V(A). Planned Program (Summary)

Program # 3

1. Name of the Planned Program

Global Food Security and Hunger--Fundamental Plant and Animal Systems

☐ Reporting on this Program

V(B). Program Knowledge Area(s)

1. Program Knowledge Areas and Percentage

<table>
<thead>
<tr>
<th>KA Code</th>
<th>Knowledge Area</th>
<th>%1862 Extension</th>
<th>%1890 Extension</th>
<th>%1862 Research</th>
<th>%1890 Research</th>
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</thead>
<tbody>
<tr>
<td>201</td>
<td>Plant Genome, Genetics, and Genetic Mechanisms</td>
<td>25%</td>
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<td></td>
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<tr>
<td>206</td>
<td>Basic Plant Biology</td>
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<td>15%</td>
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<td>301</td>
<td>Reproductive Performance of Animals</td>
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<tr>
<td>302</td>
<td>Nutrient Utilization in Animals</td>
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<td>15%</td>
<td></td>
<td></td>
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<tr>
<td>304</td>
<td>Animal Genome</td>
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</tr>
<tr>
<td>305</td>
<td>Animal Physiological Processes</td>
<td></td>
<td>10%</td>
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<tr>
<td>Total</td>
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<td>100%</td>
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V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

<table>
<thead>
<tr>
<th>Year: 2013</th>
<th>Extension</th>
<th>Research</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1862</td>
<td>1890</td>
</tr>
<tr>
<td>Plan</td>
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<td>0.0</td>
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<tr>
<td>Actual Paid Professional</td>
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<tr>
<td>Actual Volunteer</td>
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2. Actual dollars expended in this Program (includes Carryover Funds from previous years)

<table>
<thead>
<tr>
<th></th>
<th>Extension</th>
<th>Research</th>
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<tbody>
<tr>
<td>Smith-Lever 3b &amp; 3c</td>
<td>1890 Extension</td>
<td>Hatch</td>
</tr>
<tr>
<td>1862 Matching</td>
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<td>0</td>
</tr>
<tr>
<td>1862 All Other</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1890 All Other</td>
<td>0</td>
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</table>

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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, infertility in dairy cows, performance limiting amino acids in animal rations, and health and disease resistance in poultry. For plants, the program emphasis includes determining the molecular interactions during nitrogen fixation symbiosis between legumes and rhizobial bacteria, characterization of arbuscular mycorrhizal fungi, determining functions of ubiquitin and other polypeptide tags, understanding basic mechanisms of flower senescence and cold shock adaptation, combating the impacts of phytophthora and Chestnut blight and defining and eliminating negative effects on grazing animals of ergot alkaloids produced by fungi that are symbiotic with pasture grasses. While not much integrated research goes on in this area, due to the basic nature of the science, the Chestnut blight project combines both research and extension in a highly effective, award winning, multistate research project.

Dairy cow pregnancy rates have declined 30% in the last 50 years, and approximately 80% of the total loss occurs during the embryonic stage (before day 42). Throughout the United States, which has approximately 9 million dairy cows, the industry is losing almost a billion dollars each year due to high embryonic loss. Researchers have suggested that lower pregnancy rates result from low progesterone concentrations. Research at Davis College has shown that hepatocytes cultured in the presence of insulin exhibit reduced progesterone catabolism, which is a result of lowered hepatic cytochrome P450 activity. Currently, there is a paucity of information on nutritional regulation of cytochrome P450 activity, especially on mechanisms to reduce these catabolic enzymes. Therefore, a study designed to measure differences in the activity of cytochrome P450s and progesterone clearance, following alterations in diet would contribute substantially to understanding the influence of nutrition on peripheral progesterone concentrations.

The researchers were able to clearly demonstrate that progesterone clearance can be modified by hormones regulated by the composition of the diet. By altering the composition of the diet in a balanced way that still meets the needs of the cow and lactation, it is possible to dramatically reduce the catabolism of progesterone. If the hypothesis that excess progesterone catabolism is at least a part of the reason for particularly low fertility rates in dairy cattle, then feeding them a diet which shifts the volatile fatty acid production towards propionate should increase their fertility. Furthermore, by carefully selecting feedstuffs one can meet the demands for milk production while increasing propionate production.

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
2013 West Virginia University Research Annual Report of Accomplishments and Results - Global Food Security and Hunger--Fundamental Plant and Animal Systems

<table>
<thead>
<tr>
<th>2013</th>
<th>Direct Contacts Adults</th>
<th>Indirect Contacts Adults</th>
<th>Direct Contacts Youth</th>
<th>Indirect Contacts Youth</th>
</tr>
</thead>
<tbody>
<tr>
<td>Actual</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

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

   Year: 2013
   Actual: 0

   Patents listed

3. Publications (Standard General Output Measure)
   Number of Peer Reviewed Publications

<table>
<thead>
<tr>
<th>2013</th>
<th>Extension</th>
<th>Research</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Actual</td>
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<td>20</td>
<td>20</td>
</tr>
</tbody>
</table>

V(F). State Defined Outputs

Output Target

Output #1
   Output Measure
   • Presentation on research at professional meetings

   Year   Actual
   2013   16

Output #2
   Output Measure
   • Completed graduate degree programs

   Year   Actual
   2013   3
## V(G). State Defined Outcomes

### V. State Defined Outcomes Table of Content

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

<table>
<thead>
<tr>
<th>Year</th>
<th>Actual</th>
</tr>
</thead>
<tbody>
<tr>
<td>2013</td>
<td>2</td>
</tr>
</tbody>
</table>

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Many agriculturally important forage and turf grasses, including tall fescue and perennial ryegrass, are infected with symbiotic fungi from the genus Neotyphodium. These fungi grow internally in the plants, which show no external symptoms. The fungi benefit the plant by providing tolerance to biological or environmental stress. In many cases, these fungi produce bioactive chemicals including ergot alkaloids and lolines. Loline alkaloids, in general, are effective against insects, but the relative activities of different lolines need to be assessed. Certain ergot alkaloids provide protection against insects; however, many ergot alkaloids also are harmful to grazing animals, resulting in poor weight gain, poor health, and reduced reproduction.

What has been done

Davis College researchers have identified many of the genes required to produce ergot alkaloids and lolines. The goals of this current project are to eliminate, replace, or add specific genes to symbiotic fungi to alter the spectrum of ergot alkaloids and lolines produced in a controlled manner. The modified fungi will be reintroduced into their grass hosts (grown in containment), and the chemical profiles will be analyzed. Plants containing the modified fungi will be studied to determine the effects of specific chemicals on insect pests and parasitic nematodes (soil-dwelling round worms). This approach may produce fungi that provide enhanced bioprotective properties.
to their grass hosts. The alterations in ergot alkaloids also may reduce toxicity to grazing animals.

Results
Two independent lolE knockout mutants were generated from strain E2368 and one has been introduced into meadow fescue. The resulting symbiotum had no known loline alkaloid, but the possibility that this mutant produces a previously unknown intermediate in the loline alkaloid pathway is under investigation. Goals that have not yet been met include the completion of the engineering of certain strains (most of which are listed as in progress above), the chemical characterization of several engineered strains that have recently been introduced into plants, and the future provision of completely characterized strains to collaborators for assays of anti-insect and anti-nematode activities.

4. Associated Knowledge Areas

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Outcome #3

1. Outcome Measures

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

Not Reporting on this Outcome Measure

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

<table>
<thead>
<tr>
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<th>Actual</th>
</tr>
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<tbody>
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Issue (Who cares and Why)
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What has been done
Researchers have suggested that lower pregnancy rates result from low progesterone concentrations. Research at Davis College has shown that hepatocytes cultured in the presence of insulin exhibit reduced progesterone catabolism, which is a result of lowered hepatic cytochrome P450 activity. Currently, there is a paucity of information on nutritional regulation of cytochrome P450 activity, especially on mechanisms to reduce these catabolic enzymes. Therefore, a study designed to measure differences in the activity of cytochrome P450s and progesterone clearance, following alterations in diet would contribute substantially to understanding the influence of nutrition on peripheral progesterone concentrations.

Results
The researchers were able to clearly demonstrate that progesterone clearance can be modified by hormones regulated by the composition of the diet. By altering the composition of the diet in a balanced way that still meets the needs of the cow and lactation, it is possible to dramatically reduce the catabolism of progesterone. If the hypothesis that excess progesterone catabolism is at least a part of the reason for particularly low fertility rates in dairy cattle, then feeding them a diet which shifts the volatile fatty acid production towards propionate should increase their fertility. Furthermore, by carefully selecting feedstuffs one can meet the demands for milk production while increasing propionate production.

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<td>Animal Genome</td>
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<td>305</td>
<td>Animal Physiological Processes</td>
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V(H). Planned Program (External Factors)

External factors which affected outcomes
- Natural Disasters (drought, weather extremes, etc.)
- Appropriations changes
- Competing Public priorities

Brief Explanation
The sequestration in 2013 limited the funding we were able to use to conduct our research program in this area.

V(I). Planned Program (Evaluation Studies)

Evaluation Results

Experiment Station research program evaluation will take place at two levels and on
two different time cycles. All programs will using these general criteria plus additional criteria tailored
to each program as detailed in the Plan of Work under Outputs and State Defined Outputs and
Outcomes.
   Annual evaluation will continue as before, looking at productivity in terms of immediate impact:

   •  Referee journal articles and books
   •  Professional presentations
   •  General audience papers and news reports
   •  M.S. and PhD graduates
   •  Trends in terms of competitive funding

   And in terms of longer-term impact:

   •  Citations in scientific journals
   •  Patents
   •  Successful technology transfer or start-ups based on research programs
   •  Awards based on continuing impact and research excellence

   In addition, every five years we will have a full portfolio review of our research programs in
terms of:

   •  Long term productivity
   •  Relevance to our constituent groups and the State and Region
   •  The allocation of research inputs among the programs
   •  Consideration of eliminating some research programs that are not productive or have
diminished relevance given NIFA and State priorities
   •  Consideration of adding additional program areas given NIFA and State priorities

   This year we evaluated this program in terms of outputs (refereed journal articles, citations,
graduate students graduated) and in terms of inputs (high quality competitive grants). Our highest
levels of performance were in the molecular genetics and biochemistry areas. The results of this
analysis are detailed below.

**Key Items of Evaluation**

We are in the process of hiring two more molecular geneticists in the Plant Sciences area, and
are working with other Colleges on campus to develop a joint graduate program in Genetics and
Biochemistry. We successfully merged our undergraduate program in biochemistry with the biology
and chemistry departments and hope to do something similar at the graduate level with the addition
of the College of Health Sciences to the inter-collegiate team.