence to better understand market environment and marketing opportunities, which might have contributed to and/or will potentially promote or hinder the growth of local production and farms of produce commodities and consumer access to these healthy foods where they are needed the most. Completed the analysis of trends and cross-state distribution of fruit and vegetable consumption and obesity rates. Summarized work and findings on this topic in the previous and current periods.

Results
The study analyzed fruit and vegetable consumption and its association with adult overweight/obesity in the U.S. The findings suggest that the effect of fruit and vegetable consumption on obesity rates is negative, statistically significant, and robust to various estimation specifications. The middle-aged people, African Americans, and people undergoing a marriage separation have the higher obesity prevalence and the lowest rate of fruit and vegetable consumption compared respectively with all other age, ethic, and marital-status groups. Education attainment, income levels, and employment status have either no significance effective or have expected effects on dietary choices and obesity on dietary choices and obesity outcome. But generally they have no counter intuitive effect on either outcome.

4. Associated Knowledge Areas

KA Code	Knowledge Area
601	Economics of Agricultural Production and Farm Management
604	Marketing and Distribution Practices

Outcome #10

1. Outcome Measures

Students will have increased knowledge about current issues on fruit and vegetable consumption/demand and its relationship with overweight/obesity in the U.S.

2. Associated Institution Types

- 1890 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	10

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
It is important to inform and educate our students about the current and critical issues on food, agriculture, health and nutrition so that they can make informed decisions on their career choices. They can also make contributions to and have positive impact in communities.

What has been done
Activities include teaching and training for students at TSU. Many students were are minority students such as African American, African, Asian, and Middle-eastern students.

Results
Ten students were enrolled in these two graduate-level courses. These students were introduced to background and critical issues, literature, and findings of this study. Students participated in discussions in various occasions when the study was mentioned and discussed throughout the course. The study has increased their knowledge about current issues on fruit and vegetable consumption/demand and its relationship with overweight/obesity in the U.S.

4. Associated Knowledge Areas

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

Outcome #11

1. Outcome Measures

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

Not Reporting on this Outcome Measure

Outcome #12

1. Outcome Measures

US sugar policy (Lewis)

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Does Mexico?s sugar industry violated international trade laws and cause harm to the U.S. sugar industry?

What has been done
We have published articles on U.S. sugar policy, which were given to the U.S. sugar industry's international trade lawyers and were used in the U.S. government?s anti-dumping and countervailing case against Mexico.

Results

4. Associated Knowledge Areas

KA Code	Knowledge Area
601	Economics of Agricultural Production and Farm Management
602	Business Management, Finance, and Taxation
603	Market Economics

604	Marketing and Distribution Practices
606	International Trade and Development

Outcome #13

1. Outcome Measures

Willingness to Purchase Tennessee Steak (Jensen)

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Beef producers desire to obtain premium prices for their product.

What has been done
This study examined willingness to pay (WTP) for Tennessee beef in five Tennessee metropolitan areas.

Results
Factors positively influencing WTP for Tennessee steaks include preferences for grain-fed, flavorful beef. Factors negatively influencing it include price consciousness and shopping at big box stores. Placing greater importance on freshness, safety, and natural products positively influences WTP for Tennessee ground beef.

4. Associated Knowledge Areas

KA Code	Knowledge Area
601	Economics of Agricultural Production and Farm Management
604	Marketing and Distribution Practices
607	Consumer 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

Brief Explanation

V(I). Planned Program (Evaluation Studies)

Evaluation Results

Evaluation measures of the economic-based research include the description and count of venues that the study and its findings reach stakeholders. The recorded number of stakeholders who have received the information and increased their knowledge through publication, conference and other presentations were measured suing surveys. Website exposure measures by the number of visits and views. Student numbers were obtained from enrollment analysis. Results from surveys indicate a satisfaction with knowledge gained, but a desire for a greater diversity of presentation venues.

Key Items of Evaluation

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
102	Soil, Plant, Water, Nutrient Relationships	20%	20%	25%	10%
111	Conservation and Efficient Use of Water	0%	0%	15%	0%
112	Watershed Protection and Management	80%	80%	22%	30%
132	Weather and Climate	0%	0%	2%	10%
133	Pollution Prevention and Mitigation	0%	0%	5%	30%
135	Aquatic and Terrestrial Wildlife	0%	0%	9%	10%
136	Conservation of Biological Diversity	0%	0%	4%	10%
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	Pathogens and Nematodes Affecting Plants	0%	0%	5%	0%
215	Biological Control of Pests Affecting Plants	0%	0%	3%	0%
216	Integrated Pest Management Systems	0%	0%	2%	0%
403	Waste Disposal, Recycling, and Reuse	0%	0%	3%	0%
	Total	100%	100%	100%	100%

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2015	Extension		Research	
	1862	1890	1862	1890
Plan	5.0	1.0	35.0	6.0
Actual Paid	9.0	0.0	22.9	12.0
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**
178437	58081	800203	564038
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
766995	75215	1698478	564038
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
50000	0	400127	0

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. Watershed integrity is also a primary component of TSU research in this program, research is conducted to minimize the impact of human intervention on water resources.

Soil research is fundamental to UT AgResearch's and TSU'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 effect of climate change on soil decay is also being examined as well as techniques for remediation of contaminated soils.

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.

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?

.

V(E). Planned Program (Outputs)

1. Standard output measures

2015	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	16	0	1	0

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

Patent Applications Submitted

Year: 2015

Actual: 0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2015	Extension	Research	Total
Actual	0	98	98

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Workshops to communicate research findings to stakeholders.

Year	Actual
2015	0

Output #2

Output Measure

- Workshops to educate producers in the target population on how to reduce sediment load to surface water.

Year	Actual
2015	0

Output #3

Output Measure

- Number of arbuscular mycorrhizal fungi that enhance biomass productivity by cellulosic

herbaceous perennials in fly ash-amended soils.

Year	Actual
2015	0

Output #4

Output Measure

- The impact for the Runoff Reduction Assessment Tool (RRAT) for the design and analysis of post-construction stormwater design has been significant. It has already been adopted for use by most of the smaller communities in Tennessee in meeting their state stormwater requirements. (Yoder)

Year	Actual
2015	1

Output #5

Output Measure

- Field spray results noted that herbicide deposition on leaves, spray deposition on water-sensitive paper, and weed control were statistically better for twin spray-entrained nozzles that applied a broader droplet spectrum than single tips or twin tips mounted with diverging sprays. (Womac)

Year	Actual
2015	1

Output #6

Output Measure

- Tennessee data shows that urea treated with N-butyl thiophosphoric triamide (NBTP) and the polymer coated urea (ESN or Environmentally Sensitive Nitrogen) were the only products that showed lowest ammonia loss levels and gave corn yields similar to the standard Ammonium Nitrate fertilizer. The other product evaluated (a Calcium salt) was not effective in preventing volatilization loss of nitrogen and gave corn yields no better than untreated Urea. (Savoy and Yin)

Year	Actual
2015	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.
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	Develop a greater understanding of the mechanisms of emerging contaminants for the scientific community to expedite the decision making process in terms of protecting environmental health.
12	Research to influence change in understanding of proper management of riparian landscapes.
13	Improve mechanistic understanding of microbial processing of soil decay and its long-term responses to climate warming.
14	Research to reduce the impact of pharmaceuticals and personal care products in surface water in rural and urbanizing watersheds.
15	Mycorrhizae: Plant and Soil Protection (Auge)
16	Retention of Animal Antibiotics by Soil Minerals (Essington)
17	SPARROW to Analyze Fertilizer Use in Watersheds (Clark, Lambert)

18	Tracking Soil Estrogen to Protect Aquatics (Lee)

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
2015	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Field Nursery operation and management is considered intensive agricultural production systems because it uses a combination of resources such as labor, irrigation, fertilizer nutrients to produce plants in large numbers in relatively small acreages. Therefore, there is a need for minimizing surface runoff especially at the field scale level where soils have been disturbed due to plowing and disking or during harvest of the nursery stock. Subsequently nursery crop growers are not aware of the impact these management practices have on surface water quality.

What has been done
Two major tributaries of the Collins River (Hills Creek and Mountain Creek) were monitored for water quality impairment. The creeks were monitored for the following water quality parameters: Turbidity (because of the strong correlation between turbidity and sediment), specific conductance, total dissolved solids, dissolved oxygen, pH and temperature. The following nutrients, nitrogen, phosphorous, calcium, magnesium and potassium were also monitored in the creeks.

Results
While nursery growers in the Collins River sub-watershed may be viewed as contributors to surface water quality degradation, our data for the last three and a half years showed otherwise. The data indicate that essential crop nutrients like phosphorus (P) and Nitrogen (N) were relatively low in the creeks monitored. There was no visual evidence of eutrophication in either creek.

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
2015	1

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
There is the need to train future workforce (students) to meet the need of water resource issues, especially in the area of surface water quality assessment and monitoring.

What has been done
A graduate student developed and completed a thesis on one of the primary objectives of the project.

Results
The student assisted in instrument calibration; the analyses of stream water quality parameters and data entry. The graduate student completed an MS thesis.

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 Extension
- 1890 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	20

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
While nursery crop production activities are considered intensive, management practices such as irrigation fertilization, plowing and disking can contribute to both point and non-point source pollution. The residents, including nursery growers, in the Collins River watershed care about the water quality of the water bodies that drain the watershed.

What has been done
Results of our findings were shared with nursery crop growers at the 2015 Southern Nursery Association Conference in Atlanta GA. Similar results were also shared with county level Agricultural and Natural Resource (ANR) agents in forums such as field days and in organized workshop.

Results
While turbidity values were used as a surrogate for sediment load. turbidity values were found to be relatively high (greater than 20 ntu) during storm events. Concentrations of essential crop nutrients such as phosphorus and nitrogen were low in the creeks monitored; suggesting the efficient use of fertilizers by nursery growers in the sub-watershed.

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.

2. Associated Institution Types

- 1890 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	1

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Coal-based electricity generation utilities are concerned about increasing accumulations of coal fly ash (CFA) and other coal combustion byproducts and threats posed to human and environmental health. Of course, the public cares and is concerned about land, water and sediment degradation caused by the catastrophic CFA spills that have become eerily patterned triennial events in Kingston, Tennessee, 2008, WE Power Spill in Wisconsin 2011 and Duke Energy spill, North Carolina, 2014. While catastrophic coal ash spills grab national and international headlines, dangerous pollutants have been quietly seeping into drinking water supplies and streams across the nation from hundreds of improperly lined and unmonitored coal ash dumps, exposing people and wildlife to toxic and cancer-causing substances.

What has been done
Currently, catastrophic ash spill are cleaned up by removal and storage in landfills, invariably with undesirable intrusions into the environment at a later stage.
The goal of this research is find ways to use CFA as beneficial soil amendment to produce bioenergy feedstock. This is expected to consume large amount of the byproduct with simultaneous cleanup of soil, sediments and air.

Results
Our results strongly suggest that a combination of CFA and poultry litter can indeed produce desired goals of simultaneous cleaning up pollution while obtaining bioenergy feedstock. Furthermore, ongoing investigations are suggesting that the use of an arbuscular mycorrhizal isolate can reverse some of the toxic effects of CFA to allow enhanced biomass production of bioenergy feedstock.

4. Associated Knowledge Areas

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

Outcome #5

1. Outcome Measures

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

Not Reporting on this Outcome Measure

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**

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

2. **Associated Institution Types**

- 1890 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	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

A component additivity model of antimony (Sb) sorption on kaolinite was developed to predict Sb retention in multi-component system.
A comparative assessment of the retention mechanisms of tetracycline antibiotics on kaolinite and hematite has been investigated using in situ ATR-FTIR study.
Tungstate (WO42-) sorption on hematite was studied using macroscopic and spectroscopic experiments.

Results
Major functional groups of tetracycline antibiotics, which participated in inner-sphere bonding on kaolinite surface were ?CONH2, -N (CH3)2, and phenolic ?OH.
Spectroscopic investigation on tungstate sorption on hematite indicated that the formation of polytungstate spcies is prominent at lower pH values and higher tungstate conc. (i.e. > 200 µM).
For 4.11 µM (0.5 mg L-1) Sb conc., general composite model worked well, and for 41.1 µM (5 mg L-1) component additivity model indicated a better fit of the sorption envelope data.

4. Associated Knowledge Areas

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

Outcome #12

1. Outcome Measures

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

2. Associated Institution Types

- 1890 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	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.

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.

4. Associated Knowledge Areas

KA Code	Knowledge Area
135	Aquatic and Terrestrial Wildlife
136	Conservation of Biological Diversity

Outcome #13

1. Outcome Measures

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

2. Associated Institution Types

- 1890 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	2

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 (Jobbagy and Jackson 2000). Annual soil CO2 efflux is about six times of that from fossil fuel burning (Schlesinger and Bernhardt 2013). Microbial communities are the primary drivers of soil organic carbon mineralization and respiratory C loss to atmosphere. Because both climate warming and 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
Over 400 peer-review published studies were examined and data were extracted about relevant soil microbial biomass, extracellular enzyme activities, and soil organic carbon and nitrogen data from 59 of these studies. Meta-analysis statistical modeling method was applied to examine how N fertilization influenced soil microbial biomass and extracellular enzyme activities as well as soil carbon and nitrogen stocks.

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 negative correlation between microbial biomass and hydrolases were identified.

4. Associated Knowledge Areas

KA Code	Knowledge Area
132	Weather and Climate

Outcome #14

1. Outcome Measures

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

2. Associated Institution Types

- 1890 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Disposal 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 drug residues found 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 are being 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 and understand how to ensure the safe disposal of pharmaceuticals and personal care products.

What has been done

Three counties were 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 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.

Results

Pharmaceuticals containing the active ingredients used for the control of type 2 diabetes (thiazolindine), anti-inflammatory and anti-fibrotic effect (Methyl palmitate), steroid derivatives (pregnanes), antibiotic (trimethoprim), and the insect repellent deet were detected in all rivers sampled. 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
133	Pollution Prevention and Mitigation

Outcome #15

1. Outcome Measures

Mycorrhizae: Plant and Soil Protection (Auge)

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Mycorrhizal symbiosis has been the subject of hundreds of refereed articles reporting that these symbiotic soil fungi preserve soil structure and assist crop growth under various environmental stresses. However, reports are conflicting and the extent of mycorrhizal effects are unpredictable, which has made managing the symbiosis for economic and ecological benefit quite challenging.

What has been done
During the reporting period we have performed three extensive quantitative reviews of the literature to determine which experimental circumstances were associated with the largest impacts on crop gas exchange, for plants growing under drought and salt stress.

Results
The result of the published meta-analyses gives clarity and perspective over the dozens of plant and fungal taxa that have been studied, pointing to more effective approaches for future research, technology transfer and environmental restoration.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
112	Watershed Protection and Management
132	Weather and Climate
203	Plant Biological Efficiency and Abiotic Stresses Affecting Plants
212	Pathogens and Nematodes Affecting Plants

Outcome #16

1. Outcome Measures

Retention of Animal Antibiotics by Soil Minerals (Essington)

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Fugitive veterinary antibiotics may alter microbial community structure of soil and natural waters and result in the development of 'super' bugs that are antibiotic resistant.

What has been done

Results
Our research concerning the retention of the animal antibiotic tylosin (primarily used in swine production) by soil minerals indicates that this compound is adsorbed by exchangeable and non-exchangeable mechanisms. The compound is competitive with common soil cations for the soil exchange phase, and is thermodynamically preferred by the exchange phase relative to sodium and calcium. Tylosin adsorption by non-exchangeable mechanisms also reduces the exchange capacity of soil clay minerals. These findings offer a mechanism to predict tylosin behavior in soil.

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
403	Waste Disposal, Recycling, and Reuse

Outcome #17

1. Outcome Measures

SPARROW to Analyze Fertilizer Use in Watersheds (Clark, Lambert)

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual

2015	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Increased biofuel production offers the possibility of reducing the amount of tilled land and mitigating climate change by reducing the emission of greenhouse gases associated with transportation fuels. However, converting enough land to feedstock production to meet the RFS could significantly affect nutrient emissions from agriculture and regional water quality balances.

What has been done

Results

Our research predicted changes on N and P emissions into the hydrologic system. The contribution of fertilizer from agriculture to N loadings increases from 3.83% to 4.17% when 50% of the mandate for advanced biofuels is achieved through biodiesel production. However, key N emission indicators do not change significantly from baseline levels. Agriculture?s source contribution to total P emissions do not appreciably change.

4. Associated Knowledge Areas

KA Code	Knowledge Area
112	Watershed Protection and Management
133	Pollution Prevention and Mitigation
403	Waste Disposal, Recycling, and Reuse

Outcome #18

1. Outcome Measures

Tracking Soil Estrogen to Protect Aquatics (Lee)

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Reproductive and developmental abnormalities due to endocrine-disrupting chemicals, such as steroid estrogens, have been documented in wild populations of invertebrates and vertebrates.

What has been done

Because agricultural antibiotics and steroid estrogens often coexist in animal manure and soil, a series of laboratory incubation study were conducted to investigate the effect of most common agricultural antibiotics (sulfamethazine, tylosin, and chlortetracycline) on the persistence and transformation of estradiol in soil.

Results

We observed almost 80% of the hormone binding to soil within 30 minutes, and almost half of the hormone degrading in hours. For farmers applying manure to their field, this research is good news, provided they adhere to the best management practices typically recommended for manure application. For the environmentalist these results still don?t explain why low concentrations of hormones are consistently detected in surface waters. It might suggest that some type of environmental equilibrium exists between hormone inputs and sinks, given that humans and animals, both wild and domestic, produce estrogen.

4. Associated Knowledge Areas

KA Code	Knowledge Area
112	Watershed Protection and Management
133	Pollution Prevention and Mitigation
135	Aquatic and Terrestrial Wildlife
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 effectiveness of the project was determined by a) the heightened local awareness of surface water quality problems and solutions associated with field nursery production; b) best management practices (BMPs) adopted by growers for individual nursery fields; c) demand by growers for better and efficient fertilizers that are not prone to excessive surface runoff during storm events and d) better trained students in the environmental protection and enhancement area.

Key Items of Evaluation

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: 2015	Extension		Research	
	1862	1890	1862	1890
Plan	12.0	2.0	0.0	0.0
Actual Paid	11.0	3.0	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**
223047	98737	0	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
958744	127865	0	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
100000	0	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) and supported by coalitions of volunteers across Tennessee. The Tennessee toolkit for

savings lesson plans and activities for teaching financial and savings education was used 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 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 throughout the state to reach 30,000 youth with savings and financial education. Additional classes, newsletters, news releases and community events were conducted for adult audiences.

2. Brief description of the target audience

Youth and adults were targeted for this program. UT Extension is 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?

This Family Economics planned program was enhanced through the service of 11 Tennessee Extension personnel on the "Financial Security for All" CoP. Tennessee Extension personnel shared implementation strategies, outcome measurement, and evaluation approaches and results with their CoP colleagues.

V(E). Planned Program (Outputs)

1. Standard output measures

2015	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	35773	56435	27175	0

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

Patent Applications Submitted

Year:	2015
Actual:	0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2015	Extension	Research	Total
Actual	1	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
2015	198

Output #2

Output Measure

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

Year	Actual
2015	875

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.

Not Reporting on this Outcome Measure

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
2015	1697

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 Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	2615

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
2015	7668

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Because they have inadequate income, save too little, accumulate too much debt, and/or do not adequately protect and manage their assets, many working Tennesseans are neither financially stable at present nor accumulating enough assets for financial security in later life.

What has been done
On My Own is a youth financial education program provided by the Family and Consumer Sciences department of the University of Tennessee Extension Service and delivered by University of Tennessee Extension agents and classroom teachers trained to deliver the program.

The On My Own program is an interactive financial simulation designed for youth ages 13-18. During the simulation, students become the major income provider for their household which may include a spouse and/or children. Using a hypothetical occupation and income, students work through a month of expenses including housing, utilities, transportation, insurance, food, child care, clothing, entertainment and other expenses resulting from unexpected events.

Results
736 of 1699 participants began or increased savings on an average of $217 per month. The total amount of savings generated by these 736 youth was approximately $1.9 million dollars.

Other notable results were:
- 7668 of 9357 participants felt more strongly that they needed to get a good education.
- 7945 of 9396 participants felt more strongly that they needed to pay attention to their financial future.
- 9302 of 10747 participants learned how having a family can affect their lifestyle.
- 8716 of 9705 participants learned how much money it takes to get by.
- 7717 of 9357 participants learned better how to plan their spending.
- 7765 of 9311 participants planned to get more education after high school.

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
2015	151

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
2015	2218

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Because they have inadequate income, save too little, accumulate too much debt, and/or do not adequately protect and manage their assets, many working Tennesseans are neither financially stable at present nor accumulating enough assets for financial security in later life.

What has been done
2218 of 3763 participants began or increased savings an average of $ 361 per month.

Results
The collective impact of 2218 participants beginning or increasing savings by $361 a month for the entire year was $9,608,376 in savings.

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

2015	463

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Because they have inadequate income, save too little, accumulate too much debt, and/or do not adequately protect and manage their assets, many working Tennesseans are neither financially stable at present nor accumulating enough assets for financial security in later life.

What has been done
Because of the TN Saves Extension Program, 463 of 1697 participants reduced debt an average of $ 663 per month.

Results
The collective amount of debt reduction of 463 participants reducing debt by an average of $663 per month during 2015 was $3,683,628.

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 Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Issues: Because they spend too much and save too little, many Tennesseans will not have enough money to live securely throughout life. Over the next 20 years, the percentage of

retirement-age Tennesseans is expected to almost double; however, currently 52 percent of the U.S. workforce has no private pension coverage and 31 percent has no savings set aside specifically for retirement. Tennessee?s, unemployment rate ended the year down from 6.6 percent in December 2014 to 5.5 in November 2015. The South-Region CPI for all items saw an overall .5 percent increase for the year.

What has been done

What has been done: Consumer Economics programming continued its focus on (1) training citizens in sound basic financial practices, (2) encouraging Tennesseans to save to build assets over their working lives, and (3) encouraging individuals and households to reduce dependence on credit and discharge debt. One-hundred twenty-four Extension educators across the state reported conducting financial education programs, up from 95 in 2014.

Financial education activities are conducted through bankruptcy education, homebuyer education, High School Financial Planning and teacher training, saving education for adults and youth, and financial education simulations for youth. Counties across Tennessee reported 93,128 total direct educational contacts. Direct contacts by agents included 79,782 contacts via group meetings, programs, and other direct methods. An additional 5,545,996 Tennesseans were reached with the message of the importance of savings and financial responsibility through agent and volunteer media and exhibits. Agents logged a total of 14,192 hours in financial education programming with 4,152 additional hours logged by volunteers.

Results

Impacts: Although significantly more Extension clientele reported saving than in 2014 (36.9 percent in 2014 and 58.9 in 2015), the savings per month reported was much smaller. The number of clientele reporting debt reduction fell also (27.3 percent in 2015 compared to 35.2 percent in 2014). In addition, per-month reduction amounts were down from $951 in 2014 to $663 in 2015. Savings among youth remained consistent with both On My Own and Tennessee Saves Youth participants reporting similar savings to those reported in 2014 in three-month follow-up surveys. The estimated economic impact of clientele?s saving totaled $12,933,510 in 2015, with debt reduction estimates totaling $3,524,508. The total estimated impact of Extension Tennessee Saves adult and youth programs as well as youth financial simulations on Tennesseans' saving increase and debt reduction was $16,458,018.

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

{No Data Entered}

V(I). Planned Program (Evaluation Studies)

Evaluation Results

{No Data Entered}

Key Items of Evaluation

{No Data Entered}

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
125	Agroforestry	0%	0%	3%	0%
311	Animal Diseases	0%	0%	15%	0%
403	Waste Disposal, Recycling, and Reuse	0%	0%	2%	0%
501	New and Improved Food Processing Technologies	0%	0%	22%	0%
502	New and Improved Food Products	0%	0%	10%	0%
503	Quality Maintenance in Storing and Marketing Food Products	10%	10%	4%	0%
504	Home and Commercial Food Service	10%	10%	0%	0%
702	Requirements and Function of Nutrients and Other Food Components	0%	0%	10%	0%
703	Nutrition Education and Behavior	0%	0%	2%	0%
711	Ensure Food Products Free of Harmful Chemicals, Including Residues from Agricultural and Other Sources	0%	0%	0%	50%
712	Protect Food from Contamination by Pathogenic Microorganisms, Parasites, and Naturally Occurring Toxins	80%	0%	24%	50%
722	Zoonotic Diseases and Parasites Affecting Humans	0%	0%	3%	0%
903	Communication, Education, and Information Delivery	0%	80%	5%	0%
	Total	100%	100%	100%	100%

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2015	Extension		Research	
	1862	1890	1862	1890
Plan	9.0	1.0	40.0	6.0
Actual Paid	9.0	2.0	30.6	8.0
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**
178437	58081	643076	376025
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
766995	75215	1745297	376025
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
140000	1080000	1030438	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

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

Youth participants will receive 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) will emphasize 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.

UT 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.

In addition, TSU research will 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 with relevant skills for employment opportunities in food safety.

Efforts are also underway to develop new methods for detection and removal of aflatoxins and mycotoxins from foods.

2. Brief description of the target audience

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

3. How was eXtension used?

This Food Safety planned program was enhanced through the service of four Tennessee Extension personnel on the "Food Safety" CoP, including the leader who serves as a specialists in the UT Extension Department of Family and Consumer Sciences. Tennessee Extension personnel shared implementation strategies, outcome measurement, and evaluation protocols with their CoP colleagues.

V(E). Planned Program (Outputs)

1. Standard output measures

2015	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	79740	3990000	0	0

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

Patent Applications Submitted

Year:	2015
Actual:	0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2015	Extension	Research	Total
Actual	2	80	82

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

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

Year	Actual
2015	4

Output #2

Output Measure

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

Year	Actual
2015	0

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

- Website developed to educate consumers on antibiotic resistant pathogens on fresh produce.

Year	Actual
2015	1

Output #5

Output Measure

- Database of characterized antibiotic resistant microorganisms isolated from animal manure.

Year	Actual
2015	1

Output #6

Output Measure

- Database of characterized antibiotic resistant microorganisms isolated from irrigation water and watersheds.

Year	Actual

2015	1

Output #7

Output Measure

- Factsheets on improvement of kitchen cleanliness and prevention of cross-contamination.

Year	Actual
2015	2

Output #8

Output Measure

- Preliminary data indicated the potential role of luteolin in chemo-sensitizing ovarian cancer cells to paclitaxel. (Dia)

Year	Actual
2015	1

Output #9

Output Measure

- Immobilized lipases can be used to prepare sugar esters, important biobased surfactants having numerous applications in foods, cosmetics, and pharmaceuticals, at high yield (>90%, 30 gram scale) in the complete absence of organic solvents, which are typically used as miscibility agents for the starting materials, sugars and fatty acids, which are insoluble. The approach involves the formation of metastable suspensions of saccharide crystals in a liquid-phase reaction medium consisting of fatty acid and the sugar ester product via size reduction techniques such as high pressure homogenation. The resultant product serves as a technical grade product that may not require further purification. (Hayes)

Year	Actual
2015	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	Consumers will be educated via booklets on the occurrence and prevention of antibiotic resistant pathogens on fresh produce (Increase adoption of recommended safe food handling practices at the individual, family, community, production, and supply system levels.)
6	Producers will practice judicious use of antibiotics on farms through improved agricultural practices (Increase adoption of recommended safe food handling practices at the individual, family, community, production, and supply system levels).
7	Consumers will practice safe fresh produce handling practices via food safety education (Increase adoption of recommended safe food handling practices at the individual, family, community, production, and supply system levels).
8	Consumers will have increased knowledge of improved kitchen cleanliness (Increase adoption of recommended safe food handling practices at the individual, family, community, production, and supply system levels).
9	Consumers will have increased knowledge of means to reduce the chance of cross contamination(Increase adoption of recommended safe food handling practices at the individual, family, community, production, and supply system levels).
10	Consumers will adopt safer food storage practices (Increase adoption of recommended safe food handling practices at the individual, family, community, production, and supply system levels).
11	Consumers will adopt improved cleaning skills (Increase adoption of recommended safe food handling practices at the individual, family, community, production, and supply system levels).
12	Inactivation of viral pathogens (D'Souza, Davidson)
13	Prevent (rather than respond to) food-borne illness (Buchanan, Critzer, Wszelaki, Lockwood)
14	Target leading foodborne human pathogen C. jejuni (Lin)
15	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.
16	Investigate cell cytotoxicity, cell viability and cytokine analysis using murine macrophage cell line to assess the activity of treated mycotoxins.

17	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.
18	Defining role of tumor microenvironment in chemoresistance (Dia)
19	Safe Manufacturing of Foods

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
2015	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
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
2015	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
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
2015	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
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
2015	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
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

Consumers will be educated via booklets on the occurrence and prevention of antibiotic resistant pathogens on fresh produce (Increase adoption of recommended safe food handling practices at the individual, family, community, production, and supply system levels.)

2. Associated Institution Types

- 1862 Extension
- 1890 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	23

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Foodborne illness outbreaks due to contaminated fresh produce is becoming more frequent and widespread and have raised concerns and underline the challenges to the public health as well as to fresh produce industry. It is essential for every consumer to be aware of the occurrence and risks of antibiotic resistant foodborne pathogens associated with fresh produce. Fresh produce does not undergo any preservation treatment in the course of processing, consumers may be potentially exposed to antibiotic resistant bacteria through the consumption of contaminated produce.

What has been done
Booklets on prevention of cross contamination while handling fresh produce and antibiotic resistance were disseminated to consumers during conferences organized by Tennessee?s State University Extension Program.

Results
A follow up on the consumers who received the educational booklets, indicated 75% of them consumers had improved on handling fresh produce in their homes. The consumers were aware on the risks of handling raw meats while making dishes with raw produce.

4. Associated Knowledge Areas

KA Code	Knowledge Area
711	Ensure Food Products Free of Harmful Chemicals, Including Residues from Agricultural and Other Sources
712	Protect Food from Contamination by Pathogenic Microorganisms, Parasites, and

Naturally Occurring Toxins

Outcome #6

1. Outcome Measures

Producers will practice judicious use of antibiotics on farms through improved agricultural practices (Increase adoption of recommended safe food handling practices at the individual, family, community, production, and supply system levels).

2. Associated Institution Types

- 1890 Extension
- 1890 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	6

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The emergence of multidrug-resistant bacterial strains against antimicrobials considered critically vital in human medicine and will continue to be of great alarm. Recent data shows that antimicrobial resistance of bacteria in animals and food to be an increasing problem for human health and hence the need to educate food producers the risks of antimicrobial drug in agriculture.

What has been done
Six small and medium-sized produce farms were analyzed for degree of knowledge and compliance with new food safety guidelines. Soil, water, and produce samples were collected and analyzed for antibiotic resistant bacteria.
Growers? records on sources of irrigation water, water test results, manure, and types of harvesting containers used were analyzed.
Assessments were conducted to determine barriers to implementing best practices.

Results
This research developed a database on antibiotic resistant bacteria isolated from farms. Based on results of analysis of barriers, strategies have been developed to curtail the prevalence of anti-microbials in agriculture production. This program improved the communication with our stakeholders and they were in a position to share their challenges in produce production. Also a student was recruited and trained in this program and has graduated with a Ms. in animal Sciences. The student is currently undertaking a PhD Program at Tennessee State University.

4. Associated Knowledge Areas

KA Code	Knowledge Area
711	Ensure Food Products Free of Harmful Chemicals, Including Residues from Agricultural and Other Sources
712	Protect Food from Contamination by Pathogenic Microorganisms, Parasites, and Naturally Occurring Toxins

Outcome #7

1. Outcome Measures

Consumers will practice safe fresh produce handling practices via food safety education (Increase adoption of recommended safe food handling practices at the individual, family, community, production, and supply system levels).

2. Associated Institution Types

- 1890 Extension
- 1890 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	65

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Recent outbreaks of foodborne illnesses linked with fresh produce have directed consumers to question the safety of fruits and vegetables. Consumers may not link fresh produce with foodborne disease or make out that these foods require safe handling. Consumers need to be educated on safe handling of fresh produce.

What has been done
Booklets on unsafe handling of fresh produce were delivered to consumers via extension personnel at Tennessee State University.

Results
Generally, the recipients improved their skills and knowledge towards safer fresh produce.

4. Associated Knowledge Areas

KA Code	Knowledge Area

711	Ensure Food Products Free of Harmful Chemicals, Including Residues from Agricultural and Other Sources
712	Protect Food from Contamination by Pathogenic Microorganisms, Parasites, and Naturally Occurring Toxins

Outcome #8

1. Outcome Measures

Consumers will have increased knowledge of improved kitchen cleanliness (Increase adoption of recommended safe food handling practices at the individual, family, community, production, and supply system levels).

2. Associated Institution Types

- 1890 Extension
- 1890 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	15

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Cross-contamination during food handling, preparation, and storage is one of the major contributing factors in the transmission of foodborne diseases at home. Improving the effectiveness of microbiological control measures in home kitchens is crucial in preventing foodborne diseases.

What has been done
Research was conducted on microbiological evaluation of swab samples collected from consumer home refrigerators. Information on consumer cleaning practices was collected through analysis of data obtained fromin-person interviews and in-home observations. The importance and effective procedures of cleaning refrigerator to control microbiological contamination in home refrigerators were discussed with target consumers during home visits.

Results
Results indicate that consumers who clean their refrigerators regularly had significantly lower bacterial contamination on the refrigerator shelves. Target consumers have learned proper cleaning methods to improve refrigerator cleanliness.

4. Associated Knowledge Areas

KA Code	Knowledge Area

711	Ensure Food Products Free of Harmful Chemicals, Including Residues from Agricultural and Other Sources
712	Protect Food from Contamination by Pathogenic Microorganisms, Parasites, and Naturally Occurring Toxins

Outcome #9

1. Outcome Measures

Consumers will have increased knowledge of means to reduce the chance of cross contamination(Increase adoption of recommended safe food handling practices at the individual, family, community, production, and supply system levels).

2. Associated Institution Types

- 1890 Extension
- 1890 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	45

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Home refrigerators can harbor pathogenic bacteria that pose a potential to contaminate stored foods. Consumers should be informed about safe handling of refrigerated foods to reduce the risk of food contamination.

What has been done
Analysis of in-home research observations were conducted to determine situations that may cause contamination of stored foods. Research results concerning proper storage of refrigerated foods was discussed with the target consumers during home visits.

Results
Research data collected informed consumers of potential issues in their refrigerators that may cause contamination to the foods and the proper storage of refrigerated foods to reduce the chances of cross contamination.

4. Associated Knowledge Areas

KA Code	Knowledge Area
711	Ensure Food Products Free of Harmful Chemicals, Including Residues from Agricultural and Other Sources
712	Protect Food from Contamination by Pathogenic Microorganisms, Parasites, and

Naturally Occurring Toxins

Outcome #10

1. Outcome Measures

Consumers will adopt safer food storage practices (Increase adoption of recommended safe food handling practices at the individual, family, community, production, and supply system levels).

2. Associated Institution Types

- 1890 Extension
- 1890 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	39

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Cross-contamination during food preparation and storage is one of the major contributing factors in the transmission of foodborne diseases. Many foods, such as raw poultry, meat, eggs, fish, shellfish, fruits and vegetables have been cited as the potential contamination sources of foodborne pathogens. Proper food handling and storage practices by consumers will reduce the risk of foodborne illness at home.

What has been done
Follow-up analyses were conducted with the consumers who had participated in the prior in-home food storage data collections. Data pertaining to the adoption of the recommended food storage practices were collected.

Results
Improvement of refrigeration storage was assessed by the follow-up analysis. Results indicated that most (88%) of the target consumers reported improvements in their storage practices.

4. Associated Knowledge Areas

KA Code	Knowledge Area
711	Ensure Food Products Free of Harmful Chemicals, Including Residues from Agricultural and Other Sources
712	Protect Food from Contamination by Pathogenic Microorganisms, Parasites, and Naturally Occurring Toxins

Outcome #11

1. Outcome Measures

Consumers will adopt improved cleaning skills (Increase adoption of recommended safe food handling practices at the individual, family, community, production, and supply system levels).

2. Associated Institution Types

- 1890 Extension
- 1890 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	42

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Consumer hygiene practices have been frequently reported to be inefficient in controlling bacterial growth and survival in the kitchen environment. Practice of effective cleaning methods by consumers will reduce microbial contamination in home kitchens.

What has been done
Follow-up analyses were conducted by phone with the consumers who had participated in the prior data collections. Data were gathered regarding the adoption of the recommended cleaning practices.

Results
The improvement of refrigeration cleaning practices by consumers was assessed by the follow-up interviews. Results indicate that almost all (92%) of the target consumers reported improvements in their cleaning practices.

4. Associated Knowledge Areas

KA Code	Knowledge Area
711	Ensure Food Products Free of Harmful Chemicals, Including Residues from Agricultural and Other Sources
712	Protect Food from Contamination by Pathogenic Microorganisms, Parasites, and Naturally Occurring Toxins

Outcome #12

1. **Outcome Measures**

Inactivation of viral pathogens (D'Souza, Davidson)

Not Reporting on this Outcome Measure

Outcome #13

1. **Outcome Measures**

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

Not Reporting on this Outcome Measure

Outcome #14

1. **Outcome Measures**

Target leading foodborne human pathogen C. jejuni (Lin)

Not Reporting on this Outcome Measure

Outcome #15

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.

2. **Associated Institution Types**

- 1890 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
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. Food contaminated with mycotoxins, particularly with aflatoxins, can cause fatal acute illness and are associated with cancer risk.

What has been done
UV irradiation experiments (proof of concept) were conducted using a collimated beam system operating at 253.7 nm. Known concentrations of aflatoxins and hydrogen peroxide (0.15%) or riboflavin (100 ppm) were spiked in water and irradiated at UV doses ranging from 0-400 mJ cm2. Degradation of the molecules was monitored by RP-HPLC equipped with fluorescence detection.

Results
Irradiation doses up to 0-400 mJ Cm2 reduced the AFB1, AFB2, AFG1 and AFG2 content by 71.70, 94.99, 65.75 and 95.26%, respectively ($p<0.05$). Using this technique, an overall reduction of total aflatoxin content of 81.93% ($p<0.05$) was achieved. This was also true for riboflavin, where total aflatoxin content was reduced by more than 50% ($p<0.05$). Patulin was reduced to 65%.

4. Associated Knowledge Areas

KA Code	Knowledge Area
711	Ensure Food Products Free of Harmful Chemicals, Including Residues from Agricultural and Other Sources
712	Protect Food from Contamination by Pathogenic Microorganisms, Parasites, and Naturally Occurring Toxins

Outcome #16

1. Outcome Measures

Investigate cell cytotoxicity, cell viability and cytokine analysis using murine macrophage cell line to assess the activity of treated mycotoxins.

2. Associated Institution Types

- 1890 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	1

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

This task investigated the effect of UV irradiation on patulin degradation in apple juice and water and determined the effectiveness of UV treatment of apple juice or water against patulin-induced cytotoxicity for human peripheral blood mononuclear cells (PBMC).

What has been done

?Cell viability (PBMC) percentage increased from 47.3% to 81.64% as UV dose increased to 400 mJ cm2. Overall, the differences between UV treated and control cultures were statistically significant ($p<0.05$). It is quite apparent that decrease in patulin concentration was inversely proportional to increase in cell viability as the dose increased from 0- 400 mJ cm2. It should be noted that irradiation is not creating significant amounts of toxic by-products, as the cell viabilities at 400 mJ cm2 treated samples are approximately 81.64%.

Results

Our results showed that increasing the UV dose decreased the patulin-induced cytotoxicity in human peripheral mono-nuclear blood cells. The current study demonstrated that monochromic UV irradiation at 253.7 nm can be an effective physical method of reducing patulin levels in apple juice. Aflatoxins trials are going on.

4. Associated Knowledge Areas

KA Code	Knowledge Area
711	Ensure Food Products Free of Harmful Chemicals, Including Residues from Agricultural and Other Sources
712	Protect Food from Contamination by Pathogenic Microorganisms, Parasites, and Naturally Occurring Toxins

Outcome #17

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.

2. Associated Institution Types

- 1890 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	1

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Salmonella is one of the most important foodborne pathogens. Every year, Salmonella is estimated to cause one million illnesses in the United States. To reduce the incidence of illnesses caused by Salmonella, advanced detection technology is needed to provide reliable and efficient identification of Salmonella from contaminated foods.

What has been done

Experiments were conducted to study Salmonella flagellar antigens using a panel of seven monoclonal antibodies. Antigen specificity of monoclonal antibodies was characterized by enzyme-linked immunosorbent assay and 2-D gel electrophoresis. These monoclonal antibodies specific to flagella antigens were applied to immunochemical fingerprint analysis (IFA) for identification and subtyping of Salmonella.

Results

The method developed consists of three major steps including limited proteolysis, SDS-polyacrylamide gel electrophoresis, and Western blot. In summary, the flagella antigens were extracted from enriched cultures using glycine-hydrochloride and urea methods and treated with various proteinases. The resulting proteolytic fragments were separated by SDS gels and transferred to nitrocellulose membranes. Western blots were performed using flagella-specific monoclonal antibodies. The antigenic fragment profiles were captured using an imaging system and analyzed using bioinformatics software. Standardized laboratory protocols were prepared for training graduate students in performing limited proteolysis, SDS-polyacrylamide gel electrophoresis, Western blot, and image analysis.

4. Associated Knowledge Areas

KA Code	Knowledge Area
711	Ensure Food Products Free of Harmful Chemicals, Including Residues from Agricultural and Other Sources
712	Protect Food from Contamination by Pathogenic Microorganisms, Parasites, and Naturally Occurring Toxins

Outcome #18

1. Outcome Measures

Defining role of tumor microenvironment in chemoresistance (Dia)

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Chemoresistance is a condition when cancer cells escape the killing effect of chemotherapeutic drugs making it the point of no return for cancer patients. It is therefore important to identify the mechanism of action involve on how cancer cells acquire such characteristic.

What has been done
Investigation on the role of tumor microenvironment, in particular the extracellular matrix enzymes, is being undertaken. The activity of the enzyme lysyl oxidase is being compared between sensitive and chemoresistant cancer cells and the molecular mechanism involved is being characterized.

Results
Preliminary results showed that this enzyme may be associated with cancer chemoresistance.

4. Associated Knowledge Areas

KA Code	Knowledge Area
311	Animal Diseases
502	New and Improved Food Products
702	Requirements and Function of Nutrients and Other Food Components
703	Nutrition Education and Behavior

Outcome #19

1. Outcome Measures

Safe Manufacturing of Foods

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Food safety challenges facing commercial food manufacturers include implementing best practices for safely manufacturing food, regulatory compliance pertinent to the safe manufacture of foods, and implementing food safety practices in the growing and harvesting of meat, poultry and produce.

What has been done

The food safety extension program has provided science-based training and support for all sectors of the food industry in support of the nearly 1,300 food manufacturers, 150 domestic kitchen licensees, and more than 90 value-added beef producers found throughout the state as well as individuals interested in beginning a food-manufacturing venture. A notable client base are farms manufacturing value-added food products, which has grown by 31% since 2007 in Tennessee.

Results

__With the implementation of the Food Safety Modernization Act, Hazard Analysis and Critical Control Points (HACCP) programs will be mandatory for an increasing number of Tennessee food manufacturers. More than 30 professionals working in the food industry were educated in 2015. Participants increased their knowledge by 22.9%. This course will allow manufacturers to comply with USDA and FDA regulatory requirements and improve their food safety systems through workforce learning.

__Domestic Kitchen Workshop assists the cottage food industry with food safety best practices. This course provides an introduction to food microbiology, Good Manufacturing Practices (GMPs), cleaning and sanitation, Hazard Analysis and Critical Control Points (HACCP), food labeling, and allergen control for food manufacturers wishing to prepare non-potentially hazardous foods in their home kitchen. In 2015, 51 participants were certified through UT Extension's online course. The course improved participant food safety knowledge by 19%, and all participants who evaluated the program found that they would be able to practically apply the course content to their domestic kitchen. activities.

4. Associated Knowledge Areas

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

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Competing Public priorities
- Competing Programmatic Challenges

Brief Explanation

{No Data Entered}

V(I). Planned Program (Evaluation Studies)

Evaluation Results

The success of this project was tracked by:

- Increased number of produce growers and farmers in knowledge gained on how to avoid cross contamination during planting and harvesting periods,
- Understanding concepts on the implementation of farm record keeping in individual farms. The farmers indicated that they only administered antibiotic treatment only when it was needed and as directed by a veterinarian. Four farms implemented farm record keeping.
- Number of target consumers adopting safer food storage practices
- Number of target consumers adopting improved cleaning skills
- Number of students trained in research.

Produce growers and consumers were reluctant to participate in the surveys and frequently felt that farm and household information should be confidential and they did not want to share. Produce growers were also reluctant to allow the researchers visit their farm to collect samples for microbial analysis.

This program influenced consumers on safe handling practices of fresh produce during meal preparations at home. Produce growers were educated on how to reduce/control antimicrobial on their farms. This ensures food safety and quality for fresh fruits and vegetables in farms.

Of the target consumers, a majority reported taking safety measures to prevent cross contamination when storing raw meat and poultry in their refrigerators; and almost all reported an increase of frequency in cleaning refrigerator and checking refrigerator temperature. Two students were trained in performing the analytical procedures and have gained knowledge and experiences in performing food safety interview and observation

Key Items of Evaluation

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%	0%
112	Watershed Protection and Management	0%	0%	7%	0%
123	Management and Sustainability of Forest Resources	75%	75%	22%	20%
124	Urban Forestry	0%	0%	1%	0%
125	Agroforestry	10%	10%	0%	0%
131	Alternative Uses of Land	0%	0%	0%	80%
133	Pollution Prevention and Mitigation	0%	0%	7%	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%
213	Weeds Affecting Plants	0%	0%	1%	0%
215	Biological Control of Pests Affecting Plants	0%	0%	7%	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%	7%	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%	3%	0%
	Total	100%	100%	100%	100%

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2015	Extension		Research	
	1862	1890	1862	1890
Plan	9.0	2.0	45.0	6.0
Actual Paid	9.0	2.0	22.0	5.0
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**
178437	58081	517680	235016
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
766995	75215	1568583	235016
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
50000	0	868211	0

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 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 Association meetings. 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 continue development of numerous 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. Carbon storage research through the development of alley cropping systems are being developed by TSU scientists.

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.

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 were 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, outcome measurement, and research results with their CoP colleagues.

V(E). Planned Program (Outputs)

1. Standard output measures

2015	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	34035	1275526	7121	0

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

Patent Applications Submitted

Year:	2015
Actual:	0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2015	Extension	Research	Total
Actual	8	76	84

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Release of Hemlock Woolly Adelgid predators reared in Tennessee (Parkman, Grant)
  Not reporting on this Output for this Annual Report

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
2015	0

Output #4

Output Measure

- Number of workshops held to educate landowners on carbon sequestration strategies.

Year	Actual
2015	5

Output #5

Output Measure

- Number of workshops held addressing agricultural sustainability.

Year	Actual
2015	4

Output #6

Output Measure

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

Year	Actual
2015	0

Output #7

Output Measure

- Hardwood genomics website - we've added new transcriptome resources for sugar maple, sweet gum, and honeylocust. We now offer new computational tools for accessing the data -- CMap for exploring chestnut genetic maps and Apollo for annotation of chestnut gene sequences. (Staton)

Year	Actual
2015	1

Output #8

Output Measure

- Completed a descriptive study on fruit availability to wildlife in a diverse Southeastern forested landscape. (Kwit)

Year	Actual
2015	1

Output #9

Output Measure

- We advanced a wildlife habitat model for rapid estimation of impacts, and created a model for describing the development of forest cohorts from birth to death, thus allowing estimation of volume lost due to stand decline at older ages. (Zobel)

Year	Actual
2015	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	Forest Landowner Education: Number of landowners who improved profitability (marketing) of forest ownership.
3	Increase in efficiency of supply systems in Tennessee forest products.
4	Farm/forest landowners will have an increased knowledge of multi-function land management techniques (Improve climate mitigation strategies and their adoption).
5	Farm/forest landowners will adopt multi-function land management techniques (Improve climate mitigation strategies and their adoption).
6	Farm/forest landowners will realize increased income as a result of multi-function land management techniques (Improve climate mitigation strategies and their adoption).
7	Educators (i.e. Extension agents, state forestry officials) will have increased knowledge of multi-function land management techniques
8	Biomass Feedstock Availability and Assessment (Hodges, Young)
9	Thousand Cankers Disease on black walnut (Grant, Lambdin, Hadziabdic, Windham)
10	Suppression of Emerald Ash Borer (Grant, Wiggins)
11	Establishing shortleaf pine (Clatterbuck)
12	Predatory beetles against HWA (Lambdin, Grant, Wiggins)
13	Protecting amphibians from ranavirus (Gray)
14	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.
15	Migration of imidacloprid to surface waters (Wiggins, Grant)
16	Tripal software for genetic/genomic databases (Staton)
17	Woody biomass demand and economics (English)

18	Tennessee Master Logger Program
19	National Advanced Silviculture Program
20	Tennessee Teachers Conservation Workshop

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
2015	135

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

Forest Landowner Education: Number of landowners who improved profitability (marketing) of forest ownership.

2. Associated Institution Types

- 1862 Extension
- 1890 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	49

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 #3

1. Outcome Measures

Increase in efficiency of supply systems in Tennessee forest products.

2. Associated Institution Types

- 1890 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
We will not report on this program as the faculty member in charge has left the university. The program is being removed form the Plan of Work.

What has been done

Results

4. Associated Knowledge Areas

KA Code	Knowledge Area
123	Management and Sustainability of Forest Resources

Outcome #4

1. Outcome Measures

Farm/forest landowners will have an increased knowledge of multi-function land management techniques (Improve climate mitigation strategies and their adoption).

2. Associated Institution Types

- 1890 Extension
- 1890 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	110

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Training in multi-function land management techniques and skills on decision-making tools will offer limited-resource landowners opportunity to successfully attain their goals with forestland management practices and flexibility of establishing a mixed-use system. Knowledge and skills on emerging digital mapping and GIS technologies has gained interest and attention from small and underserved landowners as well as agricultural professionals.

What has been done
Research continued to evaluate optimal multi-function land management techniques. The program continued to provide training workshops to equip landowners with knowledge and skills on emerging digital mapping and GIS technologies including empowering them to use freely available tools and data for forest and ranch site planning and management.

Results
A total of 110 forest landowners participated in four training workshops which were conducted in Hardeman, Rutherfords, Shelby and Davidson counties. Participants explored variety of techniques available in Google Maps through demonstrations, hands-on exercises, and discussion.

4. Associated Knowledge Areas

KA Code	Knowledge Area
131	Alternative Uses of Land

Outcome #5

1. Outcome Measures

Farm/forest landowners will adopt multi-function land management techniques (Improve climate mitigation strategies and their adoption).

2. Associated Institution Types

- 1890 Extension
- 1890 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	93

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Training in multi-function land management techniques and skills on decision-making tools will offer limited-resource landowners opportunity to successfully attain their goals with forestland management practices and flexibility of establishing a mixed-use system. Knowledge and skills on emerging digital mapping and GIS technologies has gained interest and attention from small and underserved landowners as well as agricultural professionals.

What has been done

Research was conducted on strategies to enhance the multi-use income capacity of property. In an effort to help land owners develop and enhance the multi-use valuable natural and forest resources enterprise, the program provided a series of training workshops for forest and ranch landowners on variety of techniques available in Google Mapping tools through demonstrations, hands-on exercises, and discussion. Landowners were introduced to Google Earth Tools for supporting decision making, increasing landowner knowledge about physical features in their wooded property.

Results

The activities in this project boosts skills and promote interest in using available decision-making tools. The program enable visualize aerial photos and terrain of the land features, layout of properties boundaries. These tools open vast of opportunities to landowners to view, share, and make management decisions regarding their forestland. Participants have learned where to get property information and about estate planning. The 93 participants own a total of 1710 acres of forestland

4. Associated Knowledge Areas

KA Code	Knowledge Area
131	Alternative Uses of Land

Outcome #6

1. Outcome Measures

Farm/forest landowners will realize increased income as a result of multi-function land management techniques (Improve climate mitigation strategies and their adoption).

2. Associated Institution Types

- 1890 Extension
- 1890 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Understanding multi-function land management involves basic human spatially thinking and making decisions based on geography. Geospatial information systems (GIS) are useful tools, helping everyone from scientists to citizens to solve spatial problems. Geospatial information systems are becoming critical for successful communications about spatial related patterns and trends.

What has been done
Training Curriculum on ?Essentials of GIS? was drafted. The curriculum will be tested in 2016 through scheduled in-service training sessions using mobile GIS-lab with 25 laptop computers.

Results
A Curriculum on ?Essentials of GIS? to guide for informal teaching in this program has been drafted and is under review by expertise in Curriculum Design.

4. Associated Knowledge Areas

KA Code	Knowledge Area
131	Alternative Uses of Land

Outcome #7

1. Outcome Measures

Educators (i.e. Extension agents, state forestry officials) will have increased knowledge of multi-function land management techniques

2. Associated Institution Types

- 1890 Extension
- 1890 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Understanding multi-function land management involves basic human spatially thinking and making decisions based on geography. Geospatial information systems (GIS) are useful tools, helping everyone from scientists to citizens to solve spatial problems. Geospatial information systems are becoming increasingly important affecting a variety of areas ranging from sustainable land management to precision agriculture. Providing practical and useful training in GIS tools in this information age is critical to promote the skill of specialists, researchers and county extension agents.

What has been done
In-service Training sessions were conducted using mobile GIS-lab with 25 laptop computers, already purchased via grant-leveraged funding.

Results
A Curriculum on ?Essentials of GIS? to guide for informal teaching in this program has been drafted and is under review by expertise in Curriculum Design.

4. Associated Knowledge Areas

KA Code	Knowledge Area
131	Alternative Uses of Land

Outcome #8

1. Outcome Measures

Biomass Feedstock Availability and Assessment (Hodges, Young)

Not Reporting on this Outcome Measure

Outcome #9

1. Outcome Measures

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

Not Reporting on this Outcome Measure

Outcome #10

1. Outcome Measures

Suppression of Emerald Ash Borer (Grant, Wiggins)

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
A new invasive insect threat (emerald ash borer) has been documented in 21 counties in Tennessee, representing the southernmost distribution of this insect pest in the U.S. This insect threatens to greatly reduce, if not cause the extinction of, populations of ash in the U.S., leading to tremendous economical and ecological losses.

What has been done
Entomologists at UTIA are at the forefront of research focusing on emerald ash borer in the southern U.S., with efforts directed at implementation of biological control to protect ash trees in forests, nurseries, and urban areas. We also teamed with researchers in the northern U.S. to better assess the geographical synchrony and phenology of emerald ash borer and its introduced larval parasitoids.

Results
Thus far, no T. planipennisi have been recovered in overwintering studies or from monitoring efforts at release sites, possibly indicating that this species is unsuitable for continued release in the south.

4. Associated Knowledge Areas

KA Code	Knowledge Area
123	Management and Sustainability of Forest Resources
125	Agroforestry
215	Biological Control of Pests Affecting Plants
605	Natural Resource and Environmental Economics

Outcome #11

1. Outcome Measures

Establishing shortleaf pine (Clatterbuck)

Not Reporting on this Outcome Measure

Outcome #12

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
2015	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Hemlocks, keystone species in much of the forests of the eastern US, are under attack from the hemlock woolly adelgid (HWA).

What has been done
Biological control, provided by predaceous beetles, is believed to be the primary factor making HWA a minor pest in its native range (Asia and western N. America). Some of these predators are mass-reared at several labs for release in southeastern US forests to provide long-term and environmentally sound HWA management.

Results
Reared over 244,000 predator beetles from 2013-2015. Provided and released HWA predators at several new infestations on Tennessee?s Cumberland Plateau, the leading edge of the pest?s expansion. Documented the establishment of introduced HWA predator beetles at two state parks. Established a rearing colony of the new HWA predator Laricobius osakensis, and made initial releases to establish five field insectaries of this promising biocontrol agent. Assisted Georgia in establishing a L. osakensis colony. Modified our rearing protocol in 2015, improving rearing success by more than 47% for L. osakensis and 17% for L. nigrinus. (Parkman)

4. Associated Knowledge Areas

KA Code	Knowledge Area
123	Management and Sustainability of Forest Resources
125	Agroforestry
136	Conservation of Biological Diversity
215	Biological Control of Pests Affecting Plants
605	Natural Resource and Environmental Economics

Outcome #13

1. Outcome Measures

Protecting amphibians from ranavirus (Gray)

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Amphibian species are susceptible to ranavirus.

What has been done

Results
(1) ranaviruses can cause local extinction of common and uncommon amphibian species, (2) ranavirus is more pathogenic at warmer water temperatures, and (3) co-housing infected tadpoles with uninfected tadpoles for short duration in the field or not changing gloves between handling animals can result in ranavirus transmission and facilitate outbreaks. These results indicate that ranavirus are a serious conservation threat to amphibians, global climate change may facilitate emergence of ranavirus, and biologists need to employ strict biosecurity protocols when processing amphibians in the field to prevent ranavirus outbreaks.

4. Associated Knowledge Areas

KA Code	Knowledge Area
123	Management and Sustainability of Forest Resources
135	Aquatic and Terrestrial Wildlife
311	Animal Diseases
312	External Parasites and Pests of Animals

Outcome #14

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.

2. Associated Institution Types

- 1890 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	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 model 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
We have compiled large amount of spatial and temporal data that allow to test hypothesis under this project, such as: how much biomass is out there at user specified proximity from a potential processing plant/facility? Landsat images for the entire state of Tennessee. airborne LiDAR data from three counties?Sequatchie, Van Buren and Scott?in Tennessee, national level Digital Elevation Model (DEM) and Forest Inventory and Analysis (FIA) data were compiled and managed in ArcGIS environment as well as the hierarchical database format.

Results

It is still too early in the program to evaluate results.

4. Associated Knowledge Areas

KA Code	Knowledge Area
123	Management and Sustainability of Forest Resources

Outcome #15

1. Outcome Measures

Migration of imidacloprid to surface waters (Wiggins, Grant)

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Imidacloprid has been applied to thousands of hemlocks throughout the eastern U.S. to reduce HWA. However, the time interval required for imidacloprid to migrate through soils into surface water, especially in forest settings, is poorly understood.

What has been done
We sampled surface waters adjacent to imidacloprid-treated hemlocks monthly within one year of initial treatments.

Results
Findings show that short-term movement of imidacloprid into surface water is uncommon and heavily influenced by rain events. These results will inform land management decisions and provide land managers with information on the risk of movement of imidacloprid in treated systems.

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
135	Aquatic and Terrestrial Wildlife

Outcome #16

1. Outcome Measures

Tripal software for genetic/genomic databases (Staton)

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
My websites are built on Tripal, an open-source, custom, flexible, modular software package for genetic and genomic database construction.

What has been done
Tripal is being utilized or implemented by over 25 community databases including Genome Database for Rosaceae, CottenGen, the Legume Information System and the Arabidopsis Information Portal. Tripal has existing modules of code that may be leveraged to provide data upload, web visualization, and web searching of many data types, including DNA/RNA sequence features, genotypes, phenotypes/traits, stocks/germplasm, genetic maps and gene networks.

Results
My web and database projects contribute to the functionality of Tripal through maintenance and testing of the existing codebase as well as development of new functionality. This software encourages and enables public dissemination of research data in high-quality, standards based formats. New improvements to Tripal are centered around data sharing and collaboration capabilities between Tripal databases and adding new tools to allow users to analyze data from the website.

4. Associated Knowledge Areas

KA Code	Knowledge Area
123	Management and Sustainability of Forest Resources

136 Conservation of Biological Diversity

Outcome #17

1. Outcome Measures

Woody biomass demand and economics (English)

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Demand for woody biomass from the southern United States is increasing because of its reliability in supply, recent developments in co-firing and biofuel conversion technologies, overseas pellet demand, and the expected economic impacts from reorienting the forestry sector towards energy feedstock production.

What has been done
This research examines the interaction between a set of woody biomass harvesting sources (logging residue, non-merchantable, and merchantable roundwood) and wood types (hardwood, planted softwood, and natural softwood), and the impacts harvest costs have on the extraction of these materials in the southern US. The expected woody biomass availability and its geographic distribution are determined using a cost minimizing linear programming model. The marginal cost of woody biomass supply is determined for different energy production targets, subject to satisfying conventional wood demand.

Results
To provide 38 million dry tons from 2015 to 2030, there is little need to harvest non-merchantable or merchantable wood for bioenergy feedstocks because existing forest logging residues are sufficient to meet national woody biomass demand requirements at a marginal value less than $60/dry ton. However, when regional harvesting capacity was examined, not all regions have the capacity to develop scalable energy production sourced solely from residues. A combination of logging residue and merchantable roundwood is needed to meet higher woody biomass demand requirements.

4. Associated Knowledge Areas

KA Code	Knowledge Area
123	Management and Sustainability of Forest Resources
125	Agroforestry
131	Alternative Uses of Land
605	Natural Resource and Environmental Economics
608	Community Resource Planning and Development

Outcome #18

1. Outcome Measures

Tennessee Master Logger Program

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Training of loggers in Best Management Practices (BMPs) is necessary to protect water quality during forest harvesting operations. The program is a cooperative effort between UT Extension, Tennessee Department of Forestry Division, and the Tennessee Forestry Association.

What has been done
UT Extension conducted 14 continuing education logger workshops (8 hours each; 2,800 contact hours) in 2015. This effort reached 343 loggers, foresters, and landowners. Based on past BMP implementation survey results, renewed emphasis was placed on stream crossings and water quality associated with logging roads during continuing education sessions.

Results
Each participant increased their knowledge on BMPs 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 (requirement to maintain Master Logger designation is to attend one continuing education workshop every two years).

4. Associated Knowledge Areas

KA Code	Knowledge Area
112	Watershed Protection and Management
123	Management and Sustainability of Forest Resources

Outcome #19

1. Outcome Measures

National Advanced Silviculture Program

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
A strong need exists to provide nationwide training for federal employees (Forest Service, Bureau of Land Management and Bureau of Indian Affairs) in advanced silviculture and formulating stand prescriptions.

This is important for the preparation for certified silviculture designations within the federal government.

What has been done
UT Extension conducted 17 days of training for 33 forest silviculturists from the Forest Service, Bureau of Land Management and Bureau of Indian Affairs. Training consists of in-class lectures, field tours and exercises, and a stand prescription project that are conducted by six university silviculture professors (four are from out-of-state).

Results
Participants increase their knowledge about possible silvicultural options to meet various forest sustainability management objectives. An average of 85% of the participants annually receive the 4-year certification in silviculture resulting in more effective forest management operations on federal lands.

4. Associated Knowledge Areas

KA Code	Knowledge Area
112	Watershed Protection and Management
123	Management and Sustainability of Forest Resources

Outcome #20

1. Outcome Measures

Tennessee Teachers Conservation Workshop

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Absent from the education of many youth, are hands-on outdoor experiences. To bring the forest to the youth, teachers must be knowledgeable about the natural environment and be confident in teaching it.

What has been done
Beginning in 1997, the UT Extension Forestry partnered with the Tennessee Forestry Association, the Memphis Lumbermen?s Club and forest industry to develop the Teachers Conservation Workshop. The purpose was to educated teachers about natural resources, so that they, in turn, could educate students.

Results
Over the 18 years, 525 teachers have attended the West Tennessee and the East Tennessee workshops. Participants have indicated that during the remainder of their career, they will reach on average 400 students, implying that 210,000 students potentially will be impacted by the Teachers Conservation Workshop. Participants report that they have gained new knowledge. The following illustration demonstrate the program's impact:
__One elementary teacher created an arboretum on school property after attending the workshop.
__Four volunteered to teach at Extension programs including Earth Day programs and 4-H Forestry Judging.
__One educator developed an outdoor education amphitheater after attending the workshop.
__One educator stated, "I will certainly teach differently and with more authority because of my

new knowledge."

4. Associated Knowledge Areas

KA Code	Knowledge Area
123	Management and Sustainability of Forest Resources

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 land use issues, feedback is gathered from participants at the end of training sessions. Exit surveys to gather initial opinions and information on immediate plans following the workshop were collected. The feedback entails that more intensive training in the area of GIS and decision-making tools related to land managements were requested.

Key Items of Evaluation

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: 2015	Extension		Research	
	1862	1890	1862	1890
Plan	20.0	1.0	0.0	0.0
Actual Paid	18.0	1.0	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**
356875	124873	0	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
1533991	161712	0	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
155975	0	0	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

Dining with Diabetes is a three-session course offered throughout the state in 2015. 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 helps participants master something new.
- Feedback: Opportunity is 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 has an emphasis on modeling.
- Reinterpreting Symptoms and Changing Beliefs: People are pretty rational. They act based on beliefs. If people believe arthritis is a wear and tear disease, then they may not think they can exercise. If they think that nothing can be done for their arthritis, they are probably right. Throughout this program, there is a great emphasis on changing such beliefs.
- Persuasion: By seeing others in the class contract and succeed, even the most reluctant participant will often choose to take part. It is hard not to go along with others. The facilitator urges participants to do a little more than they are 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 these individuals to manage their pain and engage in daily activities.

2. Brief description of the target audience

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

3. How was eXtension used?

This Health and Safety planned program was enhanced through the service of:

- two Tennessee Extension personnel on the "Drinking Water and Human Health" CoP, and
- seven Tennessee Extension personnel on the "Extension Disaster Education Network" 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

2015	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	56115	3322706	5199	0

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

Patent Applications Submitted

Year:	2015
Actual:	0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2015	Extension	Research	Total
Actual	2	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
2015	157

Output #2

Output Measure

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

Year	Actual
2015	207591

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.

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
2015	708

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
2015	319

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
2015	396

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
2015	396

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
2015	392

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
2015	87

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
2015	51

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
2015	44

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

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

In 2015, several Extension health programs were implemented across Tennessee, partnering with different organizations that include the Tennessee Department of Health, to help people improve their health. These programs addressed arthritis (Arthritis Foundation Exercise Program, Tai Chi), chronic conditions (Living Well with Chronic Conditions), diabetes (Take Charge of Your Diabetes), cancer (TEAM UP TN Cancer program), and physically activity (Walk Across TN). In addition, through partnership with Governor's Foundation for Health & Wellness, the Healthier Tennessee Initiative was promoted to faith-based organizations. Participants reported an improvement in their arthritis symptoms, diet, physical activity, diabetes care, and knowledge about cancer.

- 98% (197 of 201) participants feel confident they can better manage their arthritis by continuing to do the program exercises after this program ends.
- 4,697 participants walked 177,952 miles in the Walk Across Tennessee Program.
- 39% (195 of 505) participants lost weight: 887 total pounds lost.

Six months after completing the program:

- 70% (74 of 105) participants have maintained an exercise routine.
- 85% (45 of 53) participants are making healthy food decisions.
- 55% (40 of 73) participants have had fewer doctor visits and/or emergency room visits.
- 94% (211 of 225) participants improved performance of daily activities.
- 92% (673 of 734) participants plan to get age and gender appropriate cancer screenings.
- 79% (184 of 234) participants (with diabetes) have reduced their A1c (indicating better control of diabetes).

Key Items of Evaluation

In 2015, several Extension health programs were implemented across Tennessee, partnering with different organizations that include the Tennessee Department of Health, to help people improve their health. These programs addressed arthritis (Arthritis Foundation Exercise Program, Tai Chi), chronic conditions (Living Well with Chronic Conditions), diabetes (Take Charge of Your Diabetes), cancer (TEAM UP TN Cancer program), and physically activity (Walk Across TN). In addition, through partnership with Governor's Foundation for Health & Wellness, the Healthier Tennessee Initiative was promoted to faith-based organizations. Participants reported an improvement in their arthritis symptoms,

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- 92% (673 of 734) participants plan to get age and gender appropriate cancer screenings.
- 79% (184 of 234) participants (with diabetes) have reduced their A1c (indicating better control of diabetes).

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%	8%	0%
133	Pollution Prevention and Mitigation	0%	0%	0%	46%
201	Plant Genome, Genetics, and Genetic Mechanisms	0%	0%	11%	0%
205	Plant Management Systems	60%	60%	10%	0%
211	Insects, Mites, and Other Arthropods Affecting Plants	10%	10%	6%	20%
212	Pathogens and Nematodes Affecting Plants	10%	10%	33%	27%
213	Weeds Affecting Plants	10%	10%	6%	0%
216	Integrated Pest Management Systems	10%	10%	0%	0%
605	Natural Resource and Environmental Economics	0%	0%	0%	7%
607	Consumer Economics	0%	0%	3%	0%
702	Requirements and Function of Nutrients and Other Food Components	0%	0%	12%	0%
721	Insects and Other Pests Affecting Humans	0%	0%	11%	0%
	Total	100%	100%	100%	100%

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2015	Extension		Research	
	1862	1890	1862	1890
Plan	36.0	5.0	25.0	11.0
Actual Paid	29.0	9.0	24.5	10.0
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**
579922	290403	912866	470031
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
2492736	376075	1709446	470031
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
100000	0	1115495	0

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 at TSU will:

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.

Identify new biopesticides that can substitute for synthetic petroleum-based pesticides and reduce worker exposure risk and environmental impact.

Establish parasitic flies in Tennessee to provide imported fire ant biological control.

Provide extension training and literature to producers on imported fire ant and Japanese beetle management and train students in pest management and research techniques.

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.

Conduct assessment of current and future energy use by greenhouse and nursery businesses.

Identify alternative energy sources for the greenhouse and nursery industry.

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?

.

V(E). Planned Program (Outputs)

1. Standard output measures

2015	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	1153250	87710874	74282	95

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

Patent Applications Submitted

Year:	2015
Actual:	0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2015	Extension	Research	Total
Actual	2	72	74

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

● Horticultural workshops and conferences.

Year	Actual
2015	25961

Output #2

Output Measure

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

Year	Actual
2015	1044

Output #3

Output Measure

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

Year	Actual
2015	3280

Output #4

Output Measure

- Orbital patterns and statistical tools were used to derive Photosynthetically Active Radiation (PAR) from long-term flat-plate global horizontal irradiance and to develop hourly, daily, monthly, and annual tables and maps for use in the greenhouse industry. (Logan)

Year	Actual
2015	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 treatments for invasive pests.
4	Confirmed establishments of new invasive pest parasites.
5	Producers informed about new or emerging diseases.
6	Producers are informed about new biological control treatments.
7	Producers that are informed about new sources of host resistance.
8	New cultivars exhibiting disease resistance available to growers.
9	Nursery/greenhouse operators trained in alternative energy use.
10	New trap designs and strategies for Ambrosia beetle available to growers
11	Assessing and reintroducing Pityopsis ruthii (Trigiano, Wadl)
12	Gentic diversity in dogwood cultivars (Windham, Windham, Trigiano, Wadl)
13	Downy mildew control (Lamour, Trigiano)
14	Greenhouse production (Deyton, Sams)
15	Molecular Markers for Horticultural Traits (Trigiano, Ownley, Wadl)
16	Pruning systems for healthier peach trees (Lockwood)
17	Using genetics against Phytophthora blight (Lamour)

18	Biodegradable mulches as polyethylene mulch alternatives (Moore)
19	Biofumigation of strawberries (Deyton, Sams, Butler)
20	Growth regulators for fruit tree size and drought resistance (Deyton, Sams)
21	Photosynthetic properties of raspberries (Sams, Deyton)
22	High value crops (Ownley)
23	Systematics of tachinid parasitoids of true bugs (Moulton)
24	Tennessee turfgrass contributions and plans (English)
25	Plant Disease and Insect Management for Tennessee?s Green Industry

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
2015	1657

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
2015	4999

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 treatments for invasive pests.

2. Associated Institution Types

- 1890 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	2

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Treatment methods for cleansing nursery stock of imported fire ant, Japanese beetle, and numerous non-indigenous ambrosia beetles are expensive, hazardous, impractical or ineffective, and often require shipping delays. Imported fire ant treatment methods like the Federal drench protocol are hazardous, labor intensive, and expensive. Most treatments for these pests rely on only a few active ingredients (i.e., chlorpyrifos, imidacloprid, or permethrin), providing producers with only limited alternatives. The development of new alternatives, especially reduced-risk treatments, is important for protecting agricultural workers, the environment, and ensuring treatments remain viable and available to agricultural producers. It also is important that newly developed treatments become available to producers through modifications of federal and state regulations governing these quarantine pests.

What has been done
During this reporting period, multiple imported fire ant mound drench tests were performed at three cooperating commercial nurseries. Treatments evaluated multiple insecticides, combinations of treatments with carbaryl, and a biopesticide. Research was initiated to evaluate injection volumes needed to adequately treat balled and burlapped nursery stock. A dip study using Domestic Japanese Beetle Harmonization Plan approved insecticides and rates was performed to assess temperature effects on treatments. A longevity test of insecticides against Japanese beetle was completed.

Results
Imported fire ant (IFA) mound drench tests revealed several products capable of 100% IFA elimination in 1 to 7 days after treatment (DAT). Chlorpyrifos was the only insecticide capable of eliminating IFA colonies in 1 DAT. The second and third projects evaluating injections and temperature effects on nursery plant dips are still on-going and results are not finalized at this time. The study involving longevity of insecticide residues had inconsistent results from tests

performed in previous years due to an extreme flood event of the field site. Further research studies will be needed. The final flatheaded borer study had similar results to previous evaluations, showing that herbicide-treated trees had higher borer incidence than non-herbicide treated trees, but as expected higher imidacloprid rates provided greater protection.

4. Associated Knowledge Areas

KA Code	Knowledge Area
133	Pollution Prevention and Mitigation
211	Insects, Mites, and Other Arthropods Affecting Plants

Outcome #4

1. Outcome Measures

Confirmed establishments of new invasive pest parasites.

2. Associated Institution Types

- 1890 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	2

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Imported fire ants (IFA) infest over 325 million acres and cause billions of dollars in damage in North America and are continuing to expand their range. To slow IFA spread and provide region-wide sustainable suppression of IFA populations, the USDA has an on-going classical biocontrol program to establish phorid-decapitating fly parasitoids (Pseudacteon spp.) of IFA from South America into the United States. There are about 20 species of Pseudacteon flies in South America, which exhibit niche partitioning of IFA by worker size, species, activity (foraging, mating flights), and time of the day. Therefore, to effectively manage IFA with Pseudacteon flies, it will likely require introductions of a suite of fly species.

What has been done

During fall 2015, an estimated total of 15,072 Pseudacteon cultellatus and 1,539 Pseudacteon obtusus were released in Williamson Co., TN. These releases supplement the 22,656 P. cultellatus released in 2014, 46,157 P. obtusus released between 2009-2014, 8,840 P. curvatus Formosan biotype between 2004-2008, 18,000 P. curvatus Los Flores biotype between 2000-2003, 2,856 mixtures of P. curvatus biotypes between 2011-2012, and 10,812 P. tricuspis between 1999-2006 and 2011-2012. Efforts to capture adult Pseudacteon flies near disturbed

imported fire ant colonies were made at several locations in Tennessee in August and September 2015.

Results
As in past years, we only have recovered P. curvatus phorid flies in Tennessee. It is likely still too early to detect P. cultellatus flies since releases just began during fall 2014 and 2015. It is still possible P. obtusus may be recovered in Tennessee in the coming years, but it is likely P. tricuspis releases have been unsuccessful due to the long period of time since releases began and the absence of subsequent fly recoveries. Reports from other states where Pseudacteon flies have been released indicate other non-P. curvatus fly species are establishing in very low numbers, so it may be difficult to recover these flies in future surveys.

4. Associated Knowledge Areas

KA Code	Knowledge Area
133	Pollution Prevention and Mitigation
211	Insects, Mites, and Other Arthropods Affecting Plants

Outcome #5

1. Outcome Measures

Producers informed about new or emerging diseases.

2. Associated Institution Types

- 1890 Extension
- 1890 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	20

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Nursery growers need to be informed about new and emerging diseases so that they can be prepared for the disease by taking preventive measures and minimize the potential economic impact of the disease.

What has been done
Research to identify and confirm new diseases in Tennessee. Workshops and presentations on new and emerging diseases.

Results
Presentations provided information to growers on how to recognize the new emerging diseases

4. Associated Knowledge Areas

KA Code	Knowledge Area
133	Pollution Prevention and Mitigation
212	Pathogens and Nematodes Affecting Plants

Outcome #6

1. Outcome Measures

Producers are informed about new biological control treatments.

2. Associated Institution Types

- 1890 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	10

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Nursery production systems use high rates of chemical fungicides to control powdery mildew of dogwood; this is detrimental to the environment and grower income by increasing dogwood production costs. Alternatives to chemical fungicides would be desirable.

What has been done
Microorganisms selected for superior efficacy against powdery mildew of dogwood were evaluated for bioactivity against other fungal pathogens. Interactions between the biocontrol agents were evaluated to determine which microbes can be combined to enhance biological control. In addition, the compatibility of biological control agents with common fungicides such as thiophrnate methyl and biorational products such as bicarbonate of soda was evaluated.

Results
Results confirmed previous observations on microbial bioactivity against powdery mildew, improved plant growth, and showed bioactivity against other pathogens. Preliminary studies showed that the biological control agents secreted some compounds that may be involved in controlling the fungal pathogens. In addition, scanning electron microscopy showed that the

biological control agents we are working with have parasitism activity that seem to be specific to powdery mildew and did not seem to affect other microflora on the leaf surface. These observations indicate that the biological control agents would preserve other microbes.

4. Associated Knowledge Areas

KA Code	Knowledge Area
133	Pollution Prevention and Mitigation
212	Pathogens and Nematodes Affecting Plants

Outcome #7

1. Outcome Measures

Producers that are informed about new sources of host resistance.

2. Associated Institution Types

- 1890 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	20

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Growers need to know about the availability of powdery mildew resistance in plants that will grow better without requiring routine fungicide applications.

What has been done
Research focused on powdery mildew host resistance inheritance to provide information that can facilitate breeding efforts. Identification of molecular markers and morphological markers for powdery mildew resistance will facilitate marker assisted breeding. New plants that display powdery mildew resistance were also generated.

Results
Narrow sense heritability and broad sense heritability were determined. Identification of molecular markers and morphological markers for powdery mildew resistance to assist breeding efforts are in progress. New plants that displayed powdery mildew resistance need resistance confirmation. In addfition, molecular markers studies showed that the inheritance of powdery mildew is controlled by many genes with additive effects

4. Associated Knowledge Areas

KA Code	Knowledge Area
133	Pollution Prevention and Mitigation
212	Pathogens and Nematodes Affecting Plants

Outcome #8

1. Outcome Measures

New cultivars exhibiting disease resistance available to growers.

2. Associated Institution Types

- 1890 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Disease resistance is the best method for disease control by farmers. New generations of cultivars that are resistant to powdery mildew would be a great contribution to nursery growers in that they would not require routine fungicide applications.

What has been done
Genetic characterization of the resistance in the two cultivars. Identification of quantitative trait linkage (QTL) maps identified only a few QTLs associated with powdery mildew was done.Confirmation and identification of new sources of resistance will continue.

Results
Genetic characterization of the resistance in the two cultivars. Identification of quantitative trait linkage (QTL) maps identified only a few QTLs associated with powdery mildew was done. Confirmation and identification of new sources of resistance will continue.

4. Associated Knowledge Areas

KA Code	Knowledge Area
133	Pollution Prevention and Mitigation
212	Pathogens and Nematodes Affecting Plants

Outcome #9

1. Outcome Measures

Nursery/greenhouse operators trained in alternative energy use.

2. Associated Institution Types

- 1890 Extension
- 1890 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	25

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Exploring alternative sources of energy is needed to identify lower cost sources. It can promote efficient and cost effective management practices that can overcome some of the challenges faced by the nursery/greenhouse growers. Such sources range from bioenergy operated by an individual operator to others available through institutions in the energy business.

What has been done
Information was disseminated and opportunities for training in alternative energy sources was provided to stakeholders using three venues. As a result twenty five nursery and greenhouse operators were trained.

Results
Almost 50% of the growers indicated that increase in energy cost is responsible for decline in profitability of their operations.
About 25% of the operators expressed the possibility of adopting new sources of energy in their operations.
Analysis of results indicated that younger operators were more receptive of training on use of alternative energy in their operations compared to older ones. Further research in developing suitable data to older operators is being conducted.
The project also generated data for use by two graduate students have been able to use for completing MS degrees: one on energy use by greenhouse and nursery growers and another on marketing of nursery and greenhouse products.

4. Associated Knowledge Areas

KA Code	Knowledge Area
605	Natural Resource and Environmental Economics

Outcome #10

1. Outcome Measures

New trap designs and strategies for Ambrosia beetle available to growers

2. Associated Institution Types

- 1890 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	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
Kaolin clay and pesticide combinations were evaluated for preventing beetle infestation. Nine new trap lure combinations were also evaluated and compared to the standard lure for ambrosia beetles (ethanol). An ethanol blocker product was piloted in 2015 as a trunk application.

Results
We developed two new methods for managing ambrosia beetles that is currently available to growers (kaolin and kaolin + bifenthrin). None of the nine lure combinations tested were superior to the current ethanol baited trap for target ambrosia beetle species. One ethanol blocker product for ambrosia beetle management was piloted in 2015. The product successfully decreased ethanol emission from tree bolts by 80% in some formulations. Studies will continue in 2016 to test efficacy of the product in the field.

4. Associated Knowledge Areas

KA Code	Knowledge Area
133	Pollution Prevention and Mitigation
211	Insects, Mites, and Other Arthropods Affecting Plants

Outcome #11

1. **Outcome Measures**

Assessing and reintroducing Pityopsis ruthii (Trigiano, Wadl)

Not Reporting on this Outcome Measure

Outcome #12

1. **Outcome Measures**

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

Not Reporting on this Outcome Measure

Outcome #13

1. **Outcome Measures**

Downy mildew control (Lamour, Trigiano)

Not Reporting on this Outcome Measure

Outcome #14

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
2015	0

3c. **Qualitative Outcome or Impact Statement**

Issue (Who cares and Why)
Strawberries in much of the world are grown in protected culture (high tunnels or greenhouses), and growers in the eastern USA are now trying protected culture production. Strawberry cultivars in the USA have been developed for outdoor production, which has very different microclimates from that of protected-culture (i.e. light spectrum, temperature, etc.). Strawberry cultivars need to be bred for production in high tunnels and greenhouses.

What has been done
We made crosses of native selections with genetic material from the Univ. of Florida.

Results
We have collected parent material, made crosses, and narrowed selections. Plants are currently being fruited in a greenhouse bay to further evaluate fruit quality and yield.

4. Associated Knowledge Areas

KA Code	Knowledge Area
201	Plant Genome, Genetics, and Genetic Mechanisms
205	Plant Management Systems
211	Insects, Mites, and Other Arthropods Affecting Plants
212	Pathogens and Nematodes Affecting Plants
216	Integrated Pest Management Systems
607	Consumer Economics

Outcome #15

1. Outcome Measures

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

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Cryptolepis sanguinolenta is over exploited by indigenous persons as a traditional medicine use to treat malaria.

What has been done

Results
Our preliminary data shows that there is very limited genetic diversity and that measures to conserve the species needs to be formulated soon. The molecular markers will also be useful in a breeding program aimed at repopulation and selection of high medicinal content of plants.

4. Associated Knowledge Areas

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

Outcome #16

1. Outcome Measures

Pruning systems for healthier peach trees (Lockwood)

Not Reporting on this Outcome Measure

Outcome #17

1. Outcome Measures

Using genetics against Phytophthora blight (Lamour)

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

What has been done
Continued work with oomycete plant pathogens including members of the genera Phytophthora, Pythium and Peronospora. In addition, new projects focused on fungal pathogens of soybean and endangered flies in Tennessee. The activities include development of basic genetic resources (e.g. genome sequence) followed by the development of molecular markers, primarily single nucleotide polymorphism (SNP) markers.

Results
The impacts for the above work is the development of valuable new research tools -- novel genetic markers for multiple agriculturally-important organisms. This was accomplished to allow deeper insight into the life history, epidemiology and evolution of these organisms. In all cases, the markers were applied to natural populations to answer questions concerning survival and spread.

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

Outcome #18

1. Outcome Measures

Biodegradable mulches as polyethylene mulch alternatives (Moore)

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Polyethylene (PE) mulch is currently used widely in agriculture worldwide. It has many benefits including weed management, warming the soil, increasing yield, conserving moisture, and more. However, there are sustainability issues with PE mulch.

What has been done
Biodegradable mulches (BDMs) have the potential to provide the benefits of PE mulch while being a more sustainable option.

Results
We are investigating performance of 4 BDMs in field experiments. After our first season of field work in 2015, our preliminary results indicate that yield and quality of pumpkins grown on BDMs are comparable with PE mulch. We will repeat this field experiment in 2016, and along with our collaborators, we will be monitoring how the mulch breaks down in the soil and any other changes in the soil.

4. Associated Knowledge Areas

KA Code	Knowledge Area
205	Plant Management Systems
213	Weeds Affecting Plants
607	Consumer Economics

Outcome #19

1. Outcome Measures

Biofumigation of strawberries (Deyton, Sams, Butler)

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Most strawberries and fresh market tomatoes are grown on fumigated soil. Methyl Bromide was the most effective fumigate, but is no longer available. Telone is a substitute, but lacks weed control and requires more training and certification to use. Biofumigation and anaerobic soil

disinfestation are two non-chemical methods for controlling soil-borne plant pathogens.

What has been done
We have compared biofumigation, anaerobic soil disinfestation, and combination of the two against non-treated and chemical fumigated plots.

Results
Biofumigation and the combination of biofumigation with anaerobic soil disinfestation provided higher yields than untreated plots and generally similar yields to the chemical-treated plots.

4. Associated Knowledge Areas

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

Outcome #20

1. Outcome Measures

Growth regulators for fruit tree size and drought resistance (Deyton, Sams)

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The trend in tree fruit production is to use dwarf trees to increase labor efficiency, pest control and fruit quality. Commonly used full dwarfing apple rootstocks lack fireblight (FB) tolerance for extensive use in the Southeast, and the new full dwarf FB resistant rootstocks have very limited availability. No full dwarfing rootstocks are available for peach trees.

What has been done
We evaluated the effect of palcobutrazol (PZB) and uniconazole (UCZ), growth retardants, on fruit tree growth and physiology. PBZ is commonly used in high tunnel production of peaches in China

and was used on apple trees in Europe.A review in 2004 found that nearly 80% of orchards in the United Kingdom used plant growth regulators (PGRs), and PBZ accounted for 54% of PGR use.

Results
Our trials showed that PZB and UCZ can increase photosynthetic rates of leaves, and thus may be beneficial to plants in future trials. Both PBZ and UCZ reduced vegetative growth the first growing season, and UCZ also the second year. Treatment with either compound maintained higher leaf Pn rates when plants were moisture-stressed. Labeled use of PZB in Europe has been discontinued, thus is unlikely to be registered for fruit in the USA. The persistent carry-over effect of UCZ on tree growth would complicate tree management at the tested UCZ concentrations. The compound will not be labeled on fruit trees.

4. Associated Knowledge Areas

KA Code	Knowledge Area
133	Pollution Prevention and Mitigation
205	Plant Management Systems

Outcome #21

1. Outcome Measures

Photosynthetic properties of raspberries (Sams, Deyton)

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Little is known about the photosynthesis properties of raspberries.

What has been done
We conducted studies to characterize net photosynthetic rates of raspberry leaflets by node location and leaf age; diurnal pattern of photosynthesis in sunlight and in artificial light; and the light saturation curve for leaf photosynthesis.

Results

Photosynthesis of raspberry leaves was maximized at about 75% of full sunlight. Leaves reached maximum photosynthetic capability at about 80% full leaf expansion, maintain the rate for about 5 days, and then decline. By the end of the season the mid-zone leaves were still major contributors to the plant photosynthesis. During the diurnal cycle, leaves of outdoor plants reach maximum photosynthetic rate at about 10:00 AM and then decline throughout the afternoon. Under lights, plants also reached a maximum Pn at about 10:00 but tended to maintain higher Pn rates throughout the afternoon and evening than when outdoors.

4. Associated Knowledge Areas

KA Code	Knowledge Area
205	Plant Management Systems

Outcome #22

1. Outcome Measures

High value crops (Ownley)

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Growers interested in diversifying their farming operations with high value crops may consider specialty crops that are in increasing demand, such as olives, Stevia, and chokeberries. One barrier is selection of cultivars and production methods that are compatible with the environment, and pest and disease pressures in the southeastern U.S.

What has been done
In the past 10 years, consumption of olive oil has tripled in the U.S due to its reported health benefits. U.S. consumption is now 10% of world production, while the U.S. only produces 1.3% of our olive oil consumption. Clearly there is room for growth of this commodity in the U.S.

Results
On olive, we have shown that pest and disease problems are minimal and cold hardy cultivars can be established (3-yr-period) in East Tennessee; however, due to recent severe winters,

careful site selection and/ or protected culture is be advised. Stevia is an annual crop in our area, but can likely be harvested three times. Insect pressure is minimal on Stevia, but there are a few disease problems, such as Botrytis cinerea, which will require management. Chokeberries have survived relatively well during the last few winters. Disease problems are minimal, but Japanese beetles can be problematic.

4. Associated Knowledge Areas

KA Code	Knowledge Area
205	Plant Management Systems
607	Consumer Economics

Outcome #23

1. Outcome Measures

Systematics of tachinid parasitoids of true bugs (Moulton)

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The subfamily Phasiinae is the only endoparasitoid that attacks true bugs, including stink bugs, squash bugs, chinch bugs, and other agricultural and nuisance pests.

What has been done
Our work, a complete morphological and molecular revisionary analysis of the group, has resulted in a much greater understanding of relationships among the various genera and tribes within this subfamily, ultimately yielding a revised phlyogenetic-based classification having predictive power. That is, species within the same genera and genera within the same tribe should share biological or ecological traits resulting from phyletic descent.

Results
In the realm of applied research, this means selection of potential biocontrol agents can be guided by what is known about nearest relatives if information for the agent is lacking.

4. Associated Knowledge Areas

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

Outcome #24

1. Outcome Measures

Tennessee turfgrass contributions and plans (English)

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The purposes of this study were a) to project economic contributions of the Tennessee turfgrass industry to the state's economy and b) to acquire information about turfgrass participants?f future growth plans along with identification of turfgrass problematic issues and concerns.

What has been done
To obtain this information an online survey of Tennessee?'s turfgrass industry was conducted. Surveys were designed to obtain information from sod producers, turfgrass manufacturing and service sectors, and turfgrass users.

Results
In 2013, the Tennessee turfgrass industry contributed $5.7 billion to the state?'s economy and close to 48,000 full- and part-time jobs. Wages from sod producers and users to employees contributed $305.6 million and close to 21,000 full- and part?-time jobs. Tennessee?'s turfgrass industry had a total estimated economic contribution of close to $6.0 billion and created over 68,000 full- and part-time jobs. For every dollar spent on turfgrass expenditures in the state, an additional $0.66 of economic activity is generated. For every job created from turfgrass expenditures, an additional 0.52 jobs are created in other industries throughout the state.

4. Associated Knowledge Areas

KA Code	Knowledge Area
605	Natural Resource and Environmental Economics
607	Consumer Economics

Outcome #25

1. Outcome Measures

Plant Disease and Insect Management for Tennessee?s Green Industry

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Plant diseases and insects cause millions of dollars of damage to turfgrass and ornamental plants in residential and commercial landscapes, nurseries and greenhouses in Tennessee each year. A key to pest management is the identification of the target pest or disease so that appropriate management strategies can be implemented in a timely manner. Emphasis in many educational processes has been placed on identifying pests and diseases and reliable sources of information for green industry professionals and Master Gardeners.

What has been done
Extension agents and area specialists, plus state specialists conducted educational programs in consumer and commercial horticulture reaching over 97,816 direct contacts in 49 counties during 2015. Pest management practices were taught by Extension educators at group meetings and site visits. Over 2.3 million clientele (indirect contacts) were also reached via newspaper articles and mass media. Social media was used to interact with over 35,000 unique, engaged users; with pest management information reaching over 1.7 million individuals.

Results
Educational activities across the state were evaluated to determine the following commercial and consumer horticulture impacts:
__586 Master Gardeners have used the knowledge and skills they learned in this program to assist 3152 people to identify pests and/or the damage they cause.
__562 green industry personnel adopted an integrated pest management approach to insect, mite, and disease control in turfgrass and/or ornamental plants.

__382 green industry personnel increased business profitability and sustainability through improved insect, mite and disease control in turfgrass and/or ornamental plants.

4. Associated Knowledge Areas

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

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

{No Data Entered}

V(I). Planned Program (Evaluation Studies)

Evaluation Results

Research impact and program relevance for nursery entomology research were measured primarily by the number of instances when our program was solicited or utilized for research information by stakeholders. From one-on-one information requests, grower verbal exchanges at meetings or research field sites, and phone, text or email requests for research-related information, we determined there were 78,547 instances when program information was provided during the Oct. 1, 2014 to Sept. 30, 2015 reporting period.

Key Items of Evaluation

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: 2015	Extension		Research	
	1862	1890	1862	1890
Plan	17.0	2.0	0.0	0.0
Actual Paid	14.0	3.0	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**
267656	95833	0	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
1150493	124105	0	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
185000	178172	0	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

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

incarcerated, court-ordered parents and relatives as caregivers.

The following will be 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 will be created and dissiminated. Extension FCS Agents in over 60 of Tennessee's 95 counties will offer 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. It is expected that approximately 2,000 participants will complete the Extension class annually.

For 2015 - 2019, TSU Extension Family and Community Health programs will place special 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 will produce and distribute resource materials and educational programs on a variety of topics for interested individuals, caregivers, and professionals. Various methods will be employed, including inter-generational connections.

2. Brief description of the target audience

The target audiences for this planned program are Tennessee child care providers, parents, and adolescents. While all parents of infants and young children are targeted for literacy programs, parents seeking a divorce are 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 is the only provider of this instruction.

3. How was eXtension used?

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V(E). Planned Program (Outputs)

1. Standard output measures

2015	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	46757	4289328	13689	0

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

Patent Applications Submitted

Year:	2015
Actual:	0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2015	Extension	Research	Total
Actual	1	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
2015	119

Output #2

Output Measure

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

Year	Actual
2015	895

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
2015	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
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.

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	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
802	Human Development and Family Well-Being

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

2015	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
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
2015	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
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.

Not Reporting on this Outcome Measure

V(H). Planned Program (External Factors)

External factors which affected outcomes
- Government Regulations

Brief Explanation

V(I). Planned Program (Evaluation Studies)

Evaluation Results

{No Data Entered}

Key Items of Evaluation

{No Data Entered}

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%	8%	0%
102	Soil, Plant, Water, Nutrient Relationships	0%	0%	5%	0%
121	Management of Range Resources	0%	0%	8%	0%
201	Plant Genome, Genetics, and Genetic Mechanisms	0%	0%	11%	0%
202	Plant Genetic Resources	0%	0%	3%	30%
204	Plant Product Quality and Utility (Preharvest)	0%	0%	0%	30%
205	Plant Management Systems	0%	0%	8%	0%
212	Pathogens and Nematodes Affecting Plants	0%	0%	5%	0%
213	Weeds Affecting Plants	0%	0%	0%	10%
215	Biological Control of Pests Affecting Plants	0%	0%	3%	0%
402	Engineering Systems and Equipment	0%	0%	8%	0%
404	Instrumentation and Control Systems	0%	0%	4%	0%
511	New and Improved Non-Food Products and Processes	0%	0%	32%	30%
512	Quality Maintenance in Storing and Marketing Non-Food Products	80%	80%	2%	0%
603	Market Economics	10%	10%	0%	0%
605	Natural Resource and Environmental Economics	10%	10%	0%	0%
608	Community Resource Planning and Development	0%	0%	3%	0%
	Total	100%	100%	100%	100%

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2015	Extension		Research	
	1862	1890	1862	1890

Plan	5.0	1.0	65.0	11.0
Actual Paid	5.0	1.0	58.1	7.0
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**
89225	29040	764913	329022
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
383497	37606	3430363	329022
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
0	0	5357014	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

Disseminate research findings to the scientific community, stakeholders, agricultural, environmental, life science industries. Recruit and train students, incorporating research training into teaching and extension curricula.

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. Additional research is being conducted in the development of new oilseed and biofuel crops, and optimizing harvest parameters of those crops.

As part of UT AgResearch's engineering research, 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.

The TSU research goals address performing research to enhance the production of biofuels by limited resource individuals through optimization of management strategies and development of enhanced varieties.

2. Brief description of the target audience

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

3. How was eXtension used?

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V(E). Planned Program (Outputs)

1. Standard output measures

2015	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	19824	300548	4269	0

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

Patent Applications Submitted

Year:	2015
Actual:	0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2015	Extension	Research	Total
Actual	1	137	138

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number of research-based publications distributed as part of Extension biofuels programs.

Year	Actual
2015	8721

Output #2

Output Measure

- Number of workshops and presentations concerning new or alternative biofuel feedstocks.

Year	Actual
2015	33

Output #3

Output Measure

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

Year	Actual
2015	30

Output #4

Output Measure

- We have synthesized cellulose-silica aerogels by a sol-gel process using ambient pressure drying in order to improve their mechanical properties. The compression properties of the composite aerogel improved greatly compared with those of the silica aerogel -- about 8-30 times higher. Moreover, the compressive strength of the composite aerogel prepared in this work greatly exceeded the conventional insulation materials found in the recent commercial market, and without very great increases in thermal conductivity. (Wang)

Year	Actual
2015	1

Output #5

Output Measure

- We evaluated two types of subsidies for biofuel feedstock production and water quality improvement and to analyze how each subsidy affects biomass supply and the abatement of nutrient runoff associated with the conversion of cropland to biomass production. A per-ha subsidy is more cost effective and feasible than a per-Mg system because the former has significantly lower subsidy than the latter for each kilogram (kg) of N reduction and for each Mg of switchgrass harvested. (English, Larson)

Year	Actual

2015 1

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Producers will have increased knowledge of production options available for growing bioenergy feedstocks (Increased knowledge and understanding of the biofuels supply chain).
2	An increased number of producers will adopt production of bioenergy feedstocks (Implementation of sustainable biofuels systems).
3	Students will receive training in bioenergy production (Develop a diverse and educated workforce for a biofuels industry).
4	Protocols will be developed for mutagenesis and selection of herbicide resistant biofuel feedstock varieties (Increased knowledge and understanding of the biofuels supply chain).
5	Desirable biofuel feedstock varietal mutants will be recovered (Increased knowledge and understanding of the biofuels supply chain.
6	New varieties of biofuel feedstocks will be developed (Increased knowledge and understanding of the biofuels supply chain).
7	Producers will have knowledge of benefits:costs of production (from land preparation to final ethanol production) for biofuel crops (Miscanthus, switchgrass and other underutilized native grass species) through the construction of benfit:cost analysis sheets.
8	Stakeholders will have knowledge of the energy efficiency of biofuel production from switchgrass and Miscanthus through the calculation of energy balance sheets for these crops, providing indicators of sustainability for biofuel production
9	Biofuel producers will have knowledge on optimal number of harvest machines needed for biorefinery, cost to harvest, store and transport feedstock and information on harvesting and hauling costs per gallon of biofuel produce.
10	Improved process-based ecosystem models to forecast biofuel productivity under future climate conditions.
11	Switchgrass pathogens and diseases (Ownley, Zale, Gwinn, Windham)
12	Switchgrass logistics and handling (Womac)
13	Biorefinery coproducts (Bozell)
14	Insects to help with biofuel production (Jurat-Fuentes, Klingeman, Oppert)
15	Regenerating agave (Cheng)
16	Switchgrass biomass yield improvement (Bhandari, Allen)
17	Switchgrass extractives as bioactive compounds (Canaday, Gwinn, Labbe, Ownley)

18	Carbon Fiber Production from Lignin (Harper)
19	Gene flow in switchgrass and papaya (Kwit)
20	Impact of cellulosic biofuel industry on the rural economy (Jensen, Clark, Lambert, Yu)
21	Switchgrass germination and yield persistence (Bhandari)
22	Understanding impurities during biomass gasification (Abdoulmoumine)
23	Switchgrass storage (Larsen, English, Yu, Tyler)

Outcome #1

1. Outcome Measures

Producers will have increased knowledge of production options available for growing bioenergy feedstocks (Increased knowledge and understanding of the biofuels supply chain).

2. Associated Institution Types

- 1890 Extension
- 1890 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	41

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Bioenergy, and biofuels in particular, are a mainstream concept as an alternative to the security and environmental issues related to fossil fuels. Many producers may be understandably skeptical about growing biofuel crops because of the lack of information available to them and the fact that there is currently no major market available for them to sell these products. However, it is important to disseminate this assistance to these producers because once the infrastructure and markets are fully established, producers will have the optimal tools available to them to succeed.

What has been done

Information was disseminated to farmers and other professionals related to concepts like the use of switchgrass or native-warm season grasses for forage and bioenergy as well as the production of winter canola as a cover crop with the option for use to produce biodiesel.

The project was featured on the Market Day Report on RFD-TV in December 2015 https://www.youtube.com/watch?v=rBqwPaIiNPQ

The project was featured in the Tennessee Department of Agriculture annual publication (TN AgInsider). http://www.farmflavor.com/us-ag/tennessee/environment-tn/fueling-the-future/

The project was featured on a local Nashville news station: https://www.youtube.com/watch?v=uIJLatFj8vE

Five videos were developed and published on YouTube to show the step-by-step process of producing biodiesel.

Two fact sheets were developed, published, and uploaded to the TSU Cooperative Extension website.

A Twitter account (@TSUBioenergy) and website (http://www.tnstate.edu/faculty/jdekoff/) were maintained to provide information on the bioenergy program at TSU as well as other bioenergy-related topics.

A bioenergy activity for youth and workshops for youth and teachers were implemented through a USDA NIFA Capacity Building grant (different from the one mentioned above).

Results

Based on survey results from outreach meetings:
65% of participants indicated an increased potential to grow native warm-season grasses for forage
95% of participants indicated an increase in knowledge in native warm-season grasses for forage
100% increase in participants? knowledge of winter canola production
60% increase in potential behavioral change related to winter canola

4. Associated Knowledge Areas

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

Outcome #2

1. Outcome Measures

An increased number of producers will adopt production of bioenergy feedstocks (Implementation of sustainable biofuels systems).

2. Associated Institution Types

- 1890 Extension
- 1890 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	4

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Bioenergy, and biofuels in particular, are a mainstream concept as an alternative to the security and environmental issues related to fossil fuels. Many producers may be understandably skeptical about growing biofuel crops because of the lack of information available to them and the fact that there is currently no major market available for them to sell these products. However, it is important to disseminate this assistance to these producers because once the infrastructure and markets are fully established, producers will have the optimal tools available to them to succeed.

What has been done
Demonstrations using a mobile biodiesel demonstration purchased through USDA NIFA Capacity Building grant funds were conducted. There were 5 meetings in 5 different counties. The mobile biodiesel demonstration was also a part of the Tennessee FFA convention in March 2015 and the Tennessee State Fair Green Collar Exhibit in September 2015. Two fact sheets were developed, published, and uploaded to the TSU Cooperative Extension website (http://www.tnstate.edu/extension/publication_index.aspx). A Twitter account (@TSUBioenergy) and website (http://www.tnstate.edu/faculty/jdekoff/) were maintained to provide information on the bioenergy program at TSU as well as other bioenergy-related topics. A biofuel technology workshop was led through a different USDA NIFA Capacity Building grant to provide training on biofuels and biofuel production to middle school and high school students and teachers in June 2015.

Results
Overall, participants? awareness increased by 37% and their knowledge increased by 28%. For example, prior to the workshops, participants were uncertain whether biodiesel production was economically feasible for farmers to produce. After the workshops, they agreed that it was economically feasible. Also, participants were uncertain if oilseed crops could be used to produce biodiesel. Following the workshops, they agreed that biodiesel could be produced from these crops. Participants were also unaware that there was equipment available that would allow smaller farmers to produce their own biodiesel. After the workshops, participants indicated an increase in their awareness of this equipment. Lastly, participants were not aware that only a small amount of acreage (1-15% of total acreage) needed to be devoted to producing enough biodiesel crops to provide fuel to run their diesel engines for an entire year. After the workshops, participants indicated their increased awareness of this low acreage requirement.

4. Associated Knowledge Areas

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

Outcome #3

1. Outcome Measures

Students will receive training in bioenergy production (Develop a diverse and educated workforce for a biofuels industry).

2. Associated Institution Types

- 1890 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	3

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Bioenergy is a new, environmentally-focused field that encompasses a range of scientific disciplines. It has great impact on the environment due to its importance in maintaining the world's environmental and economic integrity. The U.S. has recently increased its focus in the area of bioenergy through federal mandates and funding for research, infrastructure and feedstock development, and education to enhance the nation's energy portfolio. This emphasis has created new opportunities in the 'green jobs' market which will require new efforts and new programs for training future professionals.

What has been done
Research has been conducted on the effects of biochar and N fertilizer applications on switchgrass production for bioenergy. This research has been performed with assistance from one graduate student. Two undergraduate students have also participated in different aspects of bioenergy research.

Results
The graduate student presented research during the University-Wide Research Symposium at Tennessee State University in 2015.

4. Associated Knowledge Areas

KA Code	Knowledge Area

511 New and Improved Non-Food Products and Processes

Outcome #4

1. Outcome Measures

Protocols will be developed for mutagenesis and selection of herbicide resistant biofuel feedstock varieties (Increased knowledge and understanding of the biofuels supply chain).

2. Associated Institution Types

- 1890 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	2

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Drought presents an increased risk and cost for plant production.

What has been done
One Ph.D. student is working on the issue; protocols to isolate cell nuclei from leaf and root tissues have been developed.

Results
The nuclei isolated from drought treatment experiments are being processed for sequencing analysis to identify the epigenetic control of related traits.

4. Associated Knowledge Areas

KA Code	Knowledge Area
213	Weeds Affecting Plants
511	New and Improved Non-Food Products and Processes

Outcome #5

1. Outcome Measures

Desirable biofuel feedstock varietal mutants will be recovered (Increased knowledge and understanding of the biofuels supply chain.

Not Reporting on this Outcome Measure

Outcome #6

1. Outcome Measures

New varieties of biofuel feedstocks will be developed (Increased knowledge and understanding of the biofuels supply chain).

Not Reporting on this Outcome Measure

Outcome #7

1. Outcome Measures

Producers will have knowledge of benefits:costs of production (from land preparation to final ethanol production) for biofuel crops (Miscanthus, switchgrass and other underutilized native grass species) through the construction of benfit:cost analysis sheets.

2. Associated Institution Types

- 1890 Extension
- 1890 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Since cellulose ethanol production is at relatively early stages, there is an information gap in feedstock production as well as processing. For example, producers are concern of risk and uncertainty associated with feedstock production and marketing. Producers need to have credible information on feedstock selection, various costs associated during production (i.e., input requirement, harvesting, transportation and storage costs), biomass harvest timing, pricing, etc. Information on reliable farm budgeting is essential to attract growers for energy crop farming.

Since switchgrass and miscanthus are perennial grass species, producers needs to know the benefits of long term investment (benefits and costs over multiple year period).

What has been done
Benefit:cost analysis of long term investment (25 year project period) for switchgrass and miscanthus production and processing of these feedstocks to ethanol production; harvesting and hauling costs model and estimation for switchgrass.

Results
Research analysis provided estimation of indicators such as break-even prices, feedstock cost per gallon, breakeven price of ethanol etc which is vital for decision making of feedstock producers as well as ethanol processors.
Research results were communicated through field day presentations, webinars, scientific manuscripts, conference proceedings.

4. Associated Knowledge Areas

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

Outcome #8

1. Outcome Measures

Stakeholders will have knowledge of the energy efficiency of biofuel production from switchgrass and Miscanthus through the calculation of energy balance sheets for these crops, providing indicators of sustainability for biofuel production

2. Associated Institution Types

- 1890 Extension
- 1890 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	2

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Stakeholders should aware of energy efficiency of biofuel production from switchgrass and Miscanthus through the calculation of energy balance sheets for these crops, providing indicators of sustainability for biofuel production. The information will helpful to identify major energy inputs and thereby to use these inputs in optimal manner to conserve energy use in farms.

What has been done
Estimation of energy input for various input categories in producing Miscantus and switchgrass, estimate energy outputs of these two systems and calculate net energy balance of these two production systems.

Results
Two energy balance sheets were produced. Implications and application of the balance sheets were communicated to stakeholders through field day exhibits and scientific publications and conference proceedings, MS thesis.

4. Associated Knowledge Areas

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

Outcome #9

1. Outcome Measures

Biofuel producers will have knowledge on optimal number of harvest machines needed for biorefinery, cost to harvest, store and transport feedstock and information on harvesting and hauling costs per gallon of biofuel produce.

2. Associated Institution Types

- 1890 Extension
- 1890 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	8

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
A major hurdle facing commercial biofuel production is the cost of producing the feedstock. Since biofuel feedstock is bulky in nature, a large proportion of cost needed to be allocated for harvesting and transportation of feedstock. Economic viability of ethanol production from cellulosic feedstock depends in part of the cost to produce, harvest and deliver feedstock to the ethanol production facilities. A well-developed harvesting and transportation system does not exist for most feedstock.

What has been done

Economic analysis of the harvest, transportation and storage costs in ethanol production. Determination of optimal mechanical inputs necessary.

Results
The harvesting units needed for the continuous harvest and supply of biomass for small scale ethanol biorefinery, costs associated with operating and maintaining harvesting, transportation and storage units, optimal harvesting schedule for cost minimization strategy and returns from custom operations. In addition one MS thesis was completes and on manuscript was published.

4. Associated Knowledge Areas

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

Outcome #10

1. Outcome Measures

Improved process-based ecosystem models to forecast biofuel productivity under future climate conditions.

2. Associated Institution Types

- 1890 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	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. Results have been published in peer-review journals and presented at the professional meeting and other universities.

4. Associated Knowledge Areas

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

Outcome #11

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
2015	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Switchgrass rust is one of the most common diseases of switchgrass in fields around Vonore, TN. Switchgrass rust, Puccinia emaculata, reduces growth and biomass of switchgrass in ornamental and agronomic plantings in Tennessee and these epidemics are fueled by asexual spores, urediospores.

What has been done

Results
The resistant cultivars developed through breeding are good source to safeguard crop from such loss. Several highly resistant and susceptible genotypes have been identified and crosses are made between them to develop mapping population. (Bhandhari)

4. Associated Knowledge Areas

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

Outcome #12

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
2015	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
As a low-density feedstock, switchgrass size reduction, compaction, and transport are crucial for it to become a successful fuel crop.

What has been done

Results
A novel method to categorize equipment operational functions from logistics tracking data was implemented. GPS data taken at 1-second intervals for simultaneous, separate data streams for seven pieces of field harvest equipment and trucks were categorized for each equipment track log data entry to compute field efficiency, utilization, equipment capacity, and system capacity. The result was the ability to identify the proportion of equipment time spent productive towards harvest, versus wasted time. The concept proved advantageous for precisely determining equipment productivity without additional sensors, data collection arrays, or people riding along on equipment taking notes.

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
603	Market Economics

Outcome #13

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
2015	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Our IBSS program is focused on understanding how biomass separation technology can best be applied to critical southeastern feedstocks.

What has been done
We are carrying out an effort to develop new processes for using southeastern softwoods (typically more difficult to separate) and hardwoods as starting materials, coupled with careful experimental design in order to understand control and utility of separation processes that will be used to supply downstream conversion activities in the biorefinery. Further, our efforts are examining how mixtures of these feedstocks can be used to smooth out irregularities in the supply as different crops are harvested at different times in the growing year.

Results
This year has seen important advances with a demonstration of how lignin from our process (switchgrass and poplar) can be converted to high strength materials and composites, along with continued scaling up of the process to demonstrate its utility in the commercial arena.

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 #14

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
2015	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Better approaches are needed to metabolize cellulose and lignin for biofuel production from woody materials.

What has been done

Results
The uniqueness of targeted enzymes is exemplified by one of the cellulases from a beetle having highest activity at very high pH, which has never been described for a cellulase from fungi, bacteria, or plant origin. This feature would allow use of this enzyme in alkaline fluids, such as ionic liquids, for increased efficiency during saccharification of plant biomass. We have also advanced the heterologous expression of these insect cellulases in yeast, so that saccharification and fermentation may be performed using the same yeast strain and container. These studies also advance our understanding of the origin and evolution of cellulase activity in insects and may provide targets for the design of pesticides that inhibit effective digestion of plant material by insects.

4. Associated Knowledge Areas

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

Outcome #15

1. Outcome Measures

Regenerating agave (Cheng)

Not Reporting on this Outcome Measure

Outcome #16

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
2015	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Switchgrass needs significant improvement in yield for its viable use as a feedstock in bioenergy production

What has been done
The research focuses on enhancing feedstock biomass yield of lowland switchgrass cultivar in Tennessee and the other areas in south eastern regions of USA.

Results
Seed multiplication is in progress for the improved experimental variety which will be available in 2017 for multi-location testing. Several crosses between genotypes were generated and their evaluation is in progress. Superior clones will be identified by 2016.

4. Associated Knowledge Areas

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

204 Plant Product Quality and Utility (Preharvest)

Outcome #17

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
2015	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

What has been done

Results

We have shown that switchgrass extractives significantly inhibit several bacterial and fungal plant pathogens, as well as foodborne pathogens such as Salmonella, Staphylococcus, and E. coli. An effective biopesticide derived from switchgrass will reduce heavy reliance on copper compounds for control of bacterial pathogens.

4. Associated Knowledge Areas

KA Code	Knowledge Area
215	Biological Control of Pests Affecting Plants
511	New and Improved Non-Food Products and Processes

Outcome #18

1. Outcome Measures

Carbon Fiber Production from Lignin (Harper)

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
We need to develop high value products from lignin, which is an under valued and under utilized co-product of paper manufacturing and biofuels production. Adding value to lignin is a critical step towards making renewable chemicals and fuels economically viable.

What has been done
We developed carbon fibers from switchgrass and hardwoods that we manufactured into carbon fiber composites.

Results
The lignin fibers demonstrated superior adhesion to the polymer matrix over commercial fibers. The fibers can used in many structural and insulating applications. We have also developed lignin based carbons for battery electrodes. Coin cell batteries have successfully been tested and are now being tested in pouch cells, which are used in such devices as cell phones, tablets, and computers.

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 #19

1. Outcome Measures

Gene flow in switchgrass and papaya (Kwit)

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The molecular documentation of contemporary gene flow is of interest to the conservation biology community, as well as regulators who enforce and set standards for transgene biocontainment.

What has been done
We oversaw methodological refinement for transgene detection in non-transgenic papaya fruits.

Results
The methodological refinement for transgene detection in non-transgenic papaya fruits carries implications for organic farming regulations.

4. Associated Knowledge Areas

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

Outcome #20

1. Outcome Measures

Impact of cellulosic biofuel industry on the rural economy (Jensen, Clark, Lambert, Yu)

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The impact of cellulosic biofuel industry on the rural economy is an important question to policy makers of regional development.

What has been done
We combined an input-output model with an optimal facility locator model to determine the distribution biofuel facilities and attendant feedstock.

Results
Aggregate economic impacts were modest for all target achievement levels analyzed and were typically less than 1%. Target achievement and economic impacts are inversely related because transport costs increase as prime feedstock production locations are exhausted.

4. Associated Knowledge Areas

KA Code	Knowledge Area
603	Market Economics
605	Natural Resource and Environmental Economics
608	Community Resource Planning and Development

Outcome #21

1. Outcome Measures

Switchgrass germination and yield persistence (Bhandari)

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Crop establishment is a serious challenge in switchgrass due to its initial slow growth compared to annual weeds and seed dormancy issues. And, for any perennial grass, persistence in yield performance is critically important.

What has been done
Alamo population was selected for high germination, and significant improvement has been made with single cycle of selection. Also, switchgrass in the south has not been selected for yield persistence.

Results
Results indicated germination is a highly heritable trait, and other populations can also be improved rapidly through selection. This could help, to some extent, address establishment related problem.

4. Associated Knowledge Areas

KA Code	Knowledge Area
201	Plant Genome, Genetics, and Genetic Mechanisms
202	Plant Genetic Resources
605	Natural Resource and Environmental Economics

Outcome #22

1. Outcome Measures

Understanding impurities during biomass gasification (Abdoulmoumine)

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The presence of impurities during gasification is a major issue that hinder commercial deployment of biomass gasification projects. This negative impact of gasification impurities affects the entire supply, conversion and utilization chain of biomass gasification.

What has been done
We set out to improve our fundamental knowledge of how these impurities are released during gasification in order to develop improved strategies to eliminate them.

Results
Using pine and switchgrass, we provided a blueprint of levels of impurities that can be expected at various process conditions and carried out extensive literature searches to identify effective techniques that can be used to remove impurities.

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 #23

1. Outcome Measures

Switchgrass storage (Larsen, English, Yu, Tyler)

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The quality of biomass feedstock is crucial to the feasibility of bioenergy industry.

What has been done
We continued research to evaluate the effects of alternative outdoor storage methods on the composition of switchgrass that potentially influence biofuel yields.

Results
We estimated the storage dry matter (DM) losses for switchgrass bales that were preprocessed using an industrial baler technology prior to storage with three particles sizes of feedstock and two types of bale wraps. Switchgrass bales stored at the smallest particle size had lower DM losses than bales stored at the full length of feedstock. Also, applying additional film wrap that completely covers the net wrapped bale reduced DM losses relative to bales wrapped only in net. Storage DM losses of preprocessed switchgrass bales increased linearly with days in storage.

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

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

V(I). Planned Program (Evaluation Studies)

Evaluation Results

Evaluation studies are planned for future mobile biodiesel demonstration workshops and future biofuel technology workshops. These studies were performed for workshops in 2015. Results indicate most of teacher and youth respondents identified an increase in knowledge related to biofuel production.

Adjustments to the program are being made to increase the adoption rate of research results. In addition, the following items are being measured to assess the success of this program: increase in number of producers adopting production of bioenergy feedstocks; number of students receiving training in bioenergy production and number of new varieties of biofuel feedstocks developed.

Key Items of Evaluation

VI. National Outcomes and Indicators

1. NIFA Selected Outcomes and Indicators

Childhood Obesity (Outcome 1, Indicator 1.c)	
2048	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)	
0	Number of participants adopting best practices and technologies resulting in increased yield, reduced inputs, increased efficiency, increased economic return, and/or conservation of resources.
Global Food Security and Hunger (Outcome 2, Indicator 1)	
0	Number of new or improved innovations developed for food enterprises.
Food Safety (Outcome 1, Indicator 1)	
0	Number of viable technologies developed or modified for the detection and
Sustainable Energy (Outcome 3, Indicator 2)	
0	Number of farmers who adopted a dedicated bioenergy crop
Sustainable Energy (Outcome 3, Indicator 4)	
0	Tons of feedstocks delivered.