

**V(A). Planned Program (Summary)**

**Program # 6**

**1. Name of the Planned Program**

Integrated Health Solutions

- Reporting on this Program

**V(B). Program Knowledge Area(s)**

1. Program Knowledge Areas and Percentage

<b>KA Code</b>	<b>Knowledge Area</b>	<b>%1862 Extension</b>	<b>%1890 Extension</b>	<b>%1862 Research</b>	<b>%1890 Research</b>
112	Watershed Protection and Management	3%		3%	
133	Pollution Prevention and Mitigation	3%		3%	
216	Integrated Pest Management Systems	5%		2%	
301	Reproductive Performance of Animals	0%		6%	
305	Animal Physiological Processes	0%		6%	
311	Animal Diseases	9%		19%	
314	Toxic Chemicals, Poisonous Plants, Naturally Occurring Toxins, and Other Hazards Affecting Animals	0%		2%	
315	Animal Welfare/Well-Being and Protection	4%		3%	
501	New and Improved Food Processing Technologies	0%		5%	
502	New and Improved Food Products	0%		6%	
503	Quality Maintenance in Storing and Marketing Food Products	3%		0%	
504	Home and Commercial Food Service	3%		0%	
702	Requirements and Function of Nutrients and Other Food Components	1%		10%	
703	Nutrition Education and Behavior	13%		4%	
711	Ensure Food Products Free of Harmful Chemicals, Including Residues from Agricultural and Other Sources	15%		2%	
712	Protect Food from Contamination by Pathogenic Microorganisms, Parasites, and Naturally Occurring Toxins	15%		14%	
722	Zoonotic Diseases and Parasites Affecting Humans	18%		4%	
723	Hazards to Human Health and Safety	0%		5%	
724	Healthy Lifestyle	2%		4%	
802	Human Development and Family Well-Being	6%		2%	
	<b>Total</b>	100%		100%	

**V(C). Planned Program (Inputs)**

1. Actual amount of FTE/SYs expended this Program

Year: 2014	Extension		Research	
	1862	1890	1862	1890
<b>Plan</b>	{NO DATA ENTERED}	{NO DATA ENTERED}	{NO DATA ENTERED}	{NO DATA ENTERED}
<b>Actual Paid</b>	6.6	0.0	14.6	0.0
<b>Actual Volunteer</b>	1.5	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
1411999	0	2240959	0
1862 Matching	1890 Matching	1862 Matching	1890 Matching
2111907	0	8708188	0
1862 All Other	1890 All Other	1862 All Other	1890 All Other
3888608	0	14688310	0

**V(D). Planned Program (Activity)**

**1. Brief description of the Activity**

Food processing is one of the largest industries in Pennsylvania, and much of the research in this planned program contributes to improved and safer food processing. Research includes investigations of mycotoxins and bacteria and other problematic compounds in foods and tracking bacteria that cause foodborne illnesses in food manufacturing processes and environments.

Research into one health, toxicology, and immunology in the college includes sequencing the genomes of microorganisms that cause disease in humans and livestock, exploring gut health, analyzing the microbiome to explore the efficacy of drugs, and finding ways to produce foods of higher nutritional quality. Additional work in integrated health solutions includes studies of carcinogenesis and cancer treatment, especially through dietary supplements.

The veterinary team is exploring mastitis, milk quality, dairy hoof health, and antimicrobial use and resistance, and also some links among these topics. They are investigating the potential to increase farm profits by paying closer attention to meat quality and reducing blemishes before harvest. They have recently begun to work directly with private veterinary practices and industry consultants.

The requirements of the Food Safety Modernization Act are driving much of our extension programming in this planned program. Trainings in Hazard Analysis Critical Control Point (HAACP) and Good Agricultural Practices (GAP) are much in demand. The ServSafe curriculum is frequently presented to meet regulatory requirements for commercial food service operations. We offer specialized food safety trainings for specific industries, such as the wine industry.

Extension work in consumer food safety includes frequent offerings of Cooking for Crowds, for volunteer organizations that prepare and serve food to the public; and workshops by Master Food Preserver

volunteers, who teach home food preservation.

We are offering more extension food safety trainings in Spanish to meet the growing need, and we are translating some materials into additional languages as well.

**2. Brief description of the target audience**

- Agricultural Producers/Farmers/Landowners
- Agriculture Services/Businesses
- Nonprofit Associations/Organizations
- Business/Industry
- Community Groups
- Education
- General Public
- Government Personnel
- Human Service Providers
- Military
- Non-Governmental Organizations
- Nonprofit Associations/Organizations
- Policy Makers
- Special Populations (at-risk and underserved audiences)
- Students/Youth
- Volunteers/Extension Leaders

**3. How was eXtension used?**

Penn State Cooperative Extension supports faculty and staff use of eXtension and promotes communities of practice as a way of broadening sources of information and outreach. Penn State Cooperative Extension supports the professional development offered through eXtension.org. Members of some teams answered questions in the "Ask an Expert" sections.

One Extension Food Safety Team member has answered more than 300 questions on eXtension and is ranked in the top 20 for responding to food safety questions. Team members are the top-rated for answering food safety questions. Some team members use eXtension as a resource for information and/or articles to use in programs they conduct.

A Veterinary Team member served as an area leader in eXtension.

**V(E). Planned Program (Outputs)**

**1. Standard output measures**

2014	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
<b>Actual</b>	29041	594768	27880	23196

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

Year: 2014  
Actual: 1

**Patents listed**

Serial No. 13/538,297; Filed 6/29/2012; Title: Compositions, Methods and Kits for Treating Leukemia

**3. Publications (Standard General Output Measure)**

**Number of Peer Reviewed Publications**

2014	Extension	Research	Total
Actual	7	282	289

**V(F). State Defined Outputs**

**Output Target**

**Output #1**

**Output Measure**

- Number of participants in extension education classes and workshops.

Year	Actual
2014	82126

**Output #2**

**Output Measure**

- Number of technology disclosures involving college faculty, staff, extension educators, or students.

Year	Actual
2014	2

**V(G). State Defined Outcomes**

**V. State Defined Outcomes Table of Content**

O. No.	OUTCOME NAME
1	Investigation of the influence of mycotoxins on Shiga toxin-producing Escherichia coli (STEC) in cattle.
2	Determination that pulsed ultraviolet (UV) light can inactivate microorganisms Penicillium roqueforti and Listeria monocytogenes on the surface of hard cheeses.
3	Strains of B. pertussis (whooping cough) derived from recent hospital cases in which the genome was sequenced.
4	Determination that all Listeria spp. isolates found in a small-scale mushroom production facility have rarely been reported in foodborne disease outbreaks.
5	Exploration of efficacy of UV processing to reduce levels of the mycotoxin patulin in apple beverages.
6	Annual value (in \$) of averted infections with waterborne cryptosporidiosis assuming that educational programs of Safe Drinking Water extension team prevent just 5% of expected yearly cryptosporidium infections in Pennsylvania.
7	Potential value (in \$) of prevented food service company losses if just 5% of expected foodborne illnesses are avoided due to increased employee knowledge after participating in the retail ServSafe program.

## **Outcome #1**

### **1. Outcome Measures**

Investigation of the influence of mycotoxins on Shiga toxin-producing Escherichia coli (STEC) in cattle.

### **2. Associated Institution Types**

- 1862 Research

### **3a. Outcome Type:**

Change in Knowledge Outcome Measure

### **3b. Quantitative Outcome**

<b>Year</b>	<b>Actual</b>
2014	1

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

#### **Issue (Who cares and Why)**

Mycotoxins produced by fungi can contaminate livestock feed and negatively affect livestock. Workers responsible for animal and human health need information about the toxicity and modes of action of mycotoxins, which are associated with infection of mature cattle by Shiga toxin-producing Escherichia coli (STEC). STEC bacteria are commensal in these animals, which suggests that mycotoxins enable a mechanism that makes this bacterium pathogenic, causing vomiting and bloody diarrhea.

#### **What has been done**

During natural disease outbreaks, the researchers assessed the mycotoxin content in vomit and bloody diarrhea (mucosa) in dairy calves. They compared the virulence genes of the STECs, assessed the effect of mycotoxins in the mucosa on STEC toxin expression, and tested the efficacy of a commercially available prebiotic/probiotic drug treatment--Celmanax/Dairyman's Choice--in alleviating the disease.

#### **Results**

The study showed that the same STEC disease complex affects calves and mature cattle. The OI-122 encoded nleB gene existed in all STEC genotypes that produced serious disease, indicating that virulence of the disease may arise from the protein encoded by this gene. Low levels of aflatoxin (1-3 ppb) and fumonisin (50-350 ppb) were found in mucosa. The mycotoxins elevated toxin activity. Use of Celmanax/Dairyman's Choice in the calves eliminated STEC shedding, the interaction of STEC and mycotoxins, and associated morbidity and mortality. The work appeared in the journal Toxins.

### **4. Associated Knowledge Areas**

<b>KA Code</b>	<b>Knowledge Area</b>
311	Animal Diseases
314	Toxic Chemicals, Poisonous Plants, Naturally Occurring Toxins, and Other Hazards Affecting Animals

## **Outcome #2**

### **1. Outcome Measures**

Determination that pulsed ultraviolet (UV) light can inactivate microorganisms *Penicillium roqueforti* and *Listeria monocytogenes* on the surface of hard cheeses.

### **2. Associated Institution Types**

- 1862 Research

### **3a. Outcome Type:**

Change in Knowledge Outcome Measure

### **3b. Quantitative Outcome**

<b>Year</b>	<b>Actual</b>
2014	1

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

#### **Issue (Who cares and Why)**

Cheese surfaces may be contaminated by spoilage and pathogenic microorganisms during production, packaging, and postpackaging processes. *Penicillium roqueforti* is often found on cheese surfaces at refrigeration temperatures. Consumption of cheese contaminated with *Listeria monocytogenes* can trigger listeriosis. Therefore, cheese should be decontaminated at postprocessing stages. Pulsed UV light is a nonthermal way to ensure microbial decontamination on the surface of foods or packaging materials.

#### **What has been done**

This study investigated the efficacy of intense, short-duration pulsed UV light for inactivation of *P. roqueforti* and *L. monocytogenes* inoculated onto packaged and unpackaged hard cheeses. Treatment times and distance from the UV strobe were varied to establish optimum treatment conditions. Packaged and unpackaged cheeses were treated at 5, 8, and 13 cm for up to 60 s.

#### **Results**

For *P. roqueforti*, maximum reduction after 40 s at 5 cm was 1.32 log CFU/cm<sup>2</sup> on unpackaged cheese and 1.24 log CFU/cm<sup>2</sup> on packaged cheese. Reductions of *L. monocytogenes* under the same conditions were about 2.9 and 2.8 log CFU/cm<sup>2</sup> on packaged and unpackaged cheeses, respectively. Changes in color and lipid oxidation were examined for mild (5 s at 13 cm), moderate (30 s at 8 cm), and extreme (40 s at 5 cm) treatments. The color and chemical quality of cheeses were not significantly different after mild treatments ( $P > 0.05$ ). The mechanical

properties of the polypropylene plastic packaging were also evaluated after the 3 treatments. No significant differences were found in elastic modulus (a measure of stiffness) between untreated samples and those given mild and moderate treatments ( $P > 0.05$ ). Overall, the study showed that pulsed UV light can inactivate *P. roqueforti* and *L. monocytogenes* on the surface of hard cheeses. The work appeared in the Journal of Food Protection.

#### 4. Associated Knowledge Areas

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

#### Outcome #3

##### 1. Outcome Measures

Strains of *B. pertussis* (whooping cough) derived from recent hospital cases in which the genome was sequenced.

##### 2. Associated Institution Types

- 1862 Research

##### 3a. Outcome Type:

Change in Condition Outcome Measure

##### 3b. Quantitative Outcome

Year	Actual
2014	28

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

###### **Issue (Who cares and Why)**

The Centers for Disease Control and Prevention classifies whooping cough, caused by the bacteria *Bordetella pertussis*, as a reemerging disease. Case numbers are rising steadily—even where vaccine coverage is high—from hundreds per year in the 1970s to >41,000 in 2012. Recent high-profile epidemics in California (in 2010) and Washington (in 2012) contribute to growing concerns and feed speculation about the ongoing evolution of *B. pertussis*.

###### **What has been done**

To better understand genetic diversity of the circulating *B. pertussis* strains, researchers collected 28 clinical isolates from those and other outbreaks and analyzed genome sequences.

###### **Results**

Genome sequences suggest that isolates of *B. pertussis* currently circulating in the U.S. derive from a single genetic background. However, the genomes were subject to massive genome

rearrangements and different gene losses that account for most of the diversity among strains. The researchers are now conducting a full analysis of the virulence genes and the evolution of the organism. Having a sequenced genome facilitates further research on the strains. The work appeared in the journal Genome Announcements.

Other work in which these researchers were involved (published in mBio) concluded that global transmission of new strains is happening very rapidly and that the worldwide population of B. pertussis is evolving in response to vaccine introduction. This could enable vaccine escape.

#### 4. Associated Knowledge Areas

KA Code	Knowledge Area
722	Zoonotic Diseases and Parasites Affecting Humans
723	Hazards to Human Health and Safety

#### Outcome #4

##### 1. Outcome Measures

Determination that all *Listeria* spp. isolates found in a small-scale mushroom production facility have rarely been reported in foodborne disease outbreaks.

##### 2. Associated Institution Types

- 1862 Extension
- 1862 Research

##### 3a. Outcome Type:

Change in Knowledge Outcome Measure

##### 3b. Quantitative Outcome

Year	Actual
2014	1

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

###### **Issue (Who cares and Why)**

*Listeria monocytogenes* is a foodborne pathogen of significant concern to the agricultural and food processing industry because of its ability to grow and persist in cool and moist environments and its ability to cause listeriosis, a disease with a very high mortality rate. USDA estimated in 1996 that annual costs related to foodborne *Listeria* infections in the U.S. amounted to \$200-300 million, including about 1,600 cases per year and 425 deaths.

###### **What has been done**

A study was completed to determine the prevalence of *Listeria* spp. in a small-scale mushroom production facility on the Penn State campus. Isolates of *L. monocytogenes* were confirmed and serotyped by multiplex PCR. The epidemiological relatedness of the three *L. monocytogenes* isolates to those serotypes or lineages frequently encountered in listeriosis infections was determined by multi-virulence-locus sequence typing using six virulence genes.

#### **Results**

Of 184 samples taken from 5 production zones within the facility, 15.8% tested positive for *Listeria* spp. Among the *Listeria* spp. isolates, *L. innocua* was most prevalent (10.3%), followed by *L. welshimeri* (3.3%), *L. monocytogenes* (1.6%), and *L. grayi* (0.5%). *L. monocytogenes* was recovered only from the phase I raw material composting area. All *L. monocytogenes* isolates were grouped with serotype 4a, lineage IIIA. To date, this serotype has rarely been reported in foodborne disease outbreaks. The research appeared in the *Journal of Food Protection*.

#### **4. Associated Knowledge Areas**

<b>KA Code</b>	<b>Knowledge Area</b>
712	Protect Food from Contamination by Pathogenic Microorganisms, Parasites, and Naturally Occurring Toxins
722	Zoonotic Diseases and Parasites Affecting Humans

#### **Outcome #5**

##### **1. Outcome Measures**

Exploration of efficacy of UV processing to reduce levels of the mycotoxin patulin in apple beverages.

##### **2. Associated Institution Types**

- 1862 Extension
- 1862 Research

##### **3a. Outcome Type:**

Change in Knowledge Outcome Measure

##### **3b. Quantitative Outcome**

<b>Year</b>	<b>Actual</b>
2014	1

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

###### **Issue (Who cares and Why)**

Patulin is a mycotoxin produced by certain species of molds that grow on various foods, including fruit. Patulin occurs in apple juice, where it can pose a safety concern. Thermal processing (pasteurization) appears to only moderately reduce patulin levels. The U.S. Food and Drug

Administration recommends a patulin level of 50 µg/kg or less in apple juice. The export market alone for U.S. apple juice in 2012 was nearly \$37.4 million.

**What has been done**

This study evaluated the potential to reduce patulin levels in a malic acid model system, apple cider, and apple juice by ultraviolet (UV) radiation treatment.

**Results**

This study showed that apple juice constituents affect patulin degradation during UV treatment. Initial patulin concentration, pH, glucose, sucrose, and ascorbic acid had no significant effect on patulin degradation. Tannic acid reduced patulin degradation. High turbidity levels may make use of UV technology impractical in apple cider. UV irradiation decreased patulin levels in clarified apple juice, but the required dose level was higher than that required for 5-log reduction of Escherichia coli O157:H7. Fructose had an accelerating effect on patulin reduction in the model system studied, so adding high-fructose sweeteners to apple beverages prior to UV processing may aid patulin reduction. Effective UV processing for patulin degradation without quality losses may require filtration, phenolic adsorption treatments, and the addition of polyphenols to speed degradation. The Journal of Food Processing and Preservation carried the paper.

**4. Associated Knowledge Areas**

<b>KA Code</b>	<b>Knowledge Area</b>
501	New and Improved Food Processing Technologies
712	Protect Food from Contamination by Pathogenic Microorganisms, Parasites, and Naturally Occurring Toxins

**Outcome #6**

**1. Outcome Measures**

Annual value (in \$) of averted infections with waterborne cryptosporidiosis assuming that educational programs of Safe Drinking Water extension team prevent just 5% of expected yearly cryptosporidium infections in Pennsylvania.

**2. Associated Institution Types**

- 1862 Extension
- 1862 Research

**3a. Outcome Type:**

Change in Condition Outcome Measure

**3b. Quantitative Outcome**

<b>Year</b>	<b>Actual</b>
2014	504000

### 3c. Qualitative Outcome or Impact Statement

#### Issue (Who cares and Why)

Though there are 1 million private wells in Pennsylvania serving 3.5 million people, only about half of homeowners across the state regularly test their water. That's a problem, since half of the wells tested have at least one water quality problem. PA and Alaska are the only states that don't have private water well construction or location standards. Extension has become one of the few unbiased, research-based resources to help meet the water needs of Pennsylvania's large rural population.

#### What has been done

The extension team provides educational resources on management of private water systems, including wells, springs, and cisterns. They conduct workshops and help individuals identify water issues, determine which tests might be necessary, interpret test results, and suggest solutions to private water system problems. Yearly, they train new Master Well Owner Network volunteers, who commit to performing a certain level of outreach themselves in return for training.

#### Results

The Centers for Disease Control and Prevention report that an average of 478 cases of the waterborne illness cryptosporidiosis occurred in PA in 2009 and 2010, and that for each case of cryptosporidiosis, hospital costs averaged \$21,000. So the value of preventing just 5% (24 cases) of cryptosporidiosis cases in PA via this extension project would be \$504,000/year.

In a separate project, water samples were collected from 35 PA roadside springs, most of which were within state highway rights-of-way. Analysis for 20 common inorganic and microbiological water quality parameters showed that 97% of the springs tested failed to meet at least one EPA drinking water standard. The most common health-related pollutants were coliform bacteria, E. coli bacteria, and lead. These results suggest that untreated water from roadside springs should generally be avoided as a source of drinking water.

### 4. Associated Knowledge Areas

KA Code	Knowledge Area
112	Watershed Protection and Management
133	Pollution Prevention and Mitigation
722	Zoonotic Diseases and Parasites Affecting Humans
723	Hazards to Human Health and Safety

### Outcome #7

#### 1. Outcome Measures

Potential value (in \$) of prevented food service company losses if just 5% of expected foodborne illnesses are avoided due to increased employee knowledge after participating in the retail ServSafe program.

## 2. Associated Institution Types

- 1862 Extension

### 3a. Outcome Type:

Change in Action Outcome Measure

### 3b. Quantitative Outcome

Year	Actual
2014	31283161

### 3c. Qualitative Outcome or Impact Statement

#### Issue (Who cares and Why)

The PA Department of Agriculture requires retail food service operations to have one person certified in food safety to meet regulatory requirements. The Extension Food Safety Team offers ServSafe classes to help restaurant and retail food service managers understand and implement safe food handling practices. With reporting of foodborne illness outbreaks and food recalls, there is increased awareness among the public of food safety in commercial food service operations.

#### What has been done

By offering the nationally recognized food safety training ServSafe in 2014, thirteen Extension educators offered 138 classes to 2,223 registered participants in 48 of Pennsylvania's 67 counties. Eleven of those educators indicated they helped over 1,130 food service facilities meet Pennsylvania Department of Agriculture licensure requirements to continue operating in their community.

#### Results

These establishments employ some 13,000 workers and serve over 186,000 customers/day, making a positive contribution to the local economy. Companies that produce safe food help ensure economic stability for themselves and their employees and communities. For the consumer, buying safe products prevents foodborne illness that can lead to healthcare costs, lost wages, or even death.

A 2014 study (USDA-ERS) estimated the costs of illnesses caused by 15 major foodborne pathogens at more than \$15.6 billion/yr in the U.S. There are an estimated 8.9 million cases of foodborne illness yearly in the U.S. and nearly 2,400 deaths, so it is critical that food service operators understand safe food handling practices and educate their staff. Assuming that foodborne illness patterns mirror population patterns, and assuming that the ServSafe program reduces foodborne illness in Pennsylvania by even just 1%, it would prevent more than \$6 million in economic losses and more than 3,500 cases annually.

## 4. Associated Knowledge Areas

<b>KA Code</b>	<b>Knowledge Area</b>
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

### **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
- Populations changes (immigration, new cultural groupings, etc.)
- Other (Extramural Funding)

#### **Brief Explanation**

##### **Natural Disasters**

Natural disasters allow the rapid spread of diseases and can damage equipment, such as drinking water treatment systems, that is essential for public health.

##### **Economy**

- The economic climate continues to have a significant impact on the ability of clientele to attend meetings and conferences.
- There is continued interest in consumer issues, especially related to home food preservation, as a result of the economy and the increasing cost of food.

##### **Government Regulations**

- PA has adopted the FDA Food Code, resulting in some changes to regulations governing food service operations. Our curricula cover these new regulations.
- The Food Safety Modernization Act is having an enormous impact on the food supply chain.
- U.S. and foreign government regulations can influence the feasibility and necessity of various work.

##### **Public Policy Changes**

- Oversight of food and farm businesses at all levels of government affects our program efforts, and we must stay current.

##### **Competing Public Priorities**

- Competing public priorities force us to continually align our program priorities with budget realities.
- Public interest in locally grown foods, the sustainability of the food supply, and a desire to know what is in the foods we eat have more people interested in home food preservation.

##### **Population Changes**

- Population changes continue to drive the need to make more extension offerings available in other languages.

##### **Other - Extramural Funding**

- Some of our programs are affected by extramural funding, either by adding resources to promote them or by shaping the content of the product.
- Extramural funding has allowed some teams to conduct practical applied research projects that include integrated extension/educational components.

#### **V(I). Planned Program (Evaluation Studies)**

##### **Evaluation Results**

The generation of outcomes from existing programs and the development of new programs require improved evaluation that identifies pre- and post- responses to information and monitoring for long-term behavioral changes that result in improved outcomes. More statewide extension programs are using retrospective evaluation to gather information about the number of participants who actually put into practice lessons learned through extension programs. Measuring costs averted or profit increased can show powerful, tangible benefits of our programming--the type of feedback that keeps people coming back for more information. Customer satisfaction and needs assessment instruments (Salesforce and Atlas) are scheduled to be implemented in fall 2015 to provide feedback on the quality and value of our programs.

##### **Key Items of Evaluation**

See highlights of state-defined outcomes in this planned program.