V(A). Planned Program (Summary)

Program # 6

1. Name of the Planned Program

Global Food Security and Hunger - Integrated Pest Management

☑ 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
216	Integrated Pest Management Systems	100%		100%	
	Total	100%		100%	

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2014	Extension		Research	
	1862	1890	1862	1890
Plan	25.0	0.0	13.0	0.0
Actual Paid	20.0	0.0	4.0	0.0
Actual Volunteer	61.0	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**
192047	0	695941	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
1626460	0	1240036	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
136553	0	1977799	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

Research

- Develop new and novel techniques for pest management and pest detection

Delivery

- Provide IPM information to a wide variety of stakeholders
- Employ new methods for delivery IPM information

Education

- Conduct IPM educational programs for stakeholders
- Conduct IPM educational training for university students
- Conduct IPM educational training for Vo-Ag and FFA students
- Conduct IPM public awareness campaign

Extension

- Work with communities, schools, businesses to help them meet their regulatory responsibilities on pesticide application
- Help growers develop scouting programs to identify pest populations before significant plant damage occurs.
- Develop pest management options to be used in an integrated or rotational program.
- Identify indicators to help growers anticipate pest problems.
- Develop monitoring techniques and population damage thresholds for selected pests.
- Provide scientifically sound advice to state regulatory bodies on pest management and pesticide issues
- Create a multidisciplinary program comprising of faculty, staff, volunteers, industry partners and government officials
- Investigate IPM methods to help growers produce top quality crops, limiting or reducing production costs.
- Evaluate all pest and crop management practices into a set of commercially used methods. These include the use of: pesticides, economic/aesthetic threshold levels, resistant cultivars, optimum horticultural practices, environmental monitoring, pest scouting, and fertility monitoring and recommendations.

2. Brief description of the target audience

- Municipalities
- Pesticide applicators and their employers
- Commercial pesticide applicators
- State Dept. of Environmental Protection
- Staff and students who gain valuable scientific experience
- Industry partners in agriculture and related commodities
- Consumers
- NJAES Faculty and Staff involved in pest management research/outreach
- Farmers
- Commodity groups
- New Jersey residents
- School faculty, staff and children
- NJAES researchers
- Secondary and university students
- Governmental agencies
- Environmental organizations
- Agricultural, landscape, fine turf and other related industries

3. How was eXtension used?

Faculty participated in answering "ask the expert" questions, developing collaborative educational products and the development of professional development sessions.

V(E). Planned Program (Outputs)

1. Standard output measures

2014	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	1325	21501	0	0

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

Patent Applications Submitted

Year: 2014

Actual: 0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2014	Extension	Research	Total
Actual	8	25	33

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- A variety of strategies will be implemented to reach target audiences. This will include and not be limited to workshops, field visits, classes, newsletters, media releases, electronic communications,publications. In addition a trained volunteer teaching base will be developed. Quantitative reports of participation will be collected

Year	Actual
2014	0

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Short Term - Develop improved IPM delivery methods. Develop detection, monitoring and sampling methods that reliably predict pest levels. Develop novel management methods for a wide variety of pests. Develop IPM training for secondary and university students. Improve public awareness about IPM Determine the effectiveness of pheromones for mating disruption of pests. Greater understanding of entomopathogenic nematode species'effects on pests. Evaluation of the effectiveness of natural pesticides and crop management to reduce pests. Determine which types of plants attract pests to be used as a pest control method.
2	Medium Term - Research and educational programs, and public awareness campaign results in increased adoption of IPM in traditional and non-traditional systems. Research findings used to develop new projects. IPM training of students creates new IPM interns, professionals and researchers. Knowledge of various natural insecticides and their effectiveness on pests. Determining the best time and application method for IPM products. Greater understanding of pest biology and ecology. Greater understanding of entomopathogenic species biology and ecology.
3	Long Term - Protect commodities, homes and communities from pests. Increased abundance of high quality food and fiber products. Increased acreage in New Jersey grown under IPM practices. Reduced environmental problems associated with current pest management practices. A comprehensive understanding of best management practices for IPM that are economically viable and environmentally safe.
4	Improving Microbial Control of Arthropods - Medium Term - Research and educational programs, and public awareness campaign results in increased adoption of IPM in traditional and non-traditional systems. Research findings used to develop new projects. IPM training of students creates new IPM interns, professionals and researchers. Knowledge of various natural insecticides and their effectiveness on pests. Determining the best time and application method for IPM products. Greater understanding of pest biology and ecology. Greater understanding of entomopathogenic species biology and ecology.
5	Enabling Pesticide Registrations for Specialty Crops - Long Term - Protect commodities, homes and communities from pests. Increased abundance of high quality food and fiber products. Increased acreage in New Jersey grown under IPM practices. Reduced environmental problems associated with current pest management practices. A comprehensive understanding of best management practices for IPM that are economically viable and environmentally safe.
6	Protecting Human Health and Urban Environment through Integrated Pest Management Programs - Long Term - Protect commodities, homes and communities from pests. Increased abundance of high quality food and fiber products. Increased acreage in New Jersey grown under IPM practices. Reduced environmental problems associated with current pest management practices. A comprehensive understanding of best management practices for IPM that are economically viable and environmentally safe.
7	Improving Sustainability, Efficiency, and Efficacy of Peach Disease Management Strategies: Biofungicides, Conventional Fungicides, and Abiotic Environmental Factors - Long Term - Protect commodities, homes and communities from pests. Increased abundance of high quality food and fiber products. Increased acreage in New Jersey grown under IPM practices. Reduced environmental problems associated with current pest management practices. A comprehensive understanding of best management practices for IPM that are economically viable and environmentally safe.

8	Investigations into a New Invasive Species, Halyomorpha halys (Stal) (Hemiptera: Pentatomidae), A Potential Threat to New Jersey Agriculture - Long Term - Protect commodities, homes and communities from pests. Increased abundance of high quality food and fiber products. Increased acreage in New Jersey grown under IPM practices. Reduced environmental problems associated with current pest management practices. A comprehensive understanding of best management practices for IPM that are economically viable and environmentally safe.
9	North Jersey Ornamental Horticulture Conference Turf Day Program - Long Term - Protect commodities, homes and communities from pests. Increased abundance of high quality food and fiber products. Increased acreage in New Jersey grown under IPM practices. Reduced environmental problems associated with current pest management practices. A comprehensive understanding of best management practices for IPM that are economically viable and environmentally safe.
10	IPM for Landscape Contractors - Long Term - Protect commodities, homes and communities from pests. Increased abundance of high quality food and fiber products. Increased acreage in New Jersey grown under IPM practices. Reduced environmental problems associated with current pest management practices. A comprehensive understanding of best management practices for IPM that are economically viable and environmentally safe.
11	Management of Annual Bluegrass on Golf Courses: Improved Practices for Maintenance, Pest Control, and Viable Techniques for Transition to More Desirable Grasses - Long Term - Protect commodities, homes and communities from pests. Increased abundance of high quality food and fiber products. Increased acreage in New Jersey grown under IPM practices. Reduced environmental problems associated with current pest management practices. A comprehensive understanding of best management practices for IPM that are economically viable and environmentally safe.
12	Integrated Pest Management/Pesticide Safety Education - Long Term - Protect commodities, homes and communities from pests. Increased abundance of high quality food and fiber products. Increased acreage in New Jersey grown under IPM practices. Reduced environmental problems associated with current pest management practices. A comprehensive understanding of best management practices for IPM that are economically viable and environmentally safe.
13	Analyzing Bat Guano for Brown Marmorated Stink Bugs and Other Agricultural Pests - Long Term - Protect commodities, homes and communities from pests. Increased abundance of high quality food and fiber products. Increased acreage in New Jersey grown under IPM practices. Reduced environmental problems associated with current pest management practices. A comprehensive understanding of best management practices for IPM that are economically viable and environmentally safe.
14	Blueberry and Cranberry Insect Pest Management - Towards the Development and Implementation of Reduced-Risk - Long Term - Protect commodities, homes and communities from pests. Increased abundance of high quality food and fiber products. Increased acreage in New Jersey grown under IPM practices. Reduced environmental problems associated with current pest management practices. A comprehensive understanding of best management practices for IPM that are economically viable and environmentally safe.
15	Insect Biochemical Defenses Against Toxic Compounds - Long Term - Protect commodities, homes and communities from pests. Increased abundance of high quality food and fiber products. Increased acreage in New Jersey grown under IPM practices. Reduced environmental problems associated with current pest management practices. A comprehensive understanding of best management practices for IPM that are economically viable and environmentally safe.

16	Internet Technologies for Distance Education: Online Pesticide Training and Recertification for Licensed Professionals - Long Term - Protect commodities, homes and communities from pests. Increased abundance of high quality food and fiber products. Increased acreage in New Jersey grown under IPM practices. Reduced environmental problems associated with current pest management practices. A comprehensive understanding of best management practices for IPM that are economically viable and environmentally safe.
17	Field Crop Observational IPM Training for Master Gardener Volunteers - Long Term - Protect commodities, homes and communities from pests. Increased abundance of high quality food and fiber products. Increased acreage in New Jersey grown under IPM practices. Reduced environmental problems associated with current pest management practices. A comprehensive understanding of best management practices for IPM that are economically viable and environmentally safe.
18	Blueberry Integrated Pest Management Delivery - Long Term - Protect commodities, homes and communities from pests. Increased abundance of high quality food and fiber products. Increased acreage in New Jersey grown under IPM practices. Reduced environmental problems associated with current pest management practices. A comprehensive understanding of best management practices for IPM that are economically viable and environmentally safe.
19	Upland Fruit (Tree Fruit and Grape) Integrated Pest Management (IPM) Delivery - Long Term - Protect commodities, homes and communities from pests. Increased abundance of high quality food and fiber products. Increased acreage in New Jersey grown under IPM practices. Reduced environmental problems associated with current pest management practices. A comprehensive understanding of best management practices for IPM that are economically viable and environmentally safe.

Outcome #1

1. **Outcome Measures**

Short Term - Develop improved IPM delivery methods. Develop detection, monitoring and sampling methods that reliably predict pest levels. Develop novel management methods for a wide variety of pests. Develop IPM training for secondary and university students. Improve public awareness about IPM Determine the effectiveness of pheromones for mating disruption of pests. Greater understanding of entomopathogenic nematode species'effects on pests. Evaluation of the effectiveness of natural pesticides and crop management to reduce pests. Determine which types of plants attract pests to be used as a pest control method.

Not Reporting on this Outcome Measure

Outcome #2

1. **Outcome Measures**

Medium Term - Research and educational programs, and public awareness campaign results in increased adoption of IPM in traditional and non-traditional systems. Research findings used to develop new projects. IPM training of students creates new IPM interns, professionals and researchers. Knowledge of various natural insecticides and their effectiveness on pests. Determining the best time and application method for IPM products. Greater understanding of pest biology and ecology. Greater understanding of entomopathogenic species biology and ecology.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Management of the Brown Marmorated Stink Bug

The brown marmorated stink bug (BMSB) is a major invasive pest of many economically important crops throughout the Mid-Atlantic States. Control tactics are difficult and generally include repeated chemical sprays. However, with the potential risks pesticides pose to the environment and non-target organisms, more research is needed on BMSB behavior, seasonal biology, economic impact, and alternative control methods.

What has been done
NJAES researchers are using laboratory studies and field surveys and trials to assess the extent and nature of injury caused by BMSB on various agricultural crops, to determine the potential for biological control of this pest, to determine host plant characteristics that attract BMSB for use in trap crop control, and to develop best management practices for BSMB control.

Results
Feeding injury diagnostics by plant phenology were conducted this year and it was determined that early season feeding on plants by brown marmorated stink bugs was highly injurious, whereas feeding just prior to harvest did not cause significant injury. Research on phenological stage dependent injury by BMSB to wine grapes validated data from the prior year showing that white varietals are more susceptible to BMSB feeding and that injury beginning at veraison can lead to reduced yield. Natural enemy surveys using sentinel BMSB egg masses identified that predation, while low, remains the key mortality agent. Katydids were a primary predator. However, egg mortality due to predation was found at about 6% under organic management, which is significantly less disruptive to natural enemies than conventional programs. This work will be expanded to include gut content analysis and to include additional life stages of BMSB. A second year examining the diurnal activity of BMSB adults/nymphs was completed and showed that adult activity remains constant throughout the day. However, nymphs are most active 7 to 10 hours after sunrise. Research on the dispersal behavior of BMSB adults/nymphs showed that the dispersal of both adults and nymphs within orchards is related to surrounding land use and

varietal ripening dates. Results from another study of dispersal behavior of BMSB in peach using protein markers (a mark-recapture technique) suggest that there is a strong edge effect, with 85% of insects stopping at the orchard edge before moving to the interior. Surprisingly some individuals stayed at the edge for one week. This supports the use of border sprays to manage BMSB, a control technique that minimizes the use of expensive and toxic pesticides. All of these findings will inform the development of more effective management practices for controlling the spread of the brown marmorated stink bug and reducing the associated crop damage and losses.

4. Associated Knowledge Areas

KA Code	Knowledge Area
216	Integrated Pest Management Systems

Outcome #3

1. Outcome Measures

Long Term - Protect commodities, homes and communities from pests. Increased abundance of high quality food and fiber products. Increased acreage in New Jersey grown under IPM practices. Reduced environmental problems associated with current pest management practices. A comprehensive understanding of best management practices for IPM that are economically viable and environmentally safe.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Development and Implementation of New Reduced-Risk Insect Management Strategies for Blueberries and Cranberries

Blueberry maggot, cranberry weevil, cranberry fruit worm, Sparganothis fruit worm, blueberry aphids, oriental beetle, and plum curculio are among the most important insect pests of highbush blueberries and cranberries in New Jersey. In addition, the Brown Marmorated Stink Bug (BMSB) and Spotted Wing Drosophila (SWD), two new invasive species, pose a major threat to the blueberry and cranberry industries in New Jersey. The implementation of Food Quality Protection

Act (FQPA) is expected to reduce the availability of insecticides that are currently used to manage these insect pests. There is a need for new, low-risk management strategies to management strategies for these pests that are not affected by FQPA.

What has been done
An NJAES Extension Specialist is using laboratory-based research studies and field research to develop new low-risk management strategies against these major pests. These strategies include: monitoring strategies for new invasive pests, mating disruption for oriental beetle, use of host-plant volatiles for pest monitoring and control, use of pheromones for insect monitoring and management, evaluation and implementation of new chemical strategies, and assessment of efficiency of biological control agents.

Results
Different baits were tested for monitoring spotted wing drosophila (SWD), a new invasive pest of small fruit crops including blueberries. Six attractants (Kombucha, Cowles, and Suzukii, Apple cider vinegar (ACV), Trecé, and Kerr) were evaluated. Results showed that the attractants Suzukii and Trecé were the most attractive to the SWD throughout the 2014 season. Color and pheromone-baited traps were evaluated for cranberry weevil. These studies showed that cranberry weevil adults are more attracted to yellow and white than green, blue, red, brown, and black. Glandlure II (E) reduced cranberry weevil captures while geranic acid had no effect. In 2013-2014, an NJAES Extension Specialist conducted a study to assess the efficacy of an odor-baited "trap-bush" approach against Plum curculio (PC), comparing PC injury to fruit (i.e., number of oviposition-scarred fruit), in "trap-bush" plots versus "control" plots. Trap-bush plots had bushes baited with an attractant (grandisoic acid + benzaldehyde) along the perimeter, whereas the control plots had unbaited bushes. The amount of injury was significantly greater on and near trap bushes compared with those on and near unbaited bushes. No difference in fruit injury was found between interior plots. These results indicate that odor-baited trap bushes can be used to manipulate PC behavior, i.e., aggregate adults, in blueberries such that insecticides are targeted only to a few perimeter-row bushes within fields rather to entire fields.

4. Associated Knowledge Areas

KA Code	Knowledge Area
216	Integrated Pest Management Systems

Outcome #4

1. Outcome Measures

Improving Microbial Control of Arthropods - Medium Term - Research and educational programs, and public awareness campaign results in increased adoption of IPM in traditional and non-traditional systems. Research findings used to develop new projects. IPM training of students creates new IPM interns, professionals and researchers. Knowledge of various natural insecticides and their effectiveness on pests. Determining the best time and application method for IPM products. Greater understanding of pest biology and ecology. Greater understanding of entomopathogenic species biology and ecology.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Improving Microbial Control of Arthropods

Broad-spectrum chemical insecticides are still the mainstay for insect pest control in most agricultural systems and urban/suburban landscapes. While chemical pesticides can rapidly kill various pests, heavy reliance on their use generates problems that include human health hazards, secondary pest outbreaks, environmental contamination, decreases in biodiversity, and insecticide resistance. There is an urgent need to accelerate the development and implementation of cost-effective, environmentally safe alternatives for insect control. A viable alternative to chemical insecticides are biological control agents as they are generally not harmful to humans or environment, and have negligible potential to cause resistance or harm non-target organisms.

What has been done
NJAES extension specialists are using laboratory and field tests to develop and advance the use of entomopathogens for pest suppression. Research conducted prior to 2014 indicated that entomopathogens can provide control (average 65%) of moderately high larval populations of the annual bluegrass weevil (ABW), Listronotus maculicollis, on golf course fairways. However, control rates were about 20% lower than for standard insecticides and tended to further fall behind the insecticides at higher, but not uncommon, ABW densities. In 2013 we observed that combined application of nematodes and imidacloprid tended to improve nematode efficacy against ABW. To examine the effect of split application on efficacy of nematodes and nematode-imidacloprid combination we conducted a field study in 2014 on the efficacy of combining the nematode Steinernema carpocapsae and the pesticide imidacloprid applied alone or in combination to control ABW.

Results
Test results indicated that nematode imidacloprid combinations (77-78% control) but not nematodes alone (50-58% control) were significantly better than imidacloprid alone. Split application of nematodes, whether for nematodes alone (88%) or in the combinations (both 95%) showed the greatest potential. Where imidacloprid is already used for white grub control, its combination with split nematode application could be a highly effective option for ABW larval control.

4. Associated Knowledge Areas

KA Code	Knowledge Area
216	Integrated Pest Management Systems

Outcome #5

1. Outcome Measures

Enabling Pesticide Registrations for Specialty Crops - Long Term - Protect commodities, homes and communities from pests. Increased abundance of high quality food and fiber products. Increased acreage in New Jersey grown under IPM practices. Reduced environmental problems associated with current pest management practices. A comprehensive understanding of best management practices for IPM that are economically viable and environmentally safe.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Enabling Pesticide Registrations for Specialty Crops

Specialty Crops are high value / low acreage crops and make up about 46% of U.S. agricultural production and $43 billion in sales. Twenty-six states derive more than 50% of agricultural crop sales from specialty crops and thirty-three states derive more than 40% of their agricultural crop sales from specialty crops. US Specialty Crop Growers produce most of the vegetables, fruits, nuts, herbs, spices, floral, nursery, landscape, turf, and Christmas trees for the American consumer. If these growers do not have safe and effective pest management tools, their crops and businesses will not survive and the American consumer will suffer. Even though these are high value crops, they are low acreage. Therefore agrichemical companies have little incentive to register their products for these crops. IR-4 fills the void for these growers and, since 1963, the IR-4 Project has cooperated with researchers, producers, the agrichemical industry and federal and state agencies to secure regulatory clearances that allow agrichemical companies to achieve registrations for pest management products on specialty crops.

What has been done
IR-4 research conducts and funds research that provides data needed to support registration of safe and effective crop protection products on specialty crops, which ensures a safe and secure food supply, allows US growers to compete in a global economy and prevents potential economic losses to individual states in the millions of dollars.

Results
Data from studies involving 30 chemical pesticides were integrated into a pesticide tolerance petitions and formally submitted to US Environmental Protection Agency. These packages will be reviewed and when deemed appropriate, EPA established a pesticide tolerance through a publication of this action in the Federal Register. In 2014, 142 pesticide tolerances were established. Utilizing established crop grouping and other allowable extrapolations, these pesticide tolerances translate to 683 registrations that can be uses to protect the domestic food supply from destructive pests while keeping healthy fruits, nuts, vegetables and other specialty crops available year round at a reasonable price. During the period of performance, IR-4 supported 7 registrations (A16901B 45WG, DPX-HGW86, Mainspring 200SC, Marengo G, Mika WG, Regalia MAXX, and Xxpire) for a total of 3,984 new ornamental crop uses. The economic impact of Ornamental Horticulture Program deliverables has been quantified. Miller and Leschewski in their "Economic Impact of the IR-4 Project and IR-4 Project Programs" report noted that the Food Crops Program generates economic activity sufficient to support 14,501 full and part time jobs with wages of $582 million. The IR-4 Ornamental Horticulture Program and associated research is estimated to add nearly $1.0 billion to annual GDP. IR-4 submitted amended registration packages for Hops Beta acid, and a new registration for the viral coat protein of papaya ringspot virus to EPA. From efficacy research funded through the biopesticide grant program, there were 7 additions of crops to biopesticide labels. In addition, a 24C labels have been developed for 9, 10 Anthraquinone including Avipel Liquid for Corn (10 states), Avipel Dry formulation for Corn (13 states). In addition, Section 18s were supported for, AV-1011 for rice in Louisiana and Arkansas and the Avipel Liquid in Sunflower in South Dakota. The need for IR-4's services in all four program areas will increase over the next several years. New and emerging factors driving the increased need for IR-4 include the unintentional introduction of new pests/invasive species, pests becoming increasing resistant to available pesticides, increased need for product performance data, increased complexity of regulatory data requirements, internationalization of data requirements, and emerging regulatory issues (e.g. pollinator protection). Other areas identified as forces to drive the increased need for IR-4 include consumer demand for locally grown, pick your own or organically grown specialty crops. There is also anticipation that there will be emerging pest management technology (e.g. RNAi) that will require IR-4's assistance for registration on specialty crops/specialty uses.

4. Associated Knowledge Areas

KA Code	Knowledge Area
216	Integrated Pest Management Systems

Outcome #6

1. Outcome Measures

Protecting Human Health and Urban Environment through Integrated Pest Management Programs - Long Term - Protect commodities, homes and communities from pests. Increased abundance of high quality food and fiber products. Increased acreage in New Jersey grown under IPM practices. Reduced environmental problems associated with current pest management practices. A comprehensive understanding of best management practices for IPM that are economically viable and environmentally safe.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Protecting Human Health and Urban Environment through Integrated Pest Management Programs

In recent years, bedbugs have re-emerged as a major household pest. The recent resurgence of bed bugs in North America, Europe, Australia, and some Asian countries have signaled strongly the crucial need to develop effective methods to control urban pests to protect public and environmental health. Climate change, urban sprawl and growing populations make the spread of pests and pest-borne diseases increasing likely. The increased frequency and speed of travel enables pests to spread freely and quickly from area to area. Current pest control methods and tools often fail to provide adequate pest suppression, result in environment contamination, risks of human-insecticide exposure, or insecticide resistance development. For example, spraying insecticides on beds and sofas is a common practice for controlling bed bugs. Most bed bug populations in the U.S. contain at least one of the gene mutations related to insecticide resistance. As a result, insecticide spray alone is not effective in eliminating bed bugs. Some effective non-chemical control methods and tools became available; however, how to combine them into an effective and sustainable program requires understanding of the bed bug biology and ecology and characteristics of the infested communities. Adopting more effective pest control techniques will reduce pesticide use, human/pesticide exposure, and leads to more sustainable control.

What has been done
An NJAES Extension Specialist conducts both laboratory and field experiments to determine how bed bugs locate their hosts, spatial distribution patterns, and dispersal behavior. Experimental arenas and naturally infested residences are be used in these studies.

Results
A new and more effective bed bug lure was developed by NJAES and was transferred in 2014 to industry for commercial development. This lure can be used in conjunction with bedbug traps to attract, trap, and eliminate bedbugs resulting in a bed bug lure is now become commercially available for helping detecting bed bugs resulting in 85% bed bug elimination rate after 7 months after implementing various bed bug treatment programs in a community in Irvington, New Jersey, Hackensack Housing Authority (New Jersey) adopted a more effective bed bug monitoring and treatment program, bed bug infestation rate reduced by > 50% after 9 months and 90-100% reduction of German cockroach reduction after 3 months of treatment in a field comparison study.

4. Associated Knowledge Areas

KA Code	Knowledge Area
216	Integrated Pest Management Systems

Outcome #7

1. Outcome Measures

Improving Sustainability, Efficiency, and Efficacy of Peach Disease Management Strategies: Biofungicides, Conventional Fungicides, and Abiotic Environmental Factors - Long Term - Protect commodities, homes and communities from pests. Increased abundance of high quality food and fiber products. Increased acreage in New Jersey grown under IPM practices. Reduced environmental problems associated with current pest management practices. A comprehensive understanding of best management practices for IPM that are economically viable and environmentally safe.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Improving Sustainability, Efficiency, and Efficacy of Peach Disease Management Strategies: Biofungicides, Conventional Fungicides, and Abiotic Environmental Factors

Major diseases on peach and nectarine include brown rot blossom blight and fruit rot, scab, and bacterial spot. Each of these diseases, if not effectively controlled, alone can cause 100% crop loss when pathogen inoculum levels and environmental conditions are favorable for disease development. Other diseases, such as rusty spot and constriction canker can also contribute to significant yield loss if not managed properly. Unfortunately, disease-resistant cultivars are not commercially available for most peach and nectarine diseases. Even when resistant cultivars exist, such as for bacterial spot, rusty spot, and constriction canker, they are not available for all harvest periods, provide only partial resistance, do not have favorable horticultural characteristics, or are less marketable. Similarly, cultural disease control tactics are at best partially effective. Given the above, commercial peach growers are heavily dependent on the application of fungicides and bactericides for effective disease management. The cost of implementing such programs can be quite high. Furthermore, since most applications are timed according to tree phenology or on a calendar basis, many unnecessary sprays may be applied.

What has been done

NJAES researcher and Extension Specialist evaluated the efficacy of biofungicides for management of peach diseases and their integration into current disease control programs, with particular emphasis on brown rot and rusty spot. Determined the ability of new fungicides to control pathogen growth during different phases of the disease cycle to allow more effective deployment in peach disease control programs. Examined the influence of environmental factors on various components of the disease cycle for peach pathogens, with particular emphasis on peach scab. Successful novel disease control strategies discovered at the research level are presented to growers during local and regional meetings as well as during field days at the research center. These strategies are tested in large block studies in cooperation with commercial growers, thereby acting as demonstration sites for teaching all growers. Finally, new control approaches are relayed to growers via articles in newsletter(s) and/or grower journals.

Results

Sub-zero temperatures in January and February 2014 and a major hail storm in May 2014 caused considerable fruit loss in many of the experimental peach orchards. This limited the amount of field studies conducted and made statistical comparisons difficult to interpret. Nevertheless, promising results were obtained from several experiments in blocks that had below-normal but acceptable numbers of fruit. Unfortunately, low rainfall in August resulted in very low levels of the fruit rot phase of the disease for all treatments. Under these conditions, no differences were observed among treatments, including the non-treated control. With respect to research on conventional fungicides, a novel bioassay was developed for estimating fungicide residues on peach fruit. The intent of the bioassay was not to determine existence of residues on fruit ready for consumption (this can be done best with chemical tests), but rather to determine if sufficient residue exists to provide acceptable disease control. Once a fungicide is applied, many environmental factors such as sunlight and rainfall cause a gradual decline in the residue. The bioassay can be used to quantitatively determine how these and other factors degrade the residue. Once these relationships are understood, growers need only apply fungicides when residues have diminished below an acceptable control threshold, rather than on a strict calendar basis. Using this "informed approach", fungicides are only applied when they are needed for protection against disease development, rather than routinely. In summary, all of these findings

related to use of biofungicides and improvements in application timing with the bioassay will allow current commercial peach growers to improve the efficiency and efficacy of their disease management programs. This outcome in turn will reduce costs and improve profitability. Furthermore, by substituting and incorporating biorational materials into their programs, conventional pesticide residues in the environment and on harvested fruit will be reduced, thereby benefiting the consuming public. Usage of biorational materials in the field will also reduce applicator exposure to conventional pesticides. Finally, proper deployment of conventional fungicide chemistries, as with the bioassay, will aid in limiting development of fungicide resistant strains of the various peach pathogens.

4. Associated Knowledge Areas

KA Code	Knowledge Area
216	Integrated Pest Management Systems

Outcome #8

1. Outcome Measures

Investigations into a New Invasive Species, Halyomorpha halys (Stal) (Hemiptera: Pentatomidae), A Potential Threat to New Jersey Agriculture - Long Term - Protect commodities, homes and communities from pests. Increased abundance of high quality food and fiber products. Increased acreage in New Jersey grown under IPM practices. Reduced environmental problems associated with current pest management practices. A comprehensive understanding of best management practices for IPM that are economically viable and environmentally safe.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Investigations into a New Invasive Species, Halyomorpha halys (Stal) (Hemiptera: Pentatomidae), A Potential Threat to New Jersey Agriculture

Halyomorpha halys (St?l) (Hemiptera: Pentatomidae), an introduced species from Asia, has the potential to become a major pest in ornamentals and is a pest in tree fruit in the Mid-Atlantic in the

United States. Halyomorpha halys has a wide host range including tree fruit, vegetables, and ornamental plants. In its native habitat, H. halys causes crop loss due to stippling, catfacing and bruising of plants and transmits a plant pathogen responsible for Paulownia Witches Broom. Overwintering adults emerge in early spring and is believed to complete one generation per year in the Northeastern United States. The extent of its spread and host range in the United States is known; however its range continues to expand. At the current time it is present in California, Delaware, Florida, Maryland, Mississippi, New Jersey, New York, Ohio, Oregon, Pennsylvania, Tennessee, Virginia and West Virginia.

What has been done
NJAES Extension Specialists conducted a nationwide survey for the presence of H. halys (BMS); evaluated the origin and distribution of H. halys in the United States using an analysis of Halyomorpha halys DNA; determined the most appropriate monitoring system for evaluating H. halys populations in agricultural and landscape systems; determined the importance of H. halys to mid-Atlantic tree fruit and soybean growers; and developed strategies to manage H. halys in agricultural and landscape systems.

Results
The results have revealed that BMSB has been detected in over 42 states, and in Canada and Europe. In the US, BMSB continues to cause severe agricultural damage in Mid-Atlantic States and is an increasing threat in an additional 5 eastern states and three western states. The project evaluated the use of pheromone traps baited with the recently USDA identified BMSB's aggregation pheromone. These data show that it is attractive to BMSB adults and nymphs throughout the season. It is expected that it will be available for use from commercial sources this spring.

4. Associated Knowledge Areas

KA Code	Knowledge Area
216	Integrated Pest Management Systems

Outcome #9

1. Outcome Measures

North Jersey Ornamental Horticulture Conference Turf Day Program - Long Term - Protect commodities, homes and communities from pests. Increased abundance of high quality food and fiber products. Increased acreage in New Jersey grown under IPM practices. Reduced environmental problems associated with current pest management practices. A comprehensive understanding of best management practices for IPM that are economically viable and environmentally safe.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
North Jersey Ornamental Horticulture Conference Turf Day Program

The landscape of NJ is comprised of 890,425 acres of turf, according to a 2001 Rutgers University study of the turf industry. Turf makes up 19% of the state's total acreage. Golf Courses, commercial properties and residential neighborhoods create a demand for professional turf management services. Professional turf managers care for 39% of the turf acreage. The 2,442 service providers who maintain commercial and residential properties contribute $400 million dollars in payroll and benefits to the state?s economy. They also contribute $691 million in cash expenditures. This competitive industry needs to be apprised of university research on best turf management practices to distinguish themselves from competitors and minimize the use of pesticides and fertilizers thus protecting our natural resources. The industry professionals who apply pesticides to turf, trees and ornamental plants are required to be licensed by the NJ Department of Environmental Protection (DEP). Professionals must participate in DEP approved recertification programs to keep their licenses. The recertification programs keep the professionals aware of current and proposed regulations, plant pest and disease issues and the safe and appropriate uses of pesticide products. Industry professional who apply fertilizers to turf must become certified fertilizer applicators to be in compliance with newly adopted state fertilizer regulations.

What has been done
Rutgers Cooperative Extension provides the industry with training and manages the professional certification program. The North Jersey Ornamental Horticulture Conference (NJOHC) has been serving the turf industry for 53 years. The main objective of the NJOHC is to promote the adoption of integrated pest management (IPM) practices by industry professionals. Adoption of IPM practices will reduce the amount of fertilizers and pesticides used on residential, commercial and public properties. The NJOHC is organized by a team of RCE faculty and program coordinators. The three day conference consists of Turf Day, Tree Day and Landscape Day. Each day features five lectures by Extension, industry and regulatory professionals. Speakers prepare and distribute handouts. Each year program evaluations are conducted. Topics are selected based on current events affecting the industry such as new regulations or climate changes and previous years program evaluations. To help professionals comply with the new fertilizer applicator laws, Rutgers NJAES Turf Specialist, gave a lecture on the fertilizer regulations that qualified certified fertilizer applicators with require continuing education credits.

Results

On the program evaluation (N=78), Ninety-five percent (95%) of the professionals will make more informed pest management decisions as a result of attending the conference. Important concepts learned were identified by participants as: NJ Turf Fertilization Application Requirements 87% (63) Calibrating Pesticide Equipment 74 % (58) Identifying White Grubs 72% (56) Managing Green Kyllinga Weed 70% (55) Selecting proper herbicide products 62% (49) Seventy-three (73) participants indicated that they have attended the North Jersey Ornamental Horticulture Conference in the past, and 76% changed pest management practices as a result of the training. Some examples of changed practices were: Making sure my employees are certified; Definitely more IPM and scouting work; Keeping fertilizer off sidewalks and driveways; Better awareness and careful handling procedures; Think twice before products are utilized; and Being more aware when making decisions about applying pesticides. Seventy four percent of the participants (74%) who had attended the conference in previous years indicated that their use of pesticide has been reduced as a result of attending the conference. ? 1-10% reduction: 15 professionals ? 11-20% reduction: 11 professionals ? 21-30% reduction: 6 professionals ? > 30% reduction: 12 professionals When asked if their businesses have saved any money as a result of the training program, 31 indicated yes, 9 no and 26 said the question was not applicable to them. When asked an opened ended question about how much is saved annually, responses ranged from $200 to $5,000 with a mode of $3,000 and percentages ranged from five to ten percent (5-10%). Fourteen participants answered the question. Professionals who attended the program in previous years (N= 71) were asked how the information presented at prior programs affected their business or career. Respondents indicated: 69 have been able to maintain their NJ Department of Environmental Protection Pesticide Applicator License. 62 practice IPM. 50 see improved communication with their customers. 49 use the information to train employees. 28 experienced an increase in sales. 11 indicated their attendance helped them get a promotion.

4. Associated Knowledge Areas

KA Code	Knowledge Area
216	Integrated Pest Management Systems

Outcome #10

1. Outcome Measures

IPM for Landscape Contractors - Long Term - Protect commodities, homes and communities from pests. Increased abundance of high quality food and fiber products. Increased acreage in New Jersey grown under IPM practices. Reduced environmental problems associated with current pest management practices. A comprehensive understanding of best management practices for IPM that are economically viable and environmentally safe.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
IPM for Landscape Contractors

In the northeastern counties there is a great density of people and thriving landscape and turf industries. There has been too much reliance on traditional chemical use for pest management, and high nitrogen and phosphorous fertilizers used unnecessarily. Often the chemicals are applied at the wrong time and without good reason. This poses risks to water quality in streams and lakes, and many environmental indicators show the chemicals can pose health threats to humans and wildlife and ecosystems as a whole. It is clear that alternatives need to be used instead of traditional practices, and science needs to be applied. IPM tactics need to be taught and widely communicated. Our challenge is to educate all the landscape contractors, each of whom represents 25-75 residential and commercial properties, which accounts for hundreds of acres of landscapes.

What has been done
An RCE Agricultural Agent works with a small team of Agricultural Resources and Management Agents and program associates to design and deliver yearly training at the North Jersey Ornamental Horticulture Conference (NJOHC). The 3-day training is specialized to meet the needs of landscape and turf professional in the northeastern counties (Passaic, Essex, Bergen, Union, and Morris). This training program marks its 53rd year in 2014; and it remains popular and much appreciated by target clientele--meeting the changing needs of these large and growing industries. Over 600 professionals attended over the 3 days in 2014. The focus is on updating the attendees on new and emerging technologies and best management practices.

Results
Yearly evaluations provide important feedback, demonstrating changes in behaviors and adoption of new practices by clients. NJOHC evaluations in 2014 indicate that of 129 respondents: 108 believed they learned something new they can apply to their management practices and 104 believe they will make more informed pest management decisions as a result of the training. Of the 96 repeat attendees: 57 had reduced the amounts of chemical pesticides applied. They also reported greater use of IPM tactics on a regular basis. Additional Outcomes: 79 report maintaining their NJDEP pesticide applicator license; 83 report the training helped them to train employees; 82 report they had improved communication with their clientele; 82 report practicing IPM tactics on properties they manage.

4. Associated Knowledge Areas

KA Code	Knowledge Area
216	Integrated Pest Management Systems

Outcome #11

1. Outcome Measures

Management of Annual Bluegrass on Golf Courses: Improved Practices for Maintenance, Pest Control, and Viable Techniques for Transition to More Desirable Grasses - Long Term - Protect commodities, homes and communities from pests. Increased abundance of high quality food and fiber products. Increased acreage in New Jersey grown under IPM practices. Reduced environmental problems associated with current pest management practices. A comprehensive understanding of best management practices for IPM that are economically viable and environmentally safe.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Management of Annual Bluegrass on Golf Courses: Improved Practices for Maintenance, Pest Control, and Viable Techniques for Transition to More Desirable Grasses

Annual bluegrass (ABG) is a highly invasive weed on golf courses where it frequently becomes the dominant species despite attempts to suppress it. As a result, superintendents usually resort to managing it rather than working to eliminate it in favor of more pest-tolerant bentgrasses. The annual bluegrass weevil (ABW) and anthracnose basal rot (ABR) disease, caused by the fungus Colletotrichum cereale, have become the most severe pests of ABG. Their control often depends heavily on pesticides. There is an urgent need to gain a better understanding of the biology, and pathogenesis of ABR, develop improved integrated pest management (IPM) tools for more effective pest management, learn how stresses affect ABG and its sensitivity to ABR, and how to either mitigate these stresses or find ways to transition to more desirable/sustainable grasses.

What has been done
NJAES Extension Specialists are developing new molecular tools to study C. cereale and the infection process and assessing the impact of nitrogen, cultivation and other cultural practices on ABR. The tolerance/resistance of ABG and bentgrass varieties to ABR are evaluated in the greenhouse and field. Cultural techniques (e.g., use of over seeding species; cultivation; soil

fertility), alone or in combination with novel biocontrols and herbicides to reduce/eliminate ABG in favor of more desirable turfgrass species are studied. Tolerance/resistance of ABG and bentgrass species varieties to ABR are evaluated in the lab and field.

Results
During 2014, Extension Specialists conducted a series of field-based investigations to determine how N fertility impacts the gene expression of C. cereale and surrounding microorganisms. The complete transcriptome is being sequenced in this study to determine if C. cereale pathogenicity levels increase under low N fertility, and whether these pathogenicity levels correspond with disease severity. Two experiments on best management practices (BMP) affecting anthracnose disease on annual bluegrass determined that increasing nitrogen fertilization was the most influential and beneficial BMP. Further data analysis is needed to interpret interactions of sand topdressing with nitrogen fertiliy and mowing height.
A study assessing the impact of nitrogen fertilization and mowing height on fungicide inputs clearly indicates that fungicide inputs can be reduced if nitrogen fertility is increased and/or mowing height is increased. A study of potassium fertilization clearly indicates that low soil levels of potassium intensified anthracnose disease on annual bluegrass. Leaf tissue concentrations of > 2.0% potassium resulted in reduced anthracnose disease. A study of soil pH indicated that anthracnose disease is less severe when soil pH increases in the range of 5.2 to 6.8.
Turfgrass researchers at NJAES collected data from a trial to study the genetic ability of bentgrass to compete against annual bluegrass. Initial results indicate some cultivars of bentgrass can outcompete annual bluegrass. Results (Best Management Practice recommendations) have been distributed the golf course industry through research reports published by the United States Golf Association and TriState Turf Research Foundation. The most recent BMP recommendations are also posted on the Rutgers Center for Turfgrass Science website. We also present this information at national and local conferences. Adoption of this information by practitioners will result in reduced pesticide inputs, cost savings, and improved plant health.

4. Associated Knowledge Areas

KA Code	Knowledge Area
216	Integrated Pest Management Systems

Outcome #12

1. Outcome Measures

Integrated Pest Management/Pesticide Safety Education - Long Term - Protect commodities, homes and communities from pests. Increased abundance of high quality food and fiber products. Increased acreage in New Jersey grown under IPM practices. Reduced environmental problems associated with current pest management practices. A comprehensive understanding of best management practices for IPM that are economically viable and environmentally safe.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Integrated Pest Management/Pesticide Safety Education

Currently in New Jersey there are 15,000+ certified applicators registered with the New Jersey Department of Environmental Protection (NJDEP) - Pesticide Control Program. Of these, approximately 3,000 are private applicators. To remain certified New Jersey law requires that private and commercial applicators accumulate at least 12 hours of recertification training divided between CORE (4) and CATEGORY (8) classifications during a five-year period.

What has been done
Work was done to develop management strategies for use against the brown marmorated stink bug (BMSB) in vegetables and tree fruit. In addition, the vegetable IPM program was able to impact more acreage through the use of their website that tracks weekly European corn borer, corn earworm and BMSB population changes in the state. The vegetable and fruit IPM programs? faculty and staff also conducted research evaluating the impacts of the brown marmorated stink bug (BMSB) in their programs and participated the BMSB working group.

Results
The application of pesticide in the state is a safer operation that is being done in a manner that does not create a hazard to applicators, workers or the general public. As a result of this program, benefits were seen in the areas of fruit, greenhouse, nursery and vegetable production systems. The various programs were able to document the following benefits: Pesticide use in tree fruit was reduced up to 80% for Oriental fruit moth control. Growers in the vegetable IPM program received more timely information that resulted in less pesticide use, Nursery growers were better able to predict pest outbreaks and more effectively manage these outbreaks, Greenhouse growers were better able to manage pests and reduce insecticide and fungicide use because of the scouting program provided by the greenhouse IPM program. Growers were able to effectively manage BMSB in tree fruit and vegetables. Overall, IPM adoption in the state was seen on ~7,000 acres of blueberries, 500 acres of nursery stock, 10 greenhouse acres, 8,600 acres of peaches, 2,500 acres of apples, 100 acres of peaches and 27,500 acres in vegetables (carrots, cole crops, high-tunnel tomato production, pumpkins, peppers, snap beans, staked tomatoes, sweet corn, and sweet potatoes).

4. Associated Knowledge Areas

KA Code	Knowledge Area
216	Integrated Pest Management Systems

Outcome #13

1. Outcome Measures

Analyzing Bat Guano for Brown Marmorated Stink Bugs and Other Agricultural Pests - Long Term - Protect commodities, homes and communities from pests. Increased abundance of high quality food and fiber products. Increased acreage in New Jersey grown under IPM practices. Reduced environmental problems associated with current pest management practices. A comprehensive understanding of best management practices for IPM that are economically viable and environmentally safe.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Analyzing Bat Guano for Brown Marmorated Stink Bugs and Other Agricultural Pests

Fruit production is one of the leading agricultural industries in the state of New Jersey, with the value of utilized production of the four major crops (apples, peaches, blueberries, and cranberries) estimated at approximately $150 million per year. Pest control is a major challenge for fruit growers in New Jersey, especially those considered to be sustainable (and non-chemical), is seen as a high priority. The brown marmorated stink bug (Halyomorpha halys) (BMSB), which is resistant to many insecticides and interrupts IPM strategies for other pests.

What has been done
Our specific objectives for the project are to: 1) to document the presence of agricultural insect pests in bat guano; 2) compare their populations at farms with and without resident bat colonies; and 3) link peaks in insect pest abundance with peaks in bat foraging activity. Our primary target is the BMSB, and our secondary targets are codling moths, Oriental fruit moths, and tufted apple

bud moths.

Results
We have successfully identified brown marmorated stink bug in the fecal matter of bats, and we can infer that they consistently consume BMSB throughout the season, even when trap counts indicate low activity. We are now running statistical analyses to extrapolate from our dataset the expected number of BMSB a colony of bats will consume across the growing season. Impacts from this project include: 1. potential reduction in pesticide application 2. Improvement of environmental quality 3. Maintenance of IPM strategies for other insect pests 4. Promotion of bat conservation 5. Our molecular assay can be used as a surveillance tool for BMSB in at-risk areas.

4. Associated Knowledge Areas

KA Code	Knowledge Area
216	Integrated Pest Management Systems

Outcome #14

1. Outcome Measures

Blueberry and Cranberry Insect Pest Management - Towards the Development and Implementation of Reduced-Risk - Long Term - Protect commodities, homes and communities from pests. Increased abundance of high quality food and fiber products. Increased acreage in New Jersey grown under IPM practices. Reduced environmental problems associated with current pest management practices. A comprehensive understanding of best management practices for IPM that are economically viable and environmentally safe.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Blueberry and Cranberry Insect Pest Management - Towards the Development and Implementation of Reduced-Risk

The blueberry and cranberry industry in New Jersey suffers major yield losses due to insect pests. Growers rely heavily on insecticides to manage pest problems.

What has been done
The Blueberry/Cranberry Entomology Program at Rutgers University focused on the development and implementation of cost-effective reduced-risk insect pest management practices in blueberries and cranberries and the dissemination of this information to blueberry and cranberry growers. Several methods of information transfer including annual grower meetings, field days, twilight meetings, newsletters, and electronic media are used to serve the blueberry and cranberry industry in New Jersey. Newsletter articles (30) were published throughout the growing season to provide information on pest management and to update findings on new pesticides. Educational sessions (4) were regularly offered in Atlantic and Burlington Counties. These sessions provided an overview of research progress and future work. More informal twilight meetings (3) were held during the growing season to provide seasonally-relevant pest management information. Summer sessions (2) directed to the community (local schools and senior institutions) were also conducted regularly during the growing season. The research program also delivered presentations at meetings to the scientific community.

Results
Developed and implemented new tools for monitoring insect pest populations in blueberries and cranberries, ?Worked with IR-4 on the registration of new insecticides in blueberries and cranberries, ?Evaluated, implemented, and promoted adoption of new reduced-risk strategies for insect control in blueberries and cranberries, ?Delivered presentations to more than 100 New Jersey blueberry and cranberry growers on the use of new insect pest management practices. These strategies are reduced-risk and have had a positive impact on the environment and the well-being of humans and their communities.

4. Associated Knowledge Areas

KA Code	Knowledge Area
216	Integrated Pest Management Systems

Outcome #15

1. Outcome Measures

Insect Biochemical Defenses Against Toxic Compounds - Long Term - Protect commodities, homes and communities from pests. Increased abundance of high quality food and fiber products. Increased acreage in New Jersey grown under IPM practices. Reduced environmental problems associated with current pest management practices. A comprehensive understanding of best management practices for IPM that are economically viable and environmentally safe.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Insect Biochemical Defenses Against Toxic Compounds

Chemical control has so far successfully controlled mosquitoes in NJ. However, continued use of any insecticide increases the risk of resistance evolution in stressed populations. It is, thus, very important to monitor populations for potential resistance development. Epidemic outbreaks of mosquito-transmitted diseases occur with some frequency worldwide because vector control fails due to insecticide resistance. Although it is still possible to control salt marsh mosquitoes in New Jersey with the available insecticides, these mosquitoes possess a high potential for evolving resistance when the selection pressure increases because of a continually diminishing choice of compounds that can effectively be used in insecticide rotations.

What has been done
This research deals with Eastern Salt Marsh Mosquisito, Aedes sollicitans and a lepidopteran, the Southern Armyworm, Spodoptera eridania. Aedes sollicitans is a major bridge vector of the eastern equine encephalitis virus between birds and mammals. Large swarms of blood-seeking Ae. sollicitans can kill young livestock by exsanguination. Despite being extremely urbanized, vigorous agricultural activities are found in NJ. Lepidopterous larvae can severely damage fruits and vegetables, the commonest types of agricultural practices in NJ. S. eridania is not a problem in NJ but serves as a model system for developing strategies and techniques; it has a life history similar to the Fall Armyworm (Spodoptera frugiperda), which is a pest in NJ, especially in sweet corn. Insecticides, being a valuable resource, must be used effectively, in small doses, causing no resistance evolution, and not impeding non-target species. One major aspect of resistance to synthetic insecticides, addressed by this project, is the metabolic defenses of target insects, especially cytochrome P450s and esterases. (The other major constituent of insecticide resistance that this project does not address is insensitivity in the molecular target sites.) The project focuses on problem-solving research and outreach by being a component of the instructional programs of the Department of Entomology as well as interfacing with NJ salt marsh mosquito control activities as performed by the NJ State Mosquito Control Commission and mosquito control agencies in each NJ county. This research contributes valuable information to relevant stakeholders in NJ and abroad.

Results
The toxicity of spinosad and pyriproxifen is governed in the mosquito larvae by their ability to detoxify the compounds with their cytochrome P450 enzymes. The methoprene toxicity is counteracted about equally by the cytochrome P450 and esterase activities in the mosquitoes. This was confirmed by in vitro assays with cell free preparations from the mosquito larvae with

model substrates, the insecticidal compounds, commercial synergists and standard inducers. Data such as these and more of the same kind suggest that insect control with synthetic insecticides can be very much improved from current practices. Applications of much lower concentrations than are currently used will be possible and should be implemented as soon as possible to reduce the environmental damage done by massive, area-wide insecticide applications. Researchers also studied purified enzyme proteins of the cytochrome P450 oxido-reductase, an auxiliary enzyme essential for cytochrome P450 action, in larval mosquito tissues and reconstituted in an E.coli system. The eventual results of this work can lead to the development of more effective insecticide blends and to more effective insecticide synergists, perhaps even to the introduction of local population with R-genes (resistance genes) or Interference-RNA.

4. Associated Knowledge Areas

KA Code	Knowledge Area
216	Integrated Pest Management Systems

Outcome #16

1. Outcome Measures

Internet Technologies for Distance Education: Online Pesticide Training and Recertification for Licensed Professionals - Long Term - Protect commodities, homes and communities from pests. Increased abundance of high quality food and fiber products. Increased acreage in New Jersey grown under IPM practices. Reduced environmental problems associated with current pest management practices. A comprehensive understanding of best management practices for IPM that are economically viable and environmentally safe.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Internet Technologies for Distance Education: Online Pesticide Training and Recertification for Licensed Professionals

Modern life has constrained available time audiences can afford to attend traditional seminars, workshops, and other outreach programs. At the same time, licensed professional pesticide applicators require new, efficient and timely delivery systems to provide easy access to educational information and regulatory updates leading to a more successful licensing and re-certification procedure.

What has been done
Rutgers NJAES enhanced teaching, research and outreach efforts with the use of new technologies in digital media and the Internet to provide quality research-based information to help resolve critical issues facing agriculture, urban and rural communities, and the environment. Distance education efforts utilizing enhanced communication linkages reach existing and under-served clientele groups by facilitating distribution of research-based findings, educational opportunities, and regulatory updates. This project team developed a web site, www.recert.rutgers.edu, dedicated to training and providing licensure recertification credits on the proper use and storage of pesticides and the selection, use and storage of personal protective equipment. In so doing, this site provides 2 (two) CORE license recertification credits for commercial growers and applicators in NJ. Two separate modules are currently available for viewing and provide CORE (general pesticide safety) recertification credits for NJDEP licensed applicators and additionally for licensed applicators in NY, PA, and MD.

Results
2014 activity for online CORE recertification credits through www.recert.rutgers.edu totaled 45 commercial applicators attaining 90 CORE credits, for a program total of 590 online commercial applicators since the site launched in 2002. Pre- and post-evaluative questionnaires and online survey results reveal: ?85 % indicate a high level of satisfaction with the website design and content. ?90 % strongly agreed the convenience of taking an online course was important to them. ?80 % stated that the website provides a necessary learning experience in addition to the recertification credit. ?Users were most knowledgeable in utilizing materials to neutralize spills (97% correct) and locking storage facilities (94% correct) before completing the web site. ?Users most improved their knowledge in pesticide storage and inventory regulations (a 30% increase in evaluative survey scores) and signage regulations regarding language (a 22% increase in evaluative survey scores) after viewing the website.

4. Associated Knowledge Areas

KA Code	Knowledge Area
216	Integrated Pest Management Systems

Outcome #17

1. Outcome Measures

Field Crop Observational IPM Training for Master Gardener Volunteers - Long Term - Protect commodities, homes and communities from pests. Increased abundance of high quality food and fiber products. Increased acreage in New Jersey grown under IPM practices. Reduced environmental problems associated with current pest management practices. A comprehensive understanding of best management practices for IPM that are economically viable and environmentally safe.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Field Crop Observational IPM Training for Master Gardener Volunteers

Currently there is no official NJAES Field and Forage Crop IPM program. Field and forage crop producers are in need of current and relevant IPM information during the growing season. IPM scouting reports are one method that farmers learn of pest management issues within the region. Unfortunately, for some farmers the cost and time associated with obtaining IPM information is prohibitive.

What has been done
A master gardener crop scout training was established to teach master gardeners how to scout commercial field crops for pests. The trained volunteers primarily use observational ipm scouting. The training focused primarily on field crop production, pest management, and diagnosing insitu field problems. The on goin program was again continued in 2014 with 14 volunteers (5 new participants and 9 returning volunteers). The group of master gardeners was provided 3 hours of weekly hands on IPM field training over a 26 week period. Participants were initially provided with 3 hours of classroom training about the basics of IPM. IPM insect monitoring traps were placed across a farm. A small lab was established with a microscope, insect collecting equipment and reference books. The training was primarily focused on observing various agronomic groups from planting till harvest. During this time, participants where taught how to scout and identify pests within the various crops. Crop production and management practices were observed and explained to participants to provide a greater understanding of how agricultural commodities are produced. The objective of the project was to train Master Gardener volunteers as field and forage crop IPM scouts. An additional objective is to increase the insect and disease identification skills of the master gardener participants. The overall goal of the program is the collection of useful and relevant IPM data that could be shared with the agricultural community. The information collected from the scouts has been shared with the field and forage crop community via the NJAES Field and Forage Crop Blog. Additionally a master gardener IPM scout blog has been developed to share information gathered and learned through the program with other master gardeners. In 2014, a field day was also initiated to educate the public and community

gardeners about IPM techniques.

Results
Survey data was collected from the master gardener program participants. Master Gardener participants in the program all reported that they have significantly increased their knowledge of insect and disease pests. All participants reported a greater understanding and appreciation of agricultural production. Data has begun to be collected on the use of the newly established Master Gardener blog. Since its inception over 6,300 visits have been recorded at the IPM blog site. Over the last three growing seasons Master Gardener participants have provided over 1,800 volunteer hours, valued at over $46,000 to the newly established program. Communications with agricultural stakeholders have indicated the information provided by the program has been useful. Attendance at the programs first field day was recorded at 45 participants.

4. Associated Knowledge Areas

KA Code	Knowledge Area
216	Integrated Pest Management Systems

Outcome #18

1. Outcome Measures

Blueberry Integrated Pest Management Delivery - Long Term - Protect commodities, homes and communities from pests. Increased abundance of high quality food and fiber products. Increased acreage in New Jersey grown under IPM practices. Reduced environmental problems associated with current pest management practices. A comprehensive understanding of best management practices for IPM that are economically viable and environmentally safe.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Blueberry Integrated Pest Management Delivery

Blueberries are a unique agricultural commodity, since they are one of only several native foods in commercial production in the US. In New Jersey most blueberries are grown in the ecologically sensitive ?New Jersey Pinelands?, which is characterized by porous soils with high water tables, which are subject to vertical movement of a number of agricultural chemicals. This area is a source for much of the surface and shallow ground water found in the southern and central part of the State, and encompasses the Cape May, Rancocas, Great Egg Harbor, Mullica, and the Barnegat Bay watersheds, home to over 2.6 million people. The pest complex on blueberries is extensive, with pests attacking virtually all parts of the plant (e.g., fruit, buds, leaves, roots, stems, and flowers) and pest management requiring up to 12 pesticide sprays per year.

What has been done
An integrated pest management (IPM) program was delivered to commercial blueberry growers. The program employed seasonal field scouts who collected weekly pest management data. The program reached all blueberry growers in New Jersey, but collected farm specific data on those farms participating in the scouting program. Results of scouting data were summarized in 2 statewide newsletters (The Blueberry Bulletin and The Plant & Pest Advisory-Fruit Edition ?Now on a Web Blog format). Results were also transferred to growers with farm visits, seasonal update meetings, and a broadcast fax system. The program collected data on insect and disease pests as well as fertility levels through soil and plant tissue sampling. Based on the scouting results, pesticide recommendations were made to all growers, within the objectives listed above. A research/demonstration component demonstrated and refined the use of alternative pest management practices such as the use of trapping methods for determining treatment timings for blueberry maggot, and mating disruption for Oriental beetle. Growers participated in an IPM program, and maintained high fruit quality while minimizing pesticide use. In 2014, this included 43 growers who grew 5,000acres of blueberries or about 66% of the state acreage, and about 75% of the state production. Growers were taught about monitoring and management of spotted wing drosophila. An investigation was carried out to determine optimum trap types. Fruit was surveyed to assess fruit quality and SWD infestation rates. An industry wide survey was continued on the impacts by SWD on the NJ blueberry industry.

Results
Growers cooperated with the program in the use of new detection, monitoring and sampling methods that reliably predict pest levels. Growers were educated about novel management methods for a variety of pests in blueberries. Through demonstrations, articles, county reports and other outreach, public awareness on IPM was improved. Articles appeared in 2 newsletters with 44 editions (printed and web versions), with over 2,250 subscribers (including mail and web blog subscriptions). Newsletters on the Web recorded over 7,000 views or downloads. Growers minimized on farm pest management costs. Some growers spent as much as $250/A for pesticides while the average IPM participant spent $140/A. The average grower using IPM practices saved about $100/A. New pest management practices such as mating disruption and whole farm GIS based monitoring were used. Small plot research/demonstration trials for Oriental beetle mating disruption continued to show that Oriental beetle could be managed with mating disruption in place of soil applied insecticide. Based on our research and demonstration work, a registration package is now finished, and commercial use started in 2013. IPM training of students and farm employees created new IPM interns, professionals and researchers. The program trained 4 students and seasonal workers, and 1 farm employee as IPM scouts, enabling the 66% of NJ blueberry acreage to be under IPM practices, and an additional 16% of NJ acreage to be self-scouted. Fertility monitoring leads to recommendations of lower fertilizer use. During

2014, 286 samples were taken for combined monitoring of plant fertility and nematode levels. Soil and plant fertility tests demonstrated that about 75% of fields sampled had sufficient to high levels of soil phosphorous. In 2012, the spotted wing drosophila developed as a serious invasive pest in blueberries nationwide. While this is a serious threat to IPM programming, we made adjustments in 2014 to help protect the blueberry industry while minimizing conventional OP and carbamate insecticide use. While non-managed fields showed over 175 maggots per qt of berries, no fruit rejections were reported by IPM participants. While insecticide applications averaged just over 11 applications per field, OP and carbamate use was minimized to 55% of total applications.

4. Associated Knowledge Areas

KA Code	Knowledge Area
216	Integrated Pest Management Systems

Outcome #19

1. Outcome Measures

Upland Fruit (Tree Fruit and Grape) Integrated Pest Management (IPM) Delivery - Long Term - Protect commodities, homes and communities from pests. Increased abundance of high quality food and fiber products. Increased acreage in New Jersey grown under IPM practices. Reduced environmental problems associated with current pest management practices. A comprehensive understanding of best management practices for IPM that are economically viable and environmentally safe.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Upland Fruit (Tree Fruit and Grape) Integrated Pest Management (IPM) Delivery

New Jersey tree fruit production is located in both southern and northern counties. According to the latest agricultural statistics, NJ peach production is valued at $39.6 million and apples at $28.5 million. The industry in southern counties is heavily oriented towards wholesale markets and peach production, while the industry in northern counties is heavily dependent on direct

markets and apple production. Retail market fruit production in northern counties is valued at approx. $12-15 million. New Jersey fruit growers produce commodities that are susceptible to more than two dozen arthropod and disease pests. Management of this pest complex can cost producers up to $500 or more per acre. Some large NJ growers may spend up to $350,000 for pesticides alone.

What has been done
An integrated crop management (ICM) program was delivered to commercial fruit growers who produced apples, peaches, nectarines, and grapes. The program reached both primary and secondary participants. Secondary participants attend extension update meetings, and receive other IPM/ICM information through personal visits, fax broadcasts, articles, newsletters and the Internet. Primary participants are those growers who access all the above information and participate in a field scouting program. While some primary participants do self-scouting, the majority contribute funding through acreage participation fees which fund seasonal field scouts, travel, supplies, and laboratory costs. Weekly field scouting forms the program core and data source for newsletter articles, and from which pest management recommendations were made, with nutrition and nematode management included at specific times of the season. A broadcast fax service was used in Hunterdon and Gloucester Counties to advise of timely pest events and supplement the Plant and Pest Advisory Fruit Edition Newsletter. Organized grower meeting contact reached a total of 784 audience members, while on-farm consultations totaled 1,238 visits. The Plant and Pest Advisory Newsletter was changed to a blog format on the Web. A total of 31 weekly articles were written in that format, with a total circulation of 2067 subscribers in NJ and other states. Acreage impacted by primary participants totaled 80% of all state tree fruit acreage. Over 95% of total state tree fruit acreage was impacted by the program. IPM information reached over 90% of NJ grape growers.

Results
The program demonstrated reduced risk methods that included the use of mating disruption and ground cover management as tools to replace insecticide use for Oriental fruit moth, tarnished plant bug and stink bugs and two species of peach tree borers. Degree-day pest phenology models were updated, and proper use was advised to growers. Pesticide use records were collected at the end of the season to measure the program impact on pesticide use. Demonstrations were conducted on commercial farms to encourage use of alternative practices. Alternative practices include use of mating disruption and reduced risk pesticides. In southern counties, where the bulk of commercial peaches are produced, 75% of growers used alternative, ?reduced risk? insecticides, and 80% of growers used reduced risk fungicides. In total, program participants reduced pesticide use by 26-80% compared to standard spray schedules, depending on the practices used. Other IPM practices included grower use of degree day based pest models, reducing insecticide use by 40% compared to standard calendar spray methods. Laboratory tests where completed in 2014 as part of the fertility component. Over 75% of areas sampled were shown have sufficient to excessive phosphorous levels, which led to decreased phosphorous use on those sites. The invasive insect, brown marmorated stink bug (BMSB) has set pest management programs back 30-40 years. A trial project conducted in 2012-14 demonstrated that growers could treat field edges while using mating disruption and ground cover management to reduce insecticide use by up to 75% compared to most commercial practices now being used for BMSB.

4. Associated Knowledge Areas

KA Code	Knowledge Area

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
- Public Policy changes
- Government Regulations
- Competing Public priorities
- Competing Programmatic Challenges
- Populations changes (immigration, new cultural groupings, etc.)

Brief Explanation

None to report.

V(I). Planned Program (Evaluation Studies)

Evaluation Results

NJAES research and extension outcomes related to this planned program were evaluated utilizing a variety of evaluation methods appropriate for each initiative to determine effectiveness on both a qualitative and quantitative level. For KASA and practice change we included the measurement of knowledge gained as measured by pre/post Likert-scale assessments. Surveys were used to measure increase in skills acquired, behavior change and practice adoption. For process evaluation we focused on program delivery, participation, relevance and timeliness. Data was collected at appropriate times for each initiative that supports this planned program. IRB approved evaluation instruments were used to collect research and extension data. Data analyses and comparisons relevant to basic and applied research and demonstration were collected and analyzed and reported utilizing a variety of data collection methods appropriate to each research question. The major goal of evaluating is the demonstration of social, economic, behavior and environmental changes in conditions that contribute to improved quality of life as a result of participation in programs and benefits of research solutions. See state defined outcomes for detailed results of each initiative.

Key Items of Evaluation

None to report.