V(A). Planned Program (Summary)

Program # 3

1. Name of the Planned Program

Fundamental Plant and Animal Systems

☐ Reporting on this Program

Reason for not reporting

{No Data Entered}

V(B). Program Knowledge Area(s)

1. Program Knowledge Areas and Percentage

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
201	Plant Genome, Genetics, and Genetic Mechanisms			25%	
206	Basic Plant Biology			15%	
301	Reproductive Performance of Animals			25%	
302	Nutrient Utilization in Animals			15%	
304	Animal Genome			10%	
305	Animal Physiological Processes			10%	
	Total			100%	

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2012	Extension		Research	
	1862	1890	1862	1890
Plan	0.0	0.0	4.5	0.0
Actual Paid Professional	0.0	0.0	5.5	0.0
Actual Volunteer	0.0	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**
0	0	849582	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
0	0	1042054	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
0	0	398134	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

Research involving fundamental plant and animal systems is designed to increase our basic scientific understanding of reproductive, nutritional and general physiological systems and processes. On the animal side, practical problems addressed include embryonic mortality in sheep and cattle, performance limiting amino acids in animal rations, and health and disease resistance in poultry. For plants, the program emphasis varies from determining functions of ubiquitin and other polypeptide tags, to understanding basic mechanisms of flower senescence and cold shock adaptation, to combating the impacts of phytophthora and Chestnut blight, to defining and eliminating negative effects on grazing animals of ergot alkaloids produced by fungi that are symbiotic with pasture grasses.

One study titled, " Biochemical and Genetic Basis for Ergot Alkaloid Diversification," concluded in 2012. The study examined the production of alkaloids by ergot fungi that are symbiotic with grasses. Better understanding of the process for producing the alkaloids and the types of alkaloids produced is important because some of the alkaloids are beneficial to the grass and others are toxic to the ruminants that feed on the grass. Ergot alkaloid producing fungi generate a diverse set of bioactive alkaloids from a single pathway inefficiently converting one pathway intermediate to the next. The result of this pathway inefficiency is the accumulation of some pathway intermediates and spur products to concentration similar to that of the pathway end product. This issue is important in forage grasses that contain ergot alkaloid-producing fungal symbionts, because different ergot alkaloids provide different benefits (of potential agricultural significance) to the producing fungi and the grasses that they colonize. Some ergot alkaloids deter insect feeding and are insecticidal. Several ergot alkaloids are toxic to mammals or deter grazing, adversely affecting animal agriculture. This study has provided new information on the means by which a diverse set of alkaloids is produced from a single pathway. The investigators also demonstrated that altering the expression of an individual gene can increase or decrease levels of ergot alkaloids from different parts of the pathway, potentially altering the anti-insect or antimammalian activities of the fungus. By understanding and manipulating the ergot pathway, it may be possible to alter the profiles of ergot alkaloids in grasses to improve their agronomic and nutritional properties.

Another study titled, "Ovarian Influences on Embryonic Survival in Ruminants," also concluded in 2012. The goal of the project was to identify new genes in bovine fetal ovaries. The project was successful through deep sequencing of bovine oocytes. A predicted bovine ZnF gene was identified. Preliminary analysis of this novel ZnF gene in various bovine somatic and ovarian tissues revealed that its expression is, in fact, restricted to fetal ovaries. Identification of a novel gene in bovine fetal ovaries expands knowledge of the bovine oocyte and provides an opportunity for characterization of this gene and its role in ovarian function. A better understanding of PGF2alpha signaling resulting in CL regression is the key to

discovering new methods of estrous cycle manipulation in the cow, as well as other mammals. The demonstration that AMPK is involved in the response to activation of the prostaglandin F receptor in corpora lutea elucidates one more component of the mechanism of action of PGF2alpha in luteal regression. Further molecular characterization of the newly discovered zinc finger gene and analysis of its expression during follicular development and early embryogenesis will provide new information about the functional roles of this novel (potentially oocyte-specific) ZnF gene in the regulation of folliculogenesis and early embryogenesis in cattle.

Researchers conducting a study titled, "Phylogenetic, ecological, and biogeographical characterization of arbuscular mycorrhizal fungi and their symbioses with plants in diverse habit," continued their work in developing a gene library which now totals 386 sequences that encompass 78 species of arbuscular mycorrhizal fungi (AMF) in 16 genera. The basic research into the phylogeny of AMF is providing new information on relationships between species and genera, as well as defining the phenotypic plasticity that heretofore was interpreted as reflective of species-level differences. Patterns of LSU gene evolution, and the variants discovered in this gene, are providing evidence that concerted evolution, a process important in homogenization of variants (insuring functional ribosomes) is either slowed or inhibited enough that variants persist as ancestral polymorphisms. This work also is showing that selection is a much more potent force than genetic drift in retention of these variants because each fungus has a large effective population size. Our applied research is providing data which commercial producers can use to more effectively manage inoculum production and storage and testing new ways that these fungi can be delivered for application to horticultural crops.

A long-term study titled, "Biological Improvement of Chestnut through Technologies that Add Management of the Species, its Pathogens and Pests," has sought to determine ways to restore the American chestnut, which has been nearly eliminated from the U.S. by the chestnut blight. Outcomes of this project have focused on three field-oriented studies. The first is a long-term experiment designed to initiate biological control of chestnut blight in an American chestnut stand near West Salem, Wisconsin. The 20-year study involves the release of hypoviruses (viruses that reduce the virulence of the chestnut blight fungus) into the resident population of Cryphonectria parasitica, the fungus that causes chestnut blight. Annual evaluations of the disease have demonstrated that biological control is possible especially on trees that have been treated with strains that contain hypoviruses. The highest level of hypovirulent inoculum to perpetuate biological control was in the area of the stand with the longest history of infection and hypovirus introduction. Although some trees in the stand have died, others are recovering from the disease and should survive. The transition from high levels of disease to acceptable levels of biological control appears to require significant time; in this case, more than 20 years. As biological control is achieved, seed production should be restored so that the American chestnut component of the stand can be perpetuated. A second series of studies is designed to evaluate whether increased resistance to chestnut blight that has resulted from The American Chestnut Foundation's breeding program can be combined with biological control afforded by utilizing hypoviruses. To accomplish this, American, Chinese, European chestnuts and a variety of Chinese X American backcrosses have been planted in an orchard setting and will be used to test whether the two approaches to disease control can be combined effectively to manage chestnut blight. The third project involves an assessment of hypoviruses in the C. parasitica population in the Great Smoky Mountain National Park in TN and NC. Seven areas of the park have been surveyed and over time 159 isolates of C. parasitica on 139 American chestnut trees were collected. Only one putative hypovirulent isolate was identified. Further testing is necessary to ascertain the biological control effectiveness of the putative hypovirulent isolate.

2. Brief description of the target audience

The target audience for this area is composed of animal and plant scientists, biochemists, professional practitioners, dieticians, regulators and agribusiness firms.

3. How was eXtension used?

eXtension was not used in this program

V(E). Planned Program (Outputs)

1. Standard output measures

2012	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	0	0	0	0

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

Patent Applications Submitted

Year:	2012
Actual:	0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2012	Extension	Research	Total
Actual	0	14	0

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Presentation on research at professional meetings

Year	Actual
2012	12

Output #2

Output Measure

- Completed graduate degree programs

Year	Actual

2012	8

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Gain understanding of the mechanisms that govern flower senescence
2	Develop ergot alkaloid deficient grasses at or near wild-type vigor - # new cultivars
3	Successfully develop and employ strategies using hypovirus as a biological control agent for Chestnut blight - # new strategies employed
4	Identify ovarian-specific gene expression affecting reproductive success - # new genes identified

Outcome #1

1. Outcome Measures

Gain understanding of the mechanisms that govern flower senescence

Not Reporting on this Outcome Measure

Outcome #2

1. Outcome Measures

Develop ergot alkaloid deficient grasses at or near wild-type vigor - # new cultivars

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2012	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Certain types of ergot fungi are symbiotic with grasses. Better understanding of the process for producing the alkaloids and the types of alkaloids produced is important because some of the alkaloids are beneficial to the grass and others are toxic to the ruminants that feed on the grass. It may be possible to engineer grass varities that produce fewer ergot alkaloids but are still vigorous in the environment. Better understanding of the process for producing the alkaloids and the types of alkaloids produced is important because some of the alkaloids are beneficial to the grass in acting as insect repellants and others are toxic to the ruminants that feed on the grass.

What has been done
This study examined the production of alkaloids by ergot fungi that are symbiotic with grasses. It was discovered that ergot alkaloid producing fungi generate a diverse set of bioactive alkaloids from a single pathway inefficiently converting one pathway intermediate to the next. The result of this pathway inefficiency is the accumulation of some pathway intermediates and spur products to concentration similar to that of the pathway end product.

Results
This study has provided new information on the means by which a diverse set of alkaloids is

produced from a single pathway. The investigators also demonstrated that altering the expression of an individual gene can increase or decrease levels of ergot alkaloids from different parts of the pathway, potentially altering the anti-insect or antimammalian activities of the fungus. By understanding and manipulating the ergot pathway, it may be possible to alter the profiles of ergot alkaloids in grasses to improve their agronomic and nutritional properties.

4. Associated Knowledge Areas

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

Outcome #3

1. Outcome Measures

Successfully develop and employ strategies using hypovirus as a biological control agent for Chestnut blight - # new strategies employed

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2012	1

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The American chestnut was once an important Eastern U.S. tree species, both from an ecological standpoint and an economic standpoint. The American chestnut has been nearly eliminated from the U.S. by the chestnut blight.

What has been done
A long-term study titled, Biological Improvement of Chestnut through Technologies that Add Management of the Species, its Pathogens and Pests, has sought to determine ways to restore the American chestnut.The 20-year study involves the release of hypoviruses (viruses that reduce the virulence of the chestnut blight fungus) into the resident population of Cryphonectria parasitica, the fungus that causes chestnut blight. Annual evaluations of the disease have demonstrated that biological control is possible especially on trees that have been treated with strains that contain hypoviruses. The highest level of hypovirulent inoculum to perpetuate biological control was in the area of the stand with the longest history of infection and hypovirus introduction. Although some trees in the stand have died, others are recovering from the disease

and should survive. The transition from high levels of disease to acceptable levels of biological control appears to require significant time; in this case, more than 20 years.

Results
As biological control is achieved, seed production should be restored so that the American chestnut component of the stand can be perpetuated.

4. Associated Knowledge Areas

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

Outcome #4

1. Outcome Measures

Identify ovarian-specific gene expression affecting reproductive success - # new genes identified

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2012	1

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Better understanding of ovarian specific gene expression may help to increase reproductive success in ruminants and other animals.

What has been done
The project was successful through deep sequencing of bovine oocytes. A predicted bovine ZnF gene was identified. Preliminary analysis of this novel ZnF gene in various bovine somatic and ovarian tissues revealed that its expression is, in fact, restricted to fetal ovaries.

Results
Identification of a novel gene in bovine fetal ovaries expands knowledge of the bovine oocyte and provides an opportunity for characterization of this gene and its role in ovarian function. A better understanding of PGF2alpha signaling resulting in CL regression is the key to discovering new methods of estrous cycle manipulation in the cow, as well as other mammals.

4. Associated Knowledge Areas

KA Code	Knowledge Area
301	Reproductive Performance of Animals
304	Animal Genome
305	Animal Physiological Processes

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Natural Disasters (drought, weather extremes, etc.)
- Appropriations changes
- Competing Public priorities

Brief Explanation

V(I). Planned Program (Evaluation Studies)

Evaluation Results

This year evaluation consisted of annual evaluation of short term impacts as documented in Outputs and State Defined Outputs and Outcomes. As described in the plan of work, we will be developing a longer term program specific evaluation process in conjunction with our College Visiting Committee. This process and the timetable for evaluaiton will be determined at our Spring 2013 Visiting Committee Meeting.

Key Items of Evaluation

Basic research is difficult to evaluate on a short term basis, so this program will be evaluated internally and externally on a 5-year basis, with the date of the first review to be determined at our Spring 2013 visiting committee meeting.