

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

**Program # 8**

**1. Name of the Planned Program**

Plant Health, Systems And Production

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%		10%	
201	Plant Genome, Genetics, and Genetic Mechanisms	0%		10%	
203	Plant Biological Efficiency and Abiotic Stresses Affecting Plants	10%		10%	
205	Plant Management Systems	30%		10%	
206	Basic Plant Biology	30%		10%	
211	Insects, Mites, and Other Arthropods Affecting Plants	15%		10%	
212	Pathogens and Nematodes Affecting Plants	15%		10%	
213	Weeds Affecting Plants	0%		10%	
214	Vertebrates, Mollusks, and Other Pests Affecting Plants	0%		10%	
216	Integrated Pest Management Systems	0%		10%	
	<b>Total</b>	100%		100%	

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

**1. Actual amount of FTE/SYs expended this Program**

Year: 2012	Extension		Research	
	1862	1890	1862	1890
Plan	5.0	0.0	19.0	0.0
Actual Paid Professional	0.0	0.0	7.7	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
512090	0	1598387	0
1862 Matching	1890 Matching	1862 Matching	1890 Matching
512090	0	1598387	0
1862 All Other	1890 All Other	1862 All Other	1890 All Other
4805785	0	11941650	0

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

### 1. Brief description of the Activity

Research activities include the development of new knowledge about how epigenetic processes influence the expression of genes known to modulate nitrogen utilization in maize, an evaluation of crucifers and buckwheat as short cycle cover crops before pumpkins and cucumbers, the development of **Global Food in 3D** software to help analysts and policy makers think about the dimensions of the soybean yield plateau in the face of rising demand [[www.globalfoodin3d.com](http://www.globalfoodin3d.com)], the development of the first genome sequences of *Pseudomonas Savastanoi* pv. *Glycinea* [the sequences have been highlighted at <http://www.pseudomonas-syringae.org>], the development of knowledge of gene expression changes between resistant and susceptible lines [which helps to identify major resistant genes to soybean cyst nematode that could be used to understand the mechanism of resistance and ways to integrate those genes during breeding approaches], a comparison of the agronomic performance of corn, soybean, winter wheat, alfalfa, and forage grass cultivars available to farmers in Illinois [seed companies that sell seed in Illinois enter cultivars into these trials on a voluntary basis], the characterization of the types of herbicide resistance present in numerous waterhemp populations [this information was directly transmitted to weed management clientele who use this knowledge to fine-tune weed management recommendations], and work designed to extend ongoing nematode management research through the development of new tools for technology transfer and decision support for effective management that will appeal to and be useful to farmers [to date, no single coordinated source of parasitic nematode information is currently available].

Additional activities included efforts to improve economic and environmental sustainability in tree-fruit production through changes in rootstock use, research designed to develop a greater fundamental knowledge of the processes controlling soil nitrogen and carbon cycling, growth chamber, greenhouse, and laboratory experiments conducted to determine if target-site or non-target-site mechanisms confer mesotrione resistance in a population of waterhemp designated MCR, efforts to determine the etiology, biology, and epidemiology of bacterial spot which will help to develop effective management strategies for the disease [the pumpkin industry is the most valuable vegetable industry in Illinois], results that contribute to improving our understanding of the control of gene expression in soybean seed and seedling development [a better understanding of pathways involved in seed composition will enhance our understanding of plant disease resistance or the modification of flavonoid, protein, and oil in the seed for improved nutritional and health value], a breeding program focused on the development of high-yield adapted wheat varieties for Illinois and surrounding states, and the evaluation of plant materials that show potential for increasing the genetic diversity, disease and insect resistance, drought and cold tolerance and improving climate adaptability in addition to possessing superior ornamental features.

Activities also included results from foliar fungicide trials that were used to develop fungicide guidelines for growers, crop consultants, Extension personnel, and industry personnel, the development of

knowledge that will be used to develop allele-specific DNA markers located in regulatory regions of the maize genome [together with new insights into the molecular basis of dominance, epistasis, and heterosis, these DNA markers will enable the designing of more efficient and innovative marker-assisted breeding strategies], and a project associated with the continuation and further analysis of materials and information produced from the **Illinois Long Term Selection Experiment** for protein and oil concentration in corn grain [2012 marks the 113th growing season].

Conference presentations included the American Seed Trade Association Seed Expo, American Society of Horticultural Science, National Association of Plant Breeders, National Academy of Sciences, Nara Institute of Science and Technology, American Society of Plant Biologists, Illinois Horticulture Society, Illinois Specialty Growers, Marketing, and Organic Conference, Weed Science Society of America, Ag Masters 2012, Plant and Animal Genome Conference, American Phytopathological Society, Cucurbitaceae 2012, American Society of Agronomy, Entomological Society of America, Latin American Biological Chemists Society, Midwest Cover Crop Council, and the National Fusarium Head Blight Forum.

Extension activities focused on non-food horticulture crops and pests. The **Ask Extension -- Hort Corner** program is comprised of 77 website topics [of which 17 are in Spanish]. The site allows visitors to ask a question of a University of Illinois Extension Educator or review the questions asked and answers received by previous visitors via an online web form. A series of 12 horticulture distance education programs titled **Four Seasons Gardening** were offered at Extension offices throughout the state during the spring and fall and were attended by 522 participants. Topics included invasive weeds, sustainable landscapes, and community gardens.

Extension **Master Gardeners** gave countless hours in providing horticulture information to the public. There are currently over 3,400 active Master Gardeners in Illinois. This past year, 470 new Master Gardeners completed training at various locations throughout the state and through an online course. Master Gardeners are involved in teaching audiences how to grow, preserve, and share or sell excess produce to encourage the consumption of food rich in required nutrients for good health. Responsibilities assumed by the Master Gardeners this past year included growing food for the hungry, answering questions at farmers markets, conducting a low tunnel workshop, serving as citizen scientists to monitor hail, rain, and snowfall, helping a suburban community manage flood areas, and improving the quality of life for residents of a convalescent home who have long-term medical needs or significant disabilities.

The **University of Illinois Plant Clinic** had a total of 4,870 client contacts [submitted samples, telephone inquiries, email requests, and walk-in consultations] in 2012 and diagnosed 4,552 plant samples. Clinic staff members also prepared news releases, articles for newsletters, news columns, and podcasts, initiated the new information bulletin series **Plant Clinic Report** and maintained a website, Facebook page, and blog [all of which recorded increased pageviews]. In addition, the Extension **Digital Diagnostic System** provided extensive outreach to homeowners and commercial producers in diagnosing and providing solutions for 1,082 samples of invasive and exotic species pests. In addition, 21 issues of the Home Yard and Garden newsletter were distributed.

## 2. Brief description of the target audience

Members of the target audience include plant and animal biologists, soybean biologists, soybean breeders, farmers, Extension educators, scientists, agricultural input companies, legislators, agency regulators, agribusiness leaders, weed management professionals, corn producers, apple growers and apple grower organizations, the chemical and formulations industries, weed scientists, agricultural input suppliers, agronomic crop producers, fruit farmers, pomologists, tree fruit nurseries, wheat producers, processors and consumers, sorghum seed companies and growers, growers and vegetable industry personnel, green industries [including members of the nursery and landscape industries, botanical gardens and arboreta], scientists and agricultural professionals familiar with crop physiology, plant breeding and

fertilizer use, marketing personnel in the soybean industry, molecular biologists, genomicists, population biologists, evolutionary biologists, plant pathologists, bioinformaticists, abiotic stress physiologists, and nutritionists in the feed industry. Extension audiences included homeowners, Master Gardeners, and green industry owners and employees [landscapers, nursery stock growers, lawn and garden business owners and employees, insurance adjustors, and arborists].

**3. How was eXtension used?**

Ten Extension staff and two volunteers are members of the Consumer Horticulture, Invasive Species, or Plant Breeding and Genomics eXtension Communities of Practice.

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

**1. Standard output measures**

2012	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
<b>Actual</b>	55315	126434	18225	0

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

**Patent Applications Submitted**

Year: 2012  
 Actual: 4

**Patents listed**

TF10087-US - Transmission Raman Spectroscopy Analysis Of Seed Composition; TF11129-PRO - Elongation Of Stigma-Style Length Of Flowers To Facilitate Cross Hybridization; TF10105-PRO - RHG1 Mediated Resistance To Soybean Cyst Nematode; TF12121-PRO - Composition And Methods Of Gene Silencing In Soybean

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

**Number of Peer Reviewed Publications**

2012	Extension	Research	Total
<b>Actual</b>	0	60	60

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

**Output Target**

**Output #1**

**Output Measure**

- Number Of Completed Hatch Research Projects

<b>Year</b>	<b>Actual</b>
2012	17

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

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

O. No.	OUTCOME NAME
1	Percentage Of Nitrogen Utilization By Wheat
2	More Informed User Of Pesticides
3	Providing Management Information To Farmers With Regard To Managing Soybean Cyst Nematode Heteroda, Glycines
4	Choosing Plant Varieties That Are Known To Be Resistant to Insects And Diseases
5	Number Of Hectares Impacted By A Long-Term Comparison Of The Agronomic Performance Of Corn, Soybean, Winter Wheat And Alfalfa Cultivars
6	Testing Of Samples For Characterization Of Herbicide Resistance In Waterhemp Populations For Improved Control
7	Measuring Western Corn Rootworm Movement To Evaluate Refuge Effectiveness
8	Improved Control Of Waterhemp
9	Studying The Interaction Of Photosynthesis, Genotype, And Environment To Improve Maize Production
10	Improved Understanding Of The Control Of Gene Expression In Soybean Seed
11	Development Of Rust-Resistant Lines For Illinois Soybean Growers
12	Identification Of Nematode Pathogens Using DNA Sequencing
13	Development Of Improved Soft Red Winter Wheat Varieties
14	Evaluating The Effectiveness Of Cover Crops In Reducing Disease Severity

## **Outcome #1**

### **1. Outcome Measures**

Percentage Of Nitrogen Utilization By Wheat

Not Reporting on this Outcome Measure

## **Outcome #2**

### **1. Outcome Measures**

More Informed User Of Pesticides

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

- 1862 Extension

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

Change in Knowledge Outcome Measure

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

<b>Year</b>	<b>Actual</b>
2012	158

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

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

A great deal of demand exists for research-based horticultural information for homeowners.

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

Master Gardener multi-county training sessions and online training sessions were completed by 470 new volunteers in 2012. An online survey was completed this past year by 221 new [with 2-4 years of experience] Master Gardeners. The survey was designed by the state coordinator of Master Gardeners to assess 13 gardening practices, 11 personal improvement skills, and Master Gardener experience in teaching horticulture topics.

#### **Results**

Pre- and post-tests completed by 221 of the new Master Gardeners evidenced a 23.3% increase in scores from pre-test to post-test. All but 7 of the respondents indicated that they adopted at least one of the 13 gardening practices. Specifically, 158 [71%] of the respondents reported now identifying an insect, disease or weed problem before deciding on a control measure and choosing plant varieties that are known to be resistant to insects and diseases. In addition, more than 60% are now keeping records of pest occurrence and control methods for later reference.

More than one third are now using pesticides according to the label. Complete results from the survey are indicated in the evaluation section of this planned program.

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

<b>KA Code</b>	<b>Knowledge Area</b>
205	Plant Management Systems
206	Basic Plant Biology
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**

Providing Management Information To Farmers With Regard To Managing Soybean Cyst Nematode Heteroda, Glycines

Not Reporting on this Outcome Measure

#### **Outcome #4**

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

Choosing Plant Varieties That Are Known To Be Resistant to Insects And Diseases

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

- 1862 Extension

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

Change in Action Outcome Measure

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

<b>Year</b>	<b>Actual</b>
2012	157

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

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

A great deal of demand exists for research-based horticultural information for homeowners.

### **What has been done**

Master Gardener multi-county training sessions and online training sessions were completed by 470 new volunteers in 2012. An online survey was completed this past year by 221 new [with 2-4 years of experience] Master Gardeners. The survey was designed by the state coordinator of Master Gardeners to assess 13 gardening practices, 11 personal improvement skills, and Master Gardener experience in teaching horticulture topics.

### **Results**

Pre- and post-tests completed by 221 of the new Master Gardeners evidenced a 23.3% increase in scores from pre-test to post-test. All but 7 of the respondents indicated that they adopted at least one of the 13 gardening practices. Specifically, 158 [71%] of the respondents reported now identifying an insect, disease or weed problem before deciding on a control measure and 157 now choose plant varieties that are known to be resistant to insects and diseases. In addition, more than 60% are now keeping records of pest occurrence and control methods for later reference. More than one third are now using pesticides according to the label. Complete results from the survey are indicated in the evaluation section of this planned program.

## **4. Associated Knowledge Areas**

<b>KA Code</b>	<b>Knowledge Area</b>
205	Plant Management Systems
206	Basic Plant Biology
216	Integrated Pest Management Systems

## **Outcome #5**

### **1. Outcome Measures**

Number Of Hectacres Impacted By A Long-Term Comparison Of The Agronomic Performance Of Corn, Soybean, Winter Wheat And Alfalfa Cultivars

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

- 1862 Extension
- 1862 Research

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

Change in Action Outcome Measure

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

<b>Year</b>	<b>Actual</b>
2012	9490000

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

**Issue (Who cares and Why)**

Research continues under this long-term project designed to compare the agronomic performance of corn, soybean, winter wheat, alfalfa, and forage grass cultivars that are available to farmers in Illinois.

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

The agronomic performance of corn, soybean, winter wheat, alfalfa, and forage grass cultivars available to farmers in Illinois were compared. Seed companies that sell seed in Illinois enter cultivars into these trials on a voluntary basis, by providing seed and paying a fixed fee. Standard crop cultivar testing procedures are used to measure performance of each cultivar. Comparative results are made available for general usage. Commercial corn hybrids and publicly and privately developed forage, soybean, and winter wheat varieties were evaluated for yield and agronomic performance. A number of publicly-developed advanced experimental lines were also included in the soybean and wheat tests. The results were published as an insert in a widely-distributed farm newspaper and were distributed through Extension offices. Results are available at <http://vt.cropsci.illinois.edu/>.

#### **Results**

These trials were conducted in a timely manner, using accepted agronomic practices and statistical design. The results provided unbiased data useful to crop producers choosing cultivars of these crops to be grown in different agronomic zones of Illinois. Companies who enter cultivars also used this information widely. The results of these trials, either through direct use by farmers or through use by seed companies, affect crop production on 9,490,000 hectares of five crops in Illinois. Reports issued by this program are regarded as the premier source of unbiased performance information on current cultivars. These reports guide cultivar selection in Illinois and surrounding states to ensure producers are growing the best cultivar for their farming operation.

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

<b>KA Code</b>	<b>Knowledge Area</b>
102	Soil, Plant, Water, Nutrient Relationships
203	Plant Biological Efficiency and Abiotic Stresses Affecting Plants
205	Plant Management Systems
206	Basic Plant Biology

#### **Outcome #6**

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

Testing Of Samples For Characterization Of Herbicide Resistance In Waterhemp Populations For Improved Control

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

- 1862 Extension
- 1862 Research

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

Change in Knowledge Outcome Measure

### 3b. Quantitative Outcome

Year	Actual
2012	1000

### 3c. Qualitative Outcome or Impact Statement

#### Issue (Who cares and Why)

Waterhemp [*Amaranthus tuberculatus*] is one of the most problematic weeds for Midwest crop producers. In particular, many waterhemp populations possess resistance to one or more herbicide groups; thus, in any given field, only a subset of available herbicides may be effective.

#### What has been done

Knowledge of herbicide resistance traits at the molecular level enabled the development of molecular assays to detect specific herbicide resistances. These were utilized to test populations for resistance at a scale that would not have been possible with traditional methods of herbicide resistance testing. Crop producers and other weed management clientele submitted to us for testing waterhemp samples suspected of having herbicide resistance. Over a thousand samples were tested. Results from rapid assays for herbicide resistance in waterhemp were used to inform weed management clientele on how to best manage waterhemp populations present in their fields. Pooling data from multiple submissions enabled us to determine and track where herbicide resistant waterhemp is present in Illinois. A primary impact of this research is that it enables farmers to select the most efficacious herbicides for their fields, which can reduce wasteful applications of less effective herbicides.

#### Results

A primary output of this project has been a characterization of the types of herbicide resistance present in numerous waterhemp populations. This information was directly transmitted to weed management clientele [crop producers, commercial applicators, and industry representatives] who used this knowledge to fine-tune weed management recommendations. Additionally, the information was collated and disseminated via state, regional, and national venues [scientific publications, newsletter articles, and grower meetings] to increase awareness of herbicide resistance in waterhemp. Other significant outputs include new fundamental knowledge of how different resistance traits may evolve and be disseminated among *Amaranthus* weed populations.

### 4. Associated Knowledge Areas

KA Code	Knowledge Area
205	Plant Management Systems
206	Basic Plant Biology
213	Weeds Affecting Plants

## **Outcome #7**

### **1. Outcome Measures**

Measuring Western Corn Rootworm Movement To Evaluate Refuge Effectiveness

### **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>
2012	0

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

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

Measurement of actual Western Corn Rootworm movement and mating in refuges under field conditions is a practical way to understand if refuges perform as expected. Collection of data that resulted in outcomes that corrected erroneous assumptions about pest biology are valuable because they improve insect resistance management models of refuge design.

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

We observed: [1] that refuge male movement into transgenic corn from block refuges is most likely during the vegetative period of corn phenology; [2] that mating activity is concentrated in and around block refuges; and [3] that mating females just outside of refuge corn are older than mating females in refuge corn [this may indicate that while males are abundant in refuge, the proportion of males that are still reproductively competent may be quite low; many refuge females may wander out of refuges while they wait to be discovered by a mate-seeking male]. These observations represent some departures from assumptions that were accepted in current models. Limitations on male reproductive lifespan were not measured as part of this study; however, patterns of mating activity suggest that WCR male mating capabilities are less than what has been assumed in many models.

#### **Results**

During presentations in various venues, project findings have consistently been used to promote seed blends as superior refuge designs for assuring well-mixed WCR populations. These data have been embraced by industry; they have been used for or influenced new Insect Resistance Management models. During many presentations to growers, suggesting WCR beetle behavior was out of compliance with our expectations was found to be an effective shift of perspective, and one that is more favorably received than assertions that growers have failed to comply with refuge. These changes in knowledge about WCR movement and mating behavior/patterns were

incorporated into a published model and a *Entomologia Experimentalis et Applicata* publication about expectations for WCR mating in Bt corn.

#### 4. Associated Knowledge Areas

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

#### Outcome #8

##### 1. Outcome Measures

Improved Control Of Waterhemp

##### 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)**

Waterhemp [*Amaranthus tuberculatus*] is a difficult-to-control weed in Illinois soybean and corn production systems. This is in part due to the evolution of multiple herbicide resistances in waterhemp, which is facilitated by its dioecious nature, outcrossing, prolific seed production, and high degree of genetic diversity. A population of waterhemp [designated MCR] from a seed corn field in McLean County, Illinois displays resistance to mesotrione and other 4-hydroxyphenylpyruvate dioxygenase [HPPD] inhibitors, as well as to atrazine and certain ALS-inhibiting herbicides.

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

Our results indicate this waterhemp biotype is resistant to mesotrione [plus all commercial HPPD-inhibiting herbicides used for weed control in corn] and atrazine, from both preemergence and postemergence applications, mainly due to rapid metabolism of mesotrione and atrazine [albeit by different detoxification mechanisms and enzymes]. The fact that this population is resistant to both HPPD inhibitors and atrazine suggests the ability to achieve herbicide synergism for enhanced weed control may be attenuated under field conditions.

## Results

These research findings are particularly significant and relevant to crop production and weed management with postemergence herbicides in Zea mays because several other waterhemp populations have recently been identified in seedcorn fields throughout the Midwest that possess this unique form of multiple herbicide resistance.

### 4. Associated Knowledge Areas

KA Code	Knowledge Area
205	Plant Management Systems
206	Basic Plant Biology
213	Weeds Affecting Plants

### Outcome #9

#### 1. Outcome Measures

Studying The Interaction Of Photosynthesis, Genotype, And Environment To Improve Maize Production

#### 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)

Multiple experiments were conducted to elucidate the interaction of photosynthesis, genotype, and the environment to produce greater yield in maize. Since it is the plant that intercepts light and produces grain, a steady increase in seeding rate over the last 25 years [increase of approximately 700 seeds per ha per year] has played a large role in increasing average U.S. corn yields, and we believe that even greater plant populations will be needed to double yield over the next 25 years. The obvious caveat is that these greater plant populations must be managed to minimize plant competition, and we have examined row configuration, fertility level, fertilizer placement, hybrid selection, and the use of fungicides and/or growth regulators to minimize stress as potential ways to manage higher plant populations.

##### What has been done

We have also conducted studies with temperate x tropical maize [TTM] hybrids, which typically produce increased biomass and sugar compared to commercial maize grown for grain. We are investigating the interaction of environment on the production of sugars and biomass in these TTM genotypes. Additionally, we are investigating these TTM maize hybrids for potential use as biofuel, either ethanol- or biomass-based, and as a forage and feed crop for animal feeding. A third area of investigation is the impact of stover carbon residue on subsequent maize production.

### **Results**

Through this project, we have determined the amount and timing of nutrients required for modern maize hybrids, and have presented it at conferences and in a publication. We have also published a better understanding of the photoperiod sensitive tropical x temperate maize hybrids and their potential usefulness for feed and fuel. We have developed an analysis technique to more efficiently determine nitrogen use efficiency. Additionally, the yield penalty from continuous corn was further determined and presented.

## **4. Associated Knowledge Areas**

<b>KA Code</b>	<b>Knowledge Area</b>
102	Soil, Plant, Water, Nutrient Relationships
201	Plant Genome, Genetics, and Genetic Mechanisms
203	Plant Biological Efficiency and Abiotic Stresses Affecting Plants
205	Plant Management Systems
206	Basic Plant Biology
213	Weeds Affecting Plants
216	Integrated Pest Management Systems

## **Outcome #10**

### **1. Outcome Measures**

Improved Understanding Of The Control Of Gene Expression In Soybean Seed

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

- 1862 Research

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

Change in Knowledge Outcome Measure

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

<b>Year</b>	<b>Actual</b>
2012	0

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

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

Soybean has a wealth of naturally-occurring mutations that affect other pigmentation properties and morphological types. Several are also mutable alleles that may harbor transposable elements. To date, the molecular identification of the genes that encode these traits are largely unknown.

### **What has been done**

Over the course of the project, we reported on the changes in gene expression during immature seed development, the stage when the protein and oils are being synthesized. We also determined the genes expressed in the cotyledon during early seed germination when the seed reserves are utilized to fuel the growth of the young seedling. We employed high throughput sequencing of mRNAs to define genes potentially involved in seed and flower color, flavonoid and protein composition, trichome development, and leaf development. During 2012, we reported on over 135,000 unique small RNAs from 41 million total sequence reads.

### **Results**

These outputs contribute to the project goals of understanding the control of gene expression in soybean seed and seedling development. They will benefit the biotechnology industry and soybean producers and consumers by providing basic information on gene regulation in soybean. A better understanding of the pathways involved in seed composition will enhance our understanding of plant disease resistance and the modification of flavonoid, protein, and oil in the seed for improved nutritional and health value. Soybean products are of immense value to U.S. agriculture, annually contributing nearly \$17 billion in unprocessed crop value. Soybean has high protein [40%] and moderate oil [20%] content and is the main source of vegetable protein and oil in world markets.

## **4. Associated Knowledge Areas**

<b>KA Code</b>	<b>Knowledge Area</b>
201	Plant Genome, Genetics, and Genetic Mechanisms
206	Basic Plant Biology

## **Outcome #11**

### **1. Outcome Measures**

Development Of Rust-Resistant Lines For Illinois Soybean Growers

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

- 1862 Extension
- 1862 Research

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

Change in Action Outcome Measure

### 3b. Quantitative Outcome

Year	Actual
2012	0

### 3c. Qualitative Outcome or Impact Statement

#### Issue (Who cares and Why)

The University of Illinois soybean breeding program developed new experimental lines and tested lines for yield, agronomic traits and disease and pest resistance during 2012. The program grew over 3,100 4-row yield test plots, 11,000 2-row yield test plots, and 14,000 plant row plots. The most advanced lines from the program were evaluated in regional tests in locations throughout soybean growing regions in the north central and eastern U.S. Data from these tests have been analyzed and selections are being made to decide what lines to test in experiments planned for 2013.

#### What has been done

Lines with the greatest yield and resistance over the past few years were selected and three new varieties and ten germplasm lines were released from the program. The released varieties are LD07-3419, LD07-4530, and LD06-7620. The three varieties are conventional [non-GMO] and were released because they combine high yield potential with resistance to soybean cyst nematode [SCN], which is the most important soybean disease in Illinois and across the U.S. LD07-3419 and LD07-4530 are both maturity group [MG] III varieties which are suitable for production in central Illinois and other regions with similar latitude. LD06-7620 is a MG IV variety suitable for production in southern Illinois and other regions with similar latitude. These varieties have been licensed for commercial production. Two germplasm lines were released because of their novel combinations of SCN resistance genes which make them useful as SCN resistance sources in breeding programs. The other eight released germplasm lines carry the soybean rust resistance genes Rpp1, Rpp1-b, Rpp?[Hyuuga], and Rpp5 in both an MG II and an MG IV genetic background.

#### Results

These rust-resistant lines will be a good resource for the Midwestern U.S. soybean breeding community because these genes all originate from backgrounds that are not adapted to this region. Results from the breeding program were disseminated in a number of ways. The varieties developed from the research program were included in the University of Illinois Variety Tests and results from the tests are made available to the public through the test website and publications.

### 4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
201	Plant Genome, Genetics, and Genetic Mechanisms
203	Plant Biological Efficiency and Abiotic Stresses Affecting Plants
206	Basic Plant Biology
214	Vertebrates, Mollusks, and Other Pests Affecting Plants

## **Outcome #12**

### **1. Outcome Measures**

Identification Of Nematode Pathogens Using DNA Sequencing

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

- 1862 Research

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

Change in Knowledge Outcome Measure

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

<b>Year</b>	<b>Actual</b>
2012	0

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

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

Previous work on identifying nematode pathogens relied on the culture of disease-causing microorganisms. With the rise of new DNA sequencing technologies [next-generation DNA sequencing], the ability to acquire vast amounts of DNA sequence has become cost effective. The exponential increase of DNA sequence data output has made it possible to sequence the DNA of all organisms associated with soil-borne plant parasitic nematodes. Such analysis is referred to as metagenomics since it aims to sequence the DNA of all organisms in a given sample or environment.

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

This type of analysis when applied to sequencing a single soybean cyst nematode strain identified a bacterial pathogen/endosymbiont and at least four viruses. Since metagenomics has the potential to discover organisms in a culture-independent manner, it has the ability to identify multi-trophic interactions that may be lowering nematode reproduction and thus may be useful for nematode control. In this project we proposed to conduct a metagenomic survey of important plant parasitic nematode communities common in Illinois with the intent of identifying microorganisms tightly associated with the nematodes. The use of techniques to identify viruses will at the same time identify bacterial and fungal organisms. These microorganisms may be of use in controlling plant parasitic nematodes.

#### **Results**

The initial goal was to develop a rapid approach to discover new viruses in plant parasitic nematodes. A method was developed to physically disrupt nematodes and then recover viral particles on a small scale. The ability to work with small volumes was critical since it is often hard to obtain large numbers of plant parasitic nematodes. We were able to obtain 21 different isolates of root-knot nematode and then applied the viral isolation method to the samples. Using a multiplex strategy, we were able to obtain over 150 million DNA sequences from the pooled

nematode samples. The sequences were analyzed by comparing them to a database containing known viral proteins. The initial results showed very significant matches to seven viruses, indicating the root-knot nematodes may contain similar viruses. While these viruses are not yet proven to infect nematodes, some of them probably cause disease in the root-knot nematodes. This project has been very successful and shows that viruses can be detected in pooled nematode samples using a fairly simple technique. This approach to virus discovery could be applied to any nematode population either in the laboratory or in the field. Nematode viruses have only been recently discovered, thus this approach has the potential to rapidly identify new viral species.

#### 4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
201	Plant Genome, Genetics, and Genetic Mechanisms
206	Basic Plant Biology
212	Pathogens and Nematodes Affecting Plants

#### Outcome #13

##### 1. Outcome Measures

Development Of Improved Soft Red Winter Wheat Varieties

##### 2. Associated Institution Types

- 1862 Research

##### 3a. Outcome Type:

Change in Action Outcome Measure

##### 3b. Quantitative Outcome

Year	Actual
2012	0

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

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

An objective of the wheat breeding program is to evaluate experimental genotypes for agronomic performance and disease resistance. The breeding project is focused on the development of high yield adapted wheat varieties for Illinois and surrounding states. High priority breeding objectives also include Fusarium head blight resistance and earliness. Each growing season about 100 to 110 advanced experimental breeding lines were evaluated in replicated tests at four locations.

###### What has been done

About 300-400 preliminary breeding lines were also evaluated each season. Selections were made based on yield, test weight, milling and baking quality, maturity, height, and resistance to Fusarium head blight [scab] and barley yellow dwarf virus. In addition, about 1,500 - 2,300 breeding lines were evaluated in single plots at two locations each year, and about 300 - 400 of these lines were selected for continued evaluation in the following season. About 25,000 - 30,000 F4 headrows were evaluated each season, and about 1,500 - 2,300 headrows were selected for further evaluation in the following year based on height, maturity, disease resistance, and kernel morphology. During the five years of this project sixteen wheat breeding lines were approved and released for further evaluation, seed increase and possible commercialization.

### **Results**

Development of improved soft red winter wheat varieties has a significant economic impact and benefits wheat producers, processors, and consumers. The varieties are disease resistant, adapted varieties that reduce losses, improve stability of production, and improve the quality of the grain produced. The number of units of seed of breeding lines developed in this breeding program that were sold for commercial production increased compared to previous years.

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

<b>KA Code</b>	<b>Knowledge Area</b>
102	Soil, Plant, Water, Nutrient Relationships
201	Plant Genome, Genetics, and Genetic Mechanisms
203	Plant Biological Efficiency and Abiotic Stresses Affecting Plants
205	Plant Management Systems
206	Basic Plant Biology

### **Outcome #14**

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

Evaluating The Effectiveness Of Cover Crops In Reducing Disease Severity

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

- 1862 Research

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

Change in Knowledge Outcome Measure

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

<b>Year</b>	<b>Actual</b>
2012	0

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

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

The goal of this project is to determine if the use of cover crops in a corn:soybean rotation is an effective tool for reducing disease severity levels in soybean. This will provide soybean producers with another tool to manage important diseases. Managing diseases, weed problems, and increasing soil health through the use of cover crops will increase the sustainability of the corn:soybean rotation system and increase the profitability of soybean production by reducing yield losses resulting from disease.

### **What has been done**

Disease severity levels of Rhizoctonia root rot on field grown soybean seedlings were found to be lower in rye cover crop plots when compared to those in fallow plots at some locations. No differences in symptoms of sudden death syndrome resulting from cover crop treatments were seen in the field plots. Lower levels of Rhizoctonia root rot and sudden death syndrome were associated with soils collected from rye cover crop plots in greenhouse bioassays, but the results were not consistent among all locations. QPCR analysis showed no impact of cover crop treatments on population levels of selected soybean pathogens. ARISA analysis found differences in microbial community structures in soils collected from the different locations in the study, but did not detect any differences associated with the cover crop treatments.

### **Results**

Several isolates of fungal soybean pathogens were found to be infected with mycoviruses. Sequence analysis revealed the presence of a few previously unreported mycoviruses. This work may lead to the development of biocontrol strategies for some fungal pathogens based on mycoviruses that reduce the pathogenicity of the infected strains. The information may also help explain variation in virulence among isolates of a pathogen species, thus improving research efforts to study these organisms.

## **4. Associated Knowledge Areas**

<b>KA Code</b>	<b>Knowledge Area</b>
102	Soil, Plant, Water, Nutrient Relationships
201	Plant Genome, Genetics, and Genetic Mechanisms
203	Plant Biological Efficiency and Abiotic Stresses Affecting Plants
205	Plant Management Systems
206	Basic Plant Biology
212	Pathogens and Nematodes Affecting Plants
213	Weeds Affecting Plants
216	Integrated Pest Management Systems

## **V(H). Planned Program (External Factors)**

### **External factors which affected outcomes**

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

### **Brief Explanation**

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

### Evaluation Results

A study with slight modifications in the evaluation instrument used in 2007 was conducted in 2012 with Master Gardeners who had between two and four years of experience. The online evaluation was designed by the state coordinator of Master Gardeners who asked county Extension coordinators to send a prepared email to Master Gardeners with this level of experience inviting them to participate in the survey. The survey addressed perceived changes in 13 practices, 11 personal improvement skills, and experience in teaching horticulture topics.

The first set of findings were based on two questions that asked respondents to indicate their use of 13 gardening practices before and after becoming a University of Illinois Master Gardener. It should be noted that all but 7 of the 221 respondents indicated an increase in at least one or more of the recommended gardening practices. The results indicated that : 74.7% [165 of 221] now prune landscape plants properly; 71.5% [158] now identify an insect, disease or weed problem before deciding on a control measure; 71.0% [157] now chose plant varieties that are known to be resistant to insects and diseases; 64.7% [143] now keep records of pest occurrence for later reference; 62.4% [138] now install landscape plants properly; 62.0% [137] now keep records of results of control methods for later reference; 58.4% [129] now use water saving strategies in the garden; 57.9% [128] now choose landscape plants based on the conditions in the planting site; 54.7% [121] now take soil tests; 51.1% [113] now recycle organic materials in the yard through mulching and composting; 50.0% [113] now mulch landscape plants properly; 43.9% [97] now follow recommendations on soil test reports; and 36.2% [80] now use pesticides only according to the directions on the label.

The second set of questions addressed frequency in teaching the above gardening practices to others. Response choices included 'almost never', 'occasionally', 'often', 'very often', and 'don't know'. Approximately one fourth of the respondents [64] indicated that they had occasionally, often, or very often taught all thirteen topic areas. The topics 'often' or 'very often' taught include the following: 154 [69.8%] taught mulching landscape plants properly; 148 [67.0%] taught installing landscape plants properly; 146 [66.1%] taught choosing landscape plants based on the conditions in the planting site; 142 [64.3%] taught recycling organic materials in the yard through mulching and composting; 140 [63.3%] taught choosing plant varieties that are known to be resistant to insects and diseases; and 135 [61.1%] taught pruning landscape plants properly.

A third set of questions was developed to assess the Master Gardener's perceptions in changes related to 11 skills for working with others. Response options to each skill included 'not at all', 'slightly', 'moderately', 'much', and 'a great deal'. Of the 187 who answered this question, 81.8% indicated that their skills for one or more of those listed had improved 'much' or 'a great deal'. Skills improvement rated 'much' or 'a great deal' follow in order of frequency: 143 [76.5%] increased their skill in solving gardening problems; 128 [67.4%] acquired information better; 98 [52.4%] indicated they were willing to accept more challenges; 92 [49.2%] increased skills in working more productively with a group; 86 [46.0%] gained skill in communicating more effectively with others; 80 [42.8%] indicated setting goals more effectively; 75 [40.1%] could reach goals more effectively; 54 [28.9%]

could speak to a group more effectively; 51 [27.3%] could lead a group more effectively; 51 [27.3%] gained skill in delegating responsibilities within a group; and 22 [11.8%] improved computer skills.

### **Key Items of Evaluation**

Master Gardener training improved more than half of the participant's use of recommended practices with respect to controlling home yard and garden pests through practices designed to reduce the use of pesticides that may be harmful to the environment, conserving water in home lawn and gardening activities, and using practices that insure landscaping plant health [minimizing replacement costs to the homeowner]. Since these Master Gardeners teach others, their outreach likely has a similar effect on the practices of those they reach [nearly 90,000, face-to-face teaching contacts in 2012]. In addition, University of Illinois Extension has contributed to effectively building skills that will enhance the Master Gardener's teaching and leadership to serve both individuals and communities.