

V(A). Planned Program (Summary)**Program # 4****1. Name of the Planned Program**

Global Food Security and Hunger

 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			3%	
133	Pollution Prevention and Mitigation			4%	
135	Aquatic and Terrestrial Wildlife			4%	
201	Plant Genome, Genetics, and Genetic Mechanisms			4%	
202	Plant Genetic Resources			3%	
203	Plant Biological Efficiency and Abiotic Stresses Affecting Plants			3%	
204	Plant Product Quality and Utility (Preharvest)			7%	
205	Plant Management Systems			4%	
206	Basic Plant Biology			4%	
211	Insects, Mites, and Other Arthropods Affecting Plants			3%	
212	Pathogens and Nematodes Affecting Plants			8%	
213	Weeds Affecting Plants			4%	
216	Integrated Pest Management Systems			1%	
301	Reproductive Performance of Animals			12%	
302	Nutrient Utilization in Animals			7%	
305	Animal Physiological Processes			5%	
307	Animal Management Systems			14%	
311	Animal Diseases			3%	
701	Nutrient Composition of Food			2%	
903	Communication, Education, and Information Delivery			5%	
	Total			100%	

V(C). Planned Program (Inputs)**1. Actual amount of FTE/SYs expended this Program**

Year: 2012	Extension		Research	
	1862	1890	1862	1890
Plan	0.0	0.0	7.0	0.0
Actual Paid Professional	0.0	0.0	20.5	0.0
Actual Volunteer	0.0	0.0	0.0	0.0

2. Actual dollars expended in this Program (includes Carryover Funds from previous years)

Extension		Research	
Smith-Lever 3b & 3c	1890 Extension	Hatch	Evans-Allen
0	0	1091178	0
1862 Matching	1890 Matching	1862 Matching	1890 Matching
0	0	1426456	0
1862 All Other	1890 All Other	1862 All Other	1890 All Other
0	0	342079	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

NHAES scientists conducted applied and discovery research and undertook engagement with stakeholders in multiple aspects of plant and animal agriculture, related genetics and genomics, nutrition and health, and integrated aquaculture involving shellfish, finfish, invertebrates, and seaweed.

2. Brief description of the target audience

The target audience of this work includes consumers of animal and plant based foods and products, organic and conventional farmers, restaurants and other businesses reliant on local foods, master gardeners, home gardener associations, consumers and legislators, and those engaged in the extensive food systems network. It also includes scientists, veterinarians, agricultural researchers, Cooperative Extension specialists, agricultural teachers, graduate and undergraduate students, and the faculty and staff of the region's land grant universities.

3. How was eXtension used?

Farmers are referred to eXtension when the web site has information appropriate to their needs.

V(E). Planned Program (Outputs)

1. Standard output measures

2012	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	1994	1816	721	985

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

Patent Applications Submitted

Year: 2012

Actual: 0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2012	Extension	Research	Total
Actual	1	35	35

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number of undergraduate students directly involved in the projects

Year	Actual
2012	83

Output #2

Output Measure

- Number of graduate students directly involved in the research

Year	Actual
2012	61

Output #3

Output Measure

- Number of university courses in which project results have been incorporated

Year	Actual
2012	11

Output #4

Output Measure

- Number of presentations at regional, national, or international scientific meetings

Year	Actual
2012	0

Output #5

Output Measure

- Number of workshops, training sessions and presentations to non-scientific stakeholders

Year	Actual
2012	20

Output #6

Output Measure

- Number of reviewed, bulletin, popular and other publications

Year	Actual
2012	6

Output #7

Output Measure

- Number of websites in which project results have been incorporated

Year	Actual
2012	16

Output #8

Output Measure

- Number of surveys or other means of gathering information and data from participants

Year	Actual
2012	3

Output #9

Output Measure

- Videos produced to highlight agricultural issues or methods.

Year	Actual
2012	2

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Increased knowledge about plant production practices suited to the state and region.
2	New knowledge about dairy production, nutrition, animal health and dairy products important to regional producers.
3	Advances in squash varieties having enhanced nutritional benefits including carotenoid concentrations.
4	Increased knowledge about integrated multispecies aquaculture systems.
5	Improved juvenile growth in cod aquaculture.
6	Knowledge about fatty acid composition in pasture fed and total mixed ration fed Jersey cows, and in their milk.
7	New genomic knowledge translated into tools and strategies to facilitate varietal selection through marker assisted breeding.
8	New commercialized varieties of cucurbit vegetables suited to state and region growing conditions.
9	Improved range of weed management options available for sustainable and organic growers.
10	New NH leafhopper data available through a web-accessible database
11	A working technology to produce triploid green sea urchins for use in natural harvest and land based aquaculture.
12	Improve understanding of the components and evolution of the reproductive neuroendocrine system in fish to provide tools for enhancing finfish aquaculture.
13	Evaluate new approaches to improving pasture and the production of baleage for organic and conventional farms in Northern New England.
14	Improve methods to study reproductive physiology in cows.
15	Identification soil borne pathogens of regional crops and devising production methods to control disease.
16	Increase knowledge about variation of ozone tolerance among soybean varieties.
17	Determine the extent to which cryptic hybridization between blue mussel (<i>Mytilus edulis</i>) and bay mussel (<i>M. trossulus</i>) occurs in commercial culture of mussels in New England, and assess the impact of sleeve culture on mussel heterozygosity and growth rate.

Outcome #1

1. Outcome Measures

Increased knowledge about plant production practices suited to the state and region.

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)

-High and low tunnels are being widely adopted across the region to extend the growing season for vegetables and enhance the region's local food capacity.

-As advanced production practices, the incorporation of cover crops may provide new ways to improve soil and reduce weeds.

-Across New England, there is great interest in local sources of wheat and other grains leads to the need for identifying modern varieties which are suited to the region. However, the reintroduction of grain production in New England comes with the heightened risk of infestations of wheat rust, as this fungal pathogen is harbored by widespread ornamental barberry.

-Economic evaluation of new day-neutral strawberry varieties and production methods must be carried out prior to grower adoption in the Northeast.

What has been done

-Variety trials were conducted for high tunnel cucumber, tomato, zucchini, and summer squash. Low tunnels are being used to overwinter moderate cold tolerant vegetables (onions).

-Specialty crop improvement included the sourcing and evaluating of 60 spring wheat varieties and advanced breeding lines, 40 winter wheat varieties and advanced breeding lines, and 20 winter triticale elite lines for performance as novel food grain and alternative forage crops at the NHAES Kingman Farm.

-Two videos were produced: a technical training video on isolating cereal rust pathogens from barberry (*Berberis* spp.) and an educational video (broad audience) on the life cycle of wheat stem rust.

-The first season of a two-year study evaluating the comparative performances of matted-row and raised-bed plasticulture strawberry production systems was completed.

Results

-Variety trials of each vegetable's performance indicated their growth in high tunnels in Northern New England and provided essential information to growers who want to add these crops to their own high tunnel production. Results of cultivars trials were disseminated to farms and master gardeners through three day-long grower conferences, two field days, farmer-to-farmer discussions, as well as ten one-on-one consultations. In addition, results were shared with professionals at three scientific conferences, through one peer-reviewed publication, and through emailed research reports that targeted growers.

-Variety trials for wheat and triticale will be completed in FY13.

-Information about videos, available at www.youtube.com/globalrust, will be disseminated through NHAES and UNHCE.

4. Associated Knowledge Areas

KA Code	Knowledge Area
202	Plant Genetic Resources
204	Plant Product Quality and Utility (Preharvest)
205	Plant Management Systems

Outcome #2

1. Outcome Measures

New knowledge about dairy production, nutrition, animal health and dairy products important to regional producers.

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)

The research questions addressed by these projects emerged directly from organic and conventional dairy farmers in the region. If pasture-fed versus conventional dairies exhibited different nutrient composition in the milk each produces, this might demonstrate the added value of the pasture production and justify the higher cost of organic milk.

What has been done

NHAES scientists:

- evaluated milk production, milk composition, grazing behavior, markers of animal health (e.g., cortisol, antioxidant enzymes, etc.), nutrient digestibility, and nitrogen utilization in organic and conventional dairy cows fed kelp meal and flaxseed;
- evaluated and/or developed alternative feeding strategies to increase economic and environmental sustainability of organic and conventional dairy farms in the Northeast;
- determined whether pasture versus conventional, total mixed ration (TMR), influences the carotenoid content of bovine plasma or milk. (Carotenoids are essential nutrients for eye function.)

Results

- Incremental dietary levels of kelp meal did not improve animal performance, milk production or composition; however, the concentration of milk iodine increased linearly in response to incremental dietary levels of kelp meal. Notably, kelp supplements caused milk iodine levels to approach toxic levels for children.
- Incremental dietary levels of ground flaxseed linearly decreased dry matter intake, yields of milk and milk components, and methane emissions. Despite the positive response of ground flaxseed on mitigating methane emissions, decreases in milk yield may discourage farmers from feeding flaxseed, particularly in high levels (i.e., 15% of diet dry matter).
- Cutting red clover at sundown for baleage resulted in dry matter concentration of approximately 46% but did not preserve nonstructural carbohydrates; these were reduced by about half during fermentation. However, baleage quality appeared to be improved resulting in forage with enhanced nutrient digestibility as compared to red clover harvest at sunrise.
- Results showed that total carotenoids were significantly higher in milk from cows fed on pasture than conventional dairy total mixed ration (TMR); however, milk carotenoids levels varied over seasons in organic milk.

4. Associated Knowledge Areas

KA Code	Knowledge Area
301	Reproductive Performance of Animals
302	Nutrient Utilization in Animals
305	Animal Physiological Processes
307	Animal Management Systems
311	Animal Diseases
701	Nutrient Composition of Food

Outcome #3

1. Outcome Measures

Advances in squash varieties having enhanced nutritional benefits including carotenoid concentrations.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2012	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Acorn, buttercup/kabocha and butternut are the three most important classes of winter squash in North America. Good eating quality has been problematic in varieties of acorn, thus reducing consumer demand in retail markets. Most of the popular commercial varieties have nice appearance, but produce low starch and sugar content. Winter squash varieties vary in the composition and amount of carotenoid pigments, which are important nutrients for vision.

What has been done

NHAES researcher Loy has bred several F1 hybrid squash and evaluated the hybrids for eating quality, resistance to powdery mildew, and in collaboration with colleague Curran-Celentano, improved nutritional value (e.g. higher carotenoids).

Results

- Several F1 hybrids of winter squash show markedly enhanced eating quality, improved nutritional value and resistance to powdery mildew.
- One of these hybrids, Honey Bear, is now offered by several seed companies and another is scheduled for commercial production by a New England-based seed company.
- This past year, UNH hosted a field day at the Kingman experimental farms for growers to observe new experimental hybrids in pumpkins and squash. Cooperative Extension helped publicize the event which was successful; we plan to initiate more field days in the future to demonstrate new breeding results.
- Current efforts to promote new varieties of high quality acorn squash involve articles in trade magazines, newsletters disseminated by Cooperative Extension, and better variety description in seed catalogs.

4. Associated Knowledge Areas

KA Code	Knowledge Area
202	Plant Genetic Resources
204	Plant Product Quality and Utility (Preharvest)
205	Plant Management Systems
701	Nutrient Composition of Food

Outcome #4

1. Outcome Measures

Increased knowledge about integrated multispecies aquaculture systems.

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)

While aquaculture is essential to ease the demand on wild fish stocks, it may have negative impacts on water quality and depends too heavily on fish-meal diets derived from wild harvested fish. The adoption of integrated multi-trophic aquaculture offers a sustainable alternative to intensive monoculture. Seaweeds and oysters could utilize waste products from finfish and sea urchins, increasing the economic potential of integrated multi-trophic aquaculture while minimizing the environmental impacts. The goal of this project is to develop integrated, multi-species aquaculture systems suited for New England which includes sea urchins, oysters, various indigenous seaweeds, seaworms, cod, northern NE species of marine baitfish (striped bass, bluefish, smelt).

What has been done

- The sea urchin hatchery produced one run of juveniles and tested a refinement of immediate introduction of fertilized eggs,
- The American oyster culture compared growth of seaweeds proximate to or distant from oyster culture cages.
- The finfish component of the project focused on determining ammonia production from fish, urchins, and sea worms.
- The seaweed project established cultures from wild-collected specimens of five native red seaweeds to remove nutrients from animal aquaculture effluent. Nutrient uptake has been examined in relation to nutrient concentration in the aquaculture system.

Results

- The major findings thus far for each portion of the project have led to refinements in experimental design and overall focus.
- Initial trials with warm water culture of European oysters and bait worms have been positive and will lead to their integration with black sea bass in the coming year.

-The information on ammonia production by sea bass, as well as sea urchins and bait worms, will be used to quantify the number (mass) of fish for recirculating integrated multi-trophic aquaculture systems.

-Intraspecific genetic variation was identified in the red alga *Porphyra umbilicalis*. This genetic variation will be exploited to improve the use of this red alga in multi-trophic aquaculture.

4. Associated Knowledge Areas

KA Code	Knowledge Area
133	Pollution Prevention and Mitigation
205	Plant Management Systems
302	Nutrient Utilization in Animals
307	Animal Management Systems
903	Communication, Education, and Information Delivery

Outcome #5

1. Outcome Measures

Improved juvenile growth in cod aquaculture.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2012	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Aquaculture is becoming an increasingly important industry to supplant declining wild fisheries; however, desirable species such as summer flounder exhibit premature sexual maturation in aquaculture, which reduces their growth rate. Summer flounder females grow much faster than males, so methods to control differentiation in sexually dimorphic species would improve production rates in aquaculture.

Genistein and related flavones from soybean may influence sexual development in finfish.

What has been done

Immature summer flounder were fed increasing amounts of the flavone genistein from soybean. Histological studies were conducted to determine the impact of treatment on sexual

differentiation.

Results

Moderate levels of genistein (100mg/kg) caused 96% of summer flounder to differentiate as females compared to 19% of control fish. This treatment should increase productivity of summer cod in recirculating aquaculture systems. Results were disseminated to local fish farmers.

4. Associated Knowledge Areas

KA Code	Knowledge Area
307	Animal Management Systems
903	Communication, Education, and Information Delivery

Outcome #6

1. Outcome Measures

Knowledge about fatty acid composition in pasture fed and total mixed ration fed Jersey cows, and in their milk.

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)

There is increased concern in the US about the way food is produced and for the welfare of farm animals. The milk from pasture-fed dairy cows is known to have healthier ratios of omega 3 to omega 6 fatty acids and conjugated linoleic acids than that of conventional dairies where animals are confined to barns and fed total mixed rations (TMR). However very little is known about the relative health status of dairy cows in the two production systems.

What has been done

General and specific markers of health were measured for Jersey cows at the UNH Organic Dairy Research Farm (ORDF) and the UNH Fairchild Dairy, a conventional dairy. These markers included: body weights; body conformation scores; somatic cell counts; and levels of various biomarkers including cortisol (stress hormone), haptoglobin (anemia), fibrinogen (clotting), and white blood cell counts (infection). Comparisons were made within each group over time and

between groups over time.

Results

-Cortisol levels, a stress hormone, at each of three time points during pasture season were significantly higher in the pastured cows as compared with those in the conventional system and varied significantly between time points within each farm. The temperature-humidity index was recorded and cortisol levels trended with the index in pastured cows but not those kept under more controlled conditions indoor at the conventional farm. The mild winter and other factors exacerbated an infestation of flies at the ORDF in 2012; these and the lack of shade were added environmental stressors compared to confinement barns in the conventional dairy which are equipped with cooling fans.

-Haptoglobin levels, which are correlated with hemolytic anemia, were not significantly different between groups but had a higher average and greater variability in the conventional group and showed significant differences within groups over time.

-Somatic cell counts, an indication of mastitis, were not significantly different between groups at either time point, but had a higher average and greater variability in the conventional dairy Jerseys.

4. Associated Knowledge Areas

KA Code	Knowledge Area
302	Nutrient Utilization in Animals
305	Animal Physiological Processes

Outcome #7

1. Outcome Measures

New genomic knowledge translated into tools and strategies to facilitate varietal selection through marker assisted breeding.

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)

Commercial strawberry varieties are octoploid; each plant has eight sets of chromosomes. Plants

grown from seed segregate for many traits, hence, commercial strawberries are clonally propagated. However these clonal plants carry much higher viral disease loads. Alternative approaches for strawberry improvement include mapping important quantitative traits in diploid progenitors and using detailed molecular maps to facilitate marker-assisted breeding in commercial strawberry.

What has been done

- A core breeding population of 1000 pedigreed strawberry plants and 200 hybrids was generated.
- An international consortium, including NHAES researchers, has mined the genome sequence of diploid strawberries to identify polymorphic markers for mapping and marker-assisted breeding.

Results

- NHAES researchers assisted in the construction of the first genetic linkage map in diploid strawberry.
- NHAES researchers assisted in the design of the first strawberry single nucleotide polymorphism (SNP) microarray, for use in marker-selected breeding.
- Using this microarray, and a second mapping population, NHAES researchers have identified new quantitative trait loci (QTLs) that influence two important agronomic traits: flowering habit and fruit color intensity.
- Genetic sources of resistance to Verticillium dahlia, a fungal pathogen of strawberry and mint, have been identified. Once mapped, these genes will be transferred to commercial strawberry with the use of marker-added breeding.

4. Associated Knowledge Areas

KA Code	Knowledge Area
201	Plant Genome, Genetics, and Genetic Mechanisms
204	Plant Product Quality and Utility (Preharvest)
205	Plant Management Systems
212	Pathogens and Nematodes Affecting Plants

Outcome #8

1. Outcome Measures

New commercialized varieties of cucurbit vegetables suited to state and region growing conditions.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
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2012

0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

-Agricultural regions growing squash and pumpkin for processing have considerably shrunken over the past three decades, mostly because of marginal profitability of the crop. In addition currently popular production varieties are susceptible to foliar and fruit rot diseases which have become problematic in production areas.

-NHAES researcher Loy, a premier breeder of cucurbits, has shown that interspecific hybrid varieties have higher yield, improved cooking qualities and potential resistance to soil borne pathogens.

-The appearance of abrasions and brown discoloration on the tender skin of yellow crookneck and straightneck squash in retail outlets severely reduces consumer demand for this vegetable. Glabrous spineless) varieties reduce injury to intact fruit from spiny stems and leaf petioles during windy weather, reduce fruit damage, and prevent skin irritation to workers during harvesting.

What has been done

-Interspecific hybrid varieties of winter squash from crosses of *Cucurbita maxima* (female parental lines) to *C. moschata* (male parental lines) were developed and compared to commercial varieties for growing characteristics and for processing.

- Seventy experimental hybrids and five commercial hybrid cultivars of ornamental pumpkin with intermediate powdery mildew resistance (PMR) were evaluated in single replicate, 10-plant plots. Most major size classes of pumpkin were represented, along with hybrids displaying new white and yellow rind colors.

-In melons, 37 experimental hybrids expressing a single gene trait, long shelf life (LSL), were compared to 7 commercial hybrids adapted to New England growing conditions and 23 short-season experimental hybrids not carrying the LSL trait.

-In breeding research on yellow summer squash conducted at the NHAES, a glabrous (trait has been incorporated into elite breeding lines and experimental hybrids.

-Three commercial hybrids and twelve experimental glabrous summer squash hybrids, some with PMR were evaluated for plant vigor, growth habit, fruit appearance and productivity.

Results

-F1 Hybrid *C. maxima* X *C. moshata* winter squash demonstrated hybrid vigor and increased yield. In part this is because their seeds are sterile, so photosynthetic energy is allocated primarily to the fleshy tissue of the squash rather than seed. Based on trials at UNH and with cooperating seed companies, six to ten of the hybrids included in the evaluation are being considered for commercial release.

-Based on evaluations at UNH experimental farms and elsewhere, one LSL melon hybrid is being slated for commercial production by a seed company in the Northeast.

-Yellow straightneck and crookneck summer squash varieties are less susceptible than the standard zucchini varieties to several diseases prevalent in New England; and so, the introduction of new yellow varieties which are easier to harvest and with better shelf appearance could dramatically expand acreage and demand for this important vegetable. One glabrous variety, Slick Pik YS26, of summer squash is currently being sold, and additional varieties are scheduled for release during the next two years.

4. Associated Knowledge Areas

KA Code	Knowledge Area
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202	Plant Genetic Resources
204	Plant Product Quality and Utility (Preharvest)

Outcome #9

1. Outcome Measures

Improved range of weed management options available for sustainable and organic growers.

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)

Growers in New Hampshire are interested in using cover crops to suppress weeds and reduce the need for economically and environmentally costly herbicides.

What has been done

- Previous related work has captured the interest of farmers who wish to reduce their reliance on herbicides for weed control. Input on the current project has been solicited at regional growers meetings.
- The research included growing different cover crops in monoculture or mixtures to assess the impact on cover crop production, weed growth, the suppression of weed emergence, and growth from the seed bank.

Results

- The ultimate goal of this research is to develop crop and weed management practices that are economically sustainable and do not pollute the environment.
- NHAES scientists have shown that buckwheat and tillage radish are particularly weed suppressive cover crop species when sown in the spring and fall, respectively. These results have been disseminated via UNH Cooperative Extension to local farmers.
 - The results suggest that cover crops grown in mixture are no more weed suppressive than the most suppressive monoculture, but that biomass production of cover crop displays over-yielding tendencies when grown in mixture.

4. Associated Knowledge Areas

KA Code	Knowledge Area
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102 Soil, Plant, Water, Nutrient Relationships
213 Weeds Affecting Plants

Outcome #10

1. Outcome Measures

New NH leafhopper data available through a web-accessible database

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2012	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

One hundred twenty eight leafhopper species are known to be vectors of different bacterial and viral disease. Except for in the Canadian Maritimes, no recent descriptions of the leafhopper species associated with agricultural crops are available for North America. The University of New Hampshire has a large and fairly comprehensive collection of New England leafhoppers, which is being leveraged against field collections to provide up-to-date information for extension agents and farmers.

What has been done

Leafhopper sampling, conducted in orchards and in vegetable and blueberry plots in south-central New Hampshire, involved organic, neglected, and managed farms. Comparison of leafhopper abundances and diversity were determined over two months, using different sampling techniques. These data were captured in a spreadsheet, and voucher specimens were placed into the insect collection.

Results

- Different collecting techniques were again shown to be differentially effective depending on the target leafhopper species.
- Potato leafhoppers are present whether farms are managed with chemicals or not, possibly due to immigration from peripheral areas, and can quickly become a major problem in organic farms. Potato leafhoppers are vectors of aster-yellows phytoplasma, those farms without cultivation or with a lack of herbicide strips, the insect vectors become extremely abundant and provide a serious threat to crops susceptible to these plant bacteria (phytoplasma).
- Recommendations were disseminated to growers with crops susceptible to aster-yellows

phytoplasma, including carrots and certain nursery crops.

-In the last year of this project (FY13), an online database of leafhoppers is being developed for use by extension agents and growers.

4. Associated Knowledge Areas

KA Code	Knowledge Area
211	Insects, Mites, and Other Arthropods Affecting Plants

Outcome #11

1. Outcome Measures

A working technology to produce triploid green sea urchins for use in natural harvest and land based aquaculture.

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)

Edible sea urchin fisheries are high value commercial enterprises on all coasts of the U.S. Processed sea urchin gonads (called uni) or whole urchins are sold in Japanese, American and other world markets. Alternatives to the direct harvest of wild sea urchins are vital to sustain this fishery that is the seventh largest in the Northeastern U.S. The aquaculture of sterile triploid sea urchins in near shore lease-sites will produce urchins with gonads that contain only nutrient storage cells called nutritive phagocytes (NPs), which are the preferred form of uni.

What has been done

Green urchins in the Gulf of Maine have three month reproductive period (December to late March) which constrains experimental work.

NHAES scientists expanded laboratory methodology to commercial levels in producing triploid sea urchins:

- transplanted juvenile triploid urchins in a Hatchery environment and
- identified and trained undergraduates for experiments scheduled during the next reproductive season.

Results

- Animals were collected at the aquaculture study site and provided for laboratory studies for triploid production.
- The hatchery produced one batch of juvenile urchins and these juvenile urchins were cultured under several feeding and density regimes in preparation for culturing of triploid embryos and larvae in the coming year.
- Phytoplankton cultures are established and the hatchery is ready to begin culture of triploid larvae as soon as they are available.

4. Associated Knowledge Areas

KA Code	Knowledge Area
307	Animal Management Systems

Outcome #12

1. Outcome Measures

Improve understanding of the components and evolution of the reproductive neuroendocrine system in fish to provide tools for enhancing finfish aquaculture.

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)

There is a need for a better understanding of the neuroendocrine system and how the hypothalamus of the brain regulates puberty. This information may be applied to improve finfish aquaculture by delaying puberty and increasing juvenile growth.

What has been done

- NHAES researchers participated in the genome sequencing and annotation of the sea lamprey, one of the two surviving lineages of ancestral fish.
- A variety of approaches were used to identify different components of the reproductive neuroendocrine system in the sea lamprey and black sea bass.

Results

- The major findings from the NHAES researchers' studies include the distribution of an estrogen receptor in the brain of lamprey, the identification and function of a novel gonadotropin-inhibiting

hormone and a PQRamide hormone (RFamide peptides), the cloning and pharmacological characterization of two novel Gonadotropin-releasing hormone (GnRH) receptors in the lamprey, and the identification of two GnRHs in the black sea bass brain.

-Comparative genomics provide evidence to support the hypothesis that major brain circuits and underlying molecular machinery regulating reproduction were established at the beginning of the vertebrate radiation, and are still present in lampreys. This area of study is significant because these more complex mechanisms in later-evolved vertebrates arose through elaborations of the basic architecture that is present in lampreys today.

4. Associated Knowledge Areas

KA Code	Knowledge Area
301	Reproductive Performance of Animals
305	Animal Physiological Processes
307	Animal Management Systems

Outcome #13

1. Outcome Measures

Evaluate new approaches to improving pasture and the production of baleage for organic and conventional farms in Northern New England.

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)

The cost of organic feed grains has steadily risen over the past several years, prompting organic dairy farmers in our region to look for alternatives to imported grain. The diversification of pasture resources may provide opportunities to extend the grazing season, buffer forage production against climate variability, and increase the production of on-farm feed grains.

What has been done

Researchers at the University of New Hampshire are investigating the effects of multi-cultivar forage mixtures and feed-grain intercropping systems on forage production and stability. Stakeholder input is sought through advisory board meetings associated with a related, externally-funded project that is focused on organic dairy and discussed at farmer field days and

grower meetings.

Results

Preliminary NHAES research results suggest that forage grass production can be enhanced when grown as multi-cultivar mixtures. The project interfaces with UNHCE, as it is associated with another externally-funded project that has a large extension/outreach component.

4. Associated Knowledge Areas

KA Code	Knowledge Area
204	Plant Product Quality and Utility (Preharvest)
213	Weeds Affecting Plants

Outcome #14

1. Outcome Measures

Improve methods to study reproductive physiology in cows.

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)

Impaired reproduction is the major cause of reduced productivity and profitability for dairy and meat producers. NHAES scientists participated in a multistate research project to identify genetic, morphological, and physiological attributes of the ovaries of ruminants (cows, sheep) with the overall goal of improving fertility in these animals. One objective is to understand the physiology of subtypes of endothelial cells (EC) within the bovine corpus luteum (CL). EC cells contribute to the vasculature of the ovary and are important to the maturation and release of eggs, a critical process in fertility.

What has been done

-In collaboration with investigators from Penn State, NHAES scientists developed new methods of isolating high numbers of luteal-derived EC cells from whole tissue homogenates and of cryopreserving these EC cells.

-In addition, NHAES scientists refined methods to isolate and culture EC cells, which were used

to advance investigations of their roles in ovulation.

Results

-The new methods of isolating and culturing EC led to greater knowledge about the complex mechanisms that drive the development and maintenance of EC. These involve known factors that promote the development of vasculature (angiogenic factors), such as matrix metalloproteinases (MMPs) and the tissue inhibitors of metalloproteinases (TIMPs).

-Notably, a possible new player, called CCN1, was identified in the development of blood vessels(angiogenesis) that not been previously described to be present in the bovine follicle and the CL. CCN1, an angiogenic inducer, was more highly expressed in the early stage of follicle growth, in developing CL rather than in the mid cycle and late stages of follicle development.

-Further experiments are now possible to determine the interplay between CCN1 and known angiogenic factors during the transition of the ovarian follicle to the progesterone-producing CL.

4. Associated Knowledge Areas

KA Code	Knowledge Area
301	Reproductive Performance of Animals

Outcome #15

1. Outcome Measures

Identification soil borne pathogens of regional crops and devising production methods to control disease.

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)

Soilborne pathogens are a diverse group of pathogens that reduce plant emergence and infect plant roots and crowns. The result is reduced plant productivity, increased costs to the grower and potential ecological damage to the adjacent natural environment.

What has been done

NHAES researchers characterized isolates of *Rhizoctonia solani* a fungus associated with 'damping off' of various crop seedlings.

Results

-NHAES researchers established that there are three distinct anastomosis groups of *Rhizoctonia solani* that are capable of infecting wheat; members of an anastomosis group are able to vegetatively fuse and potentially reproduce sexually. These anastomosis groups likely represent individual species. This knowledge will have an impact on growers and industry and academic researchers as they move forward in developing chemical, biological, and cultural control strategies for all three distinct pathogens, which were previously believed to be a single species.

-NHAES researchers determined anastomosis group AG2-1 of *R. solani* infects both canola and wheat; crop rotation with wheat and canola will likely lead to reduced yield due to infection by this fungus. This is an important finding as wheat is currently recommended for rotation with canola to reduce the incidence and severity of Sclerotinia stem rot and Blackleg of canola.

4. Associated Knowledge Areas

KA Code	Knowledge Area
212	Pathogens and Nematodes Affecting Plants
216	Integrated Pest Management Systems

Outcome #16

1. Outcome Measures

Increase knowledge about variation of ozone tolerance among soybean varieties.

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)

-Ozone is a major environmental stressor of crop plants. In order to develop plants that are tolerant of ozone, we must understand the biochemical and physiological effects of ozone on plants and their interaction with the genetic background of plants.

- Polyamines (putrescine, spermine, spermidine) are thought to be biomarkers for abiotic stress.

What has been done

Activities were collaborative with Dr. Kent Burkey of North Carolina State University. He treated several soybean cultivars in open top chambers with varying levels of ozone (25- 120 parts per

billion). Ozone treated plants were analyzed for polyamine content in Minocha's lab at the NHAES.

Results

- There are strong correlations between cellular polyamines and the tolerance of certain genotypes to ozone.
- Low levels of constitutive polyamines were correlated to low tolerance to ozone.
- Enhanced accumulation of polyamines (generally by 3 to 5-fold) was found to be a component of resistance to O₃.
- Interestingly, increases in polyamines less than 3-fold or more than 10-fold were not protective to ozone damage.

4. Associated Knowledge Areas

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

Outcome #17

1. Outcome Measures

Determine the extent to which cryptic hybridization between blue mussel (*Mytilus edulis*) and bay mussel (*M. trossulus*) occurs in commercial culture of mussels in New England, and assess the impact of sleeve culture on mussel heterozygosity and growth rate.

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)

Blue mussel (*M. edulis*) is part of a species complex with bay mussel and Mediterranean mussel. Species identification is primarily based on morphometric features of the shell; however these features are highly plastic under different environmental conditions (wave exposure, salinity, position in the intertidal). Further the three species readily hybridize. The shell of bay mussel is more fragile than that of blue mussel, whereas hybrids have intermediate fragility. Mussels attach to rope culture through byssal threads. Managers of mussel aquaculture facilities are concerned

about the extent of natural hybridization.

What has been done

-Wild mussels of various size classes were collected from the Coastal Marine Lab Pier (CML) and from the Wentworth by the Sea Marina (WSM). Rope-cultured mussels were obtained from Pemaquid Mussel Farm (PMF).

-DNA has been extracted from all samples and because PMF mussels exist in the region with another mussel, their species identity has been confirmed using a molecular marker.

-Mussels were characterized for growth rate, for cryptic hybridization and heterozygosity (genetic diversity) using various molecular markers.

Results

-Less than 0.01% of rope-cultured mussels were found to be *M. trossulus* (bay mussel), and no *M. edulis* x *trossulus* hybrids were found.

-Cultured mussel heterozygosity correlates negatively with mussel size, indicating a loss of heterozygous individuals over time.

-Preliminary data suggest that more byssal threads are produced during the winter by epibiont (barnacles)-covered mussels exposed to lower wave action. Similarly, effluents of crab predators and injured mussels elicit an increase in byssal thread production but effluents from sea stars, sea urchins, and lobsters had no influence.

4. Associated Knowledge Areas

KA Code	Knowledge Area
135	Aquatic and Terrestrial Wildlife

V(H). Planned Program (External Factors)

External factors which affected outcomes

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

Brief Explanation

Dramatic reductions in state appropriations to the University System and NHAES forced the station to decrease the size of the conventional dairy herd and number of the farm support staff; budget cuts also reduced the funds available to individual research projects. This slowed progress on many research projects. An unusually warm winter, with limited snow cover (2012), led to increased problems with ticks, flies, and other insects and resulted in mild drought conditions that impacted some field research.

V(I). Planned Program (Evaluation Studies)

Evaluation Results

The primary criteria for productivity for projects covered in this planned program are a robust record of peer-reviewed publication. Projects in this planned program produced 32 peer reviewed papers as well as five graduate theses, and five book chapters.

Multiple (14/29) NHAES projects have strong coalitions with UNHCE, assuring stakeholders are kept up to date with research outcomes.

Key Items of Evaluation

The NHAES director initiated an annual education session at the NH Farm and Forest Expo, the premier statewide conference for the state agricultural and forestry community. The event provides an opportunity for stakeholders to learn about ongoing research and provides NHAES with feedback from those stakeholders.