Maine Agricultural and Forest Experiment Station
Annual Report of Accomplishments and Results
Based on the Plan of Work Report

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Hatch and Multistate Research Funds

Maine Agricultural and Forest Experiment Station
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OVERVIEW OF PLANNED PROGRAM AREAS

Goal 1—An agricultural system that is highly competitive in the global economy

Maine farmers are stewards of 1.42 million acres of land. The agricultural system in Maine directly contributes more than $1 billion annually to the state's economy and further stimulates the economy by associated banking, transportation, retail, and service activity. Natural resources are central to the export-based economy. Maine's unique geographic properties with 4,500 miles of tidal coastline, glacial soils and a northern climate ideal for growing a number of plants and crops and yet containing a land base that is nearly 90 percent forested, offer unique challenges. Potatoes, wild blueberries, lobsters, and specialty food products are all exported to other states and throughout the world. Farming systems must meet market demands for high-quality products and allow agricultural products to be produced profitably, while preserving environmental quality and the health and safety of Maine's people.

To achieve a highly competitive agricultural system, Maine must produce high-quality crops and products. To do this, Maine's producers need better disease and pest prevention strategies, new crop varieties, new harvesting management techniques, new value-added products, and access to new markets. These are all areas in which researchers at the Maine Agricultural and Forest Experiment Station (MAFES) are working for the people of Maine. Following is a highlight of this year's accomplishments:

- MAFES entomologists continued testing effects of combining different commercially available insecticides with newly synthesized Colorado potato beetle kairomone.
- MAFES scientists continued research on the evolutionary biology and molecular phylogeny of important plants, *Amelanchier, Picea,* and *Betula papyrifera.* These plants are significant to the ecology of northern landscapes, to wildlife as sources of food and shelter and to people as sources of fiber, wood, and horticultural specimens.
- Taking a physiological ecology approach, MAFES entomologists developed mathematical models to predict summer fly emergence and onset of oviposition. This model has been incorporated into existing management decision making for growers that allows optimal timing for the deployment of blueberry fly traps.
- MAFES researchers found that intranasal vaccination with attenuated *Salmonella typhimurium* may safely stimulate nasal and uterine immune responses in horses.
- Using mice as a model, MAFES animal scientists are investigating the effects of hypothyroidism on reproduction efficiency in dairy cattle.
- MAFES research found that large amounts of antibodies against bacterial fish pathogens can be humanely produced by immunizing SPF hens and harvesting the antibodies from the egg yolks. These antibodies can be used for diagnostic and therapeutic purposes.
- In a study of *Salmonella enteritidis* infections of commercial egg-layer poultry house, MAFES research found that conventional cleaning and disinfection procedures could not be relied on to completely decontaminate commercial egg layer poultry houses. Complete removal of organic matter and 1-2 week drying of surfaces after use of water, whether alone, with detergents or disinfectants, helped consistently to reduce contamination

levels. This information should help farmers, epidemiologists and regulatory agencies in reviewing risk-reduction methods against *Salmonella enteritidis*.

- MAFES researchers developed a multiplex PCR for the detection of members of the potato virus Y (PVY) complex. They also developed and tested "molecular padlock probes" for PVY, and developed PCR probes for potato mop top virus (PMTV).
- MAFES scientists developed a reverse-transcriptase polymerase chain reaction (RT-PCR) assay for detecting and distinguishing both the North American and European strains of infectious salmon anemia virus (ISAV). ISAV is a serious pathogen of Atlantic salmon aquaculture in North America and Europe.
- MAFES researchers are testing whether a genetic vaccine can prevent both infection and the formation of the carrier state in fish challenged with infectious pancreatic necrosis virus.
- MAFES research on fungicide control of pink rot confirmed that several fungicides effective on potato specifically for late blight control (*Phytophthora infestans*) are not adaptable for *P. erythroseptica* treatments. However, one material labeled for in-furrow use in control of *Rhizoctonia* may provide partial control of pink rot.
- MAFES researchers continued their participation in a multistate project that is developing new potato varieties with improved pest resistance and marketability for potato growers in the eastern United States. These new varieties are expected to improve grower profitability by improving yields, market quality, and/or decreasing costs associated with pests.
- As a result of research conducted by the University of Maine Cooperative Extension, the Maine Agriculture and Forest Experiment Station, and others throughout the U.S., a new variety of apple has been identified as having an excellent fruit quality and high appeal to consumers. The Honeycrisp apple is shown to be well adapted to Maine’s climate and can potentially increase profitability by $8 per bushel at wholesale and $18 per bushel at retail.
- The results of MAFES research on diets for marine larval fish indicate good growth and survival of Atlantic cod larvae using an experimental microparticulate diet with reduced amounts of Artemia.
- MAFES food scientists developed and evaluated four wild blueberry and soy beverage formulations. Although the beverages had high anthocyanin levels and antioxidant activity, consumers only found one formulation to be acceptable.
- MAFES researchers looking for ways to add value to seafood byproducts demonstrated that crab mince and soy protein isolate can be used in the production of a calcium-supplemented snack food that taste-testers found acceptable.
- MAFES economists performed a price analysis for the potato rotation crops canola and soybeans. This soybean/canola price-forecasting model will be a useful tool for the emerging potato rotation crops industries.
- In a survey of the attitudes of Maine consumers toward locally grown foods, MAFES economists found that more than 50 percent of respondents consider it "very important" to purchase Maine-grown foods. Respondents generally viewed local foods to be of high quality.
- MAFES economists conducted baseline cost-of-production studies for the dairy industry and derived baseline cost-of-production estimates for the production of an alternative aquaculture species, haddock.

- As part of a multistate project looking at the effect of globalization on local food systems, MAFES economists have found that more food is being imported into the US from Canada at lower real prices. Theses results show that local food suppliers will need to adjust their marketing strategies to compete against these increased imports of food product.

Scientist years:	19.4
Hatch Funds:	$650,000
Multistate Research Funds:	$345,000
State Funds:	$3,572,000
Total Funds:	$6,178,000

Key Theme—Ornamental/Green Agriculture

) To prevent depletion and possible extinction of wild plants and to produce quantities of native plants for horticultural trade, practical and commercial feasible methods of propagation are necessary. A DNA profile should be established for these native plants and new garden plants. MAFES researchers are exploring potential garden plants from Maine, trialing new garden plants (from other places) for Maine landscapes, and developing effective propagation methods for these plants. The researchers are working with *Rudbeckia hirta* L., 'Plainview Farm', a new double-flowered cultivar, to better understand its production for potted flower plants, especially height control. They are also investigating optimum phosphorus concentrations for *Scaevola aemula* R.Br. (fanflower), a new ornamental plant from Australia, which produces stunted growth when fertilized with high concentrations of phosphorus. To make sure that nurseries sell plants that retain their quality after sale, MAFES researchers are developing fertilizer recommendations for New Guinea Impatiens and Ivy Geranium, both top-selling hanging baskets in New England.

) Impact—New plants are new blood for ornamental industry. However, understanding how to grow new plants is the key issue to the success. Growth regulators and fertility management are important factors for new plant production. MAFES research has found that to produce better potted plants, growth regulator should be applied to *Rudbeckia hirta* L. 'Plainview Farm'. They also found that reducing the amount of phosphorus fertilizer applied to *Scaevola aemula* produced better growth in cool climates. To keep high quality (better performance) after sale (at the hands of customers), MAFES research showed that slow-release fertilizer should be applied. One nursery indicated that a full-charged hanging basket could be sold for $3 to $5 more than a less full basket, while the extra cost was less than $0.50 per basket. Obviously, better application of growth regulators and fertilizers produced better plants and better plants generated more money and brought back more customers.

) Source of Federal Funds—Hatch, Multistate

) Scope of Impact—Multistate research with CTH, CTS, DE, ME, MD, MA, NH, NJ, NYG, NYC, PA, RI, VT, WV, USDA/ARS

Key Theme—Aquaculture

) Aquaculture and fisheries businesses in Maine rarely have the resources to provide in-house engineering services or hire consulting engineers, and frequently approach the University for engineering assistance. This can involve feasibility studies, construction of prototypes, or laboratory testing. Problems needing in-depth attention are developed into separate projects and may be the subject of application for external funding. MAFES researchers responded to the ever-changing needs of Maine's various aquacultural industries, designing a hydraulic dredge, a can-turning device, lobster gear that would help prevent whale entanglements, new filtration material, a tidal upweller for shellfish culture, and a floating lobster nursery. They also conducted experiments on the effects of vitamin-supplemented diets on hardness of post-molt lobster shells and conducted a major investigation of the impact of Japanese shore crab, a recently identified invasive species, on larval lobsters.

) Impact—These rapid-response engineering projects have contributed to the economic viability of Maine's aquaculture, fisheries and seafood processing industries. The nutritional and physiological research on live lobster storing and shipping has identified several potential improvements in procedures for the industry. The filtration research resulted in a new biofilter material with excellent commercial possibilities. The optimization of tidal shellfish upwellers was successful and the results were well received by the oyster industry. The work on submersible mussel rafts has already attracted much attention in light of recent intervention at permit hearings and a resulting refusal to grant permits to floating rafts on navigational grounds. The Asian shore crab experiments were of great interest to the state but unfortunately there is little to be done to prevent the continued invasion. However, experiments like this have contributed to the national interest in the problem of transport of invasive species in the bilge, or ballast water of cargo vessels, and legislation to try to prevent, or at least reduce, further invasions. The lobster industry continues to be under threat due to entanglements of whales, particularly the Right Whale. Any research into the actual physical damage from different types of lobster line may provide information on the least aggressive line material.

) Source of Federal Funds—Hatch

) Scope of Impact—State specific

Goal 2—A safe and secure food and fiber system

Food production and processing is important in several key sectors in Maine: dairy, fisheries, potatoes, and wild blueberries and other fruits and vegetables. Food safety in these areas is an important concern to producers and consumers. Researchers in the Maine Agricultural and Forest Experiment Station have continued working on food-handling and processing technologies aimed at extending shelf life of product and preventing food-borne risks. MAFES scientists have continued investigating consumer food preferences and testing crops for pesticides residues. All this work helps ensure that the people of Maine have a high-quality, safe food supply and that Maine growers and producers remain competitive in the face of changing consumer demands.

In the past year to meet Maine's performance goal to develop technologies and methods to assure access to a safe food supply for Maine people, MAFES researchers accomplished the following:

- MAFES researchers found that the incorporation of 5%, 10%, and 15% wild blueberry powder into raw ground beef patties stored at 3.5 C resulted in a significant reduction in levels of a four- strain cocktail of *E. coli* 0157:H7, which was inoculated onto patties prior storage.
- For Maine's wild blueberry industry, MAFES scientists evaluated alternative herbicides and methods of application that will reduce the industry's reliance on an herbicide that is found in the groundwater.
- To ensure Maine's food and water are safe, MAFES scientists are developing methods to test for pesticides in the environment and on food, with a focus on the insecticide phosmet. Phosmet is an organophosphate insecticide used widely in Maine apple and wild blueberry production. It has a relatively high acute toxicity and is used in close proximity to the habitat of the endangered Atlantic salmon.
- MAFES food scientists have begun a survey of Maine's milk supply for aflatoxin M1, using a commercially available immunosorbent column to extract the toxin from milk.
- To increase the quality shelf life and potential marketability of Maine seafood, MAFES food scientists are developing coatings using crab shell chitosan, which can be applied to frozen seafood products.
- A MAFES analysis of demand for finfish species that are being developed for aquaculture production in Maine will provide information useful to the industry in the development of haddock grow-out and marketing plans in terms of production and market timing.

Scientist years:	1.7
Hatch Funds:	$113,000
Multistate Research Funds:	$10,000
State Funds:	$227,000
Total Funds:	$368,000

Key Theme—Food Safety

a) The blueberry maggot fly is the most important pest of commercially grown wild blueberries in eastern North America. Markets for fresh, canned, and frozen fruit have either a near-zero or zero tolerance level for infestation. This pest poses a serious threat for Maine's wild blueberry growers. Six hundred Maine growers harvest 61,000 acres of wild blueberries, averaging 74.5 million pounds annually. Maine wild blueberries comprise 63% of the North American crop and 47% of the world wild crop. Wild blueberries contribute nearly $100 million to the state's economy, primarily within poor, rural areas. There is a need to devise and to improve rapid and non-destructive methods and technology for assessing levels of blueberry maggot infestation in wild blueberries. MAFES researchers scanned approximately 2,797 wild blueberries and added this information to their spectral database. The spectral database now includes berries harvested during three seasons in different stages of ripeness, different cultivars, sizes,

cultivation areas, cultural practices, color, as well as fresh and frozen samples. Preliminary analysis of 2004 spectral data show consistent prediction ratio of 80-85%, which is similar to results from previous years. Researchers also carried out experiments involving comparison between fresh and frozen wild blueberries, and preliminary results from 2004 show that freezing does not lead to a significant decline in prediction ratio, non-significant differences of 1% to 7% exhibited between fresh and frozen wild blueberries. To determine the detection limit of the method based on maggot size, the scientists built prediction models by selecting spectra with maggot size within certain limits. Their results suggest that berries with maggots 2 mm and longer can be classified equally well. Classification is significantly lower, however, for berries with smaller maggots. This detection limit is similar to the detection limit of the standard method of boiling used currently for infestation detection. The researchers' preliminary results show that there is good potential for increasing the ratio of infestation classification and improving the basic linear discriminant models.

) Impact—The result of this research will be an expanded spectral database of individual NIRS (infested and non-infested) blueberry images, which will then be used with models for discriminating and classifying infested wild blueberries and in the design and evaluation of an in-process line detection system. The ability to detect infestation at the processing plant will allow growers and processors more flexibility with blueberry management decisions. In addition to providing an in-line maggot detection system, the development and demonstration of this type of capability would expand into assessing overall fruit quality and afford processing plant managers with a method to select and separate fruit of varying quality, thereby optimizing their blueberry revenue stream. This ability would enhance profitability of these small processing firms and in a larger sense, the rural areas of Maine impacted by blueberry production.

) Source of Federal Funds—Hatch, Multistate

) Scope of Impact—Multistate research with CA, GA, HI, IN, ME, MD, MI, NY, NC, PA, WA

Goal 3—A healthy, well-nourished population

Under Goal 3, the Maine Agricultural and Forest Experiment Station set for itself the performance goal of improving nutrition for all Maine people, especially the elderly and teen population. Improving the nutrition of young people is important because it is during youth that people acquire and consolidate eating patterns and develop lifelong attitudes toward food. Many diseases that affect us later in life are caused in part by poor eating habits. The nutrition of the elderly is important as Maine's population ages and more seniors are living into their eighties and beyond.

In this human nutrition program area, MAFES researchers are carrying out research projects that will lead to the development of a knowledge base that can be used by clinicians, cooperative

extension, public school administrators and teachers, and social service agencies to improve the nutrition of all Maine people. Accomplishments this year include the following:

- MAFES research on the nutritional aspects of wild blueberries has found that wild blueberries affect the biomechanical properties of arteries by decreasing the maximum force developed by the artery when challenged with the stress hormone phenylephrine, and may thus be responsible for blood pressure regulation.
- As part of a multistate project, MAFES nutritionists continued working on ways to increase young adults' consumption of fruits and vegetables.
- MAFES research on calcium and vitamin D in adolescent girls indicates that rapid gains in bone mineral content suggest that puberty is a critical time for interventions to support optimal mineralization of bone.
- MAFES researchers are investigating the role of phytonutrients in health, which will help food processors to develop healthier foods and help health care providers to better advise their clients about healthy diets.

Scientist Years:	1.5
Hatch Funds:	$32,000
Multistate Research Funds:	$76,000
State Funds:	$206,000
Total Funds:	$396,000

Key Theme—Human Nutrition/Human Health

a) The extreme importance of fruit and vegetable consumption in the prevention of chronic diseases has emerged during the past five years. High intakes of fruits and vegetables are associated with decreased risk of chronic diseases, especially those related to oxidative stress. However fruit and vegetable consumption is low in many older adults. Identification of the components in food that confer protection is important. Assessment of nutrition status as related to low intake of fruits and vegetables, by the use of biochemical markers and dietary assessment tools, coordinated with the appropriate intervention and education strategies is imperative for decreasing disease risk in the elderly. MAFES scientists studied the absorption of antioxidants and the effect on platelet aggregation from consumption of a high-dose blueberry drink administered to six female adults after consumption of 1 cup of wild blueberries per day for two weeks. The freeze-dried blueberry powder provided 1424 mg anthocyanins and 39,904 mmol Trolox equivalents of ORAC (oxygen radical absorbance capacity—a test that measures the total antioxidant power of foods and other chemical substances). The women also acted as their own controls by having tests done after not consuming wild blueberries and consuming a high-fat drink without added blueberry powder. The researchers found the activities of serum peroxidase, arylesterase and RBC glutathione peroxidase were not changed following the consumption of wild blueberries for two weeks and administration of the blueberry beverage. Urinary excretion of antioxidants during the first four hours after consuming the blueberry drink was increased 30% to 80% as indicated by urine ORAC or FRAP (ferric reducing antioxidant potential). The researchers found that in vivo antioxidant status appeared to be improved with blueberry consumption due to the

increased density and/or absorption of antioxidants. However, altering in vivo plasma antioxidant status has proven difficult with foods high in anthocyanins because of their low absorption coupled with their short in vivo half-life. As part of this project the researchers also conducted a longitudinal nutrition risk assessment (2000-2002) of seniors age 60 or more participating in the Older Americans Act Title III meal programs in Maine using the National Nutrition Screening Initiative Determine Your Nutritional Health checklist and body mass index (BMI). Subjects were members of local Area Agencies on Aging who either went to congregate meal sites or had their meals home delivered. Significant differences in mean risk score between the longitudinal group and the total subject group did not exist over the three years, except for the year 2000. The mean risk score obtained was at a moderate risk level for the longitudinal group. Mean BMIs calculated showed that the average participant was overweight, but there were no significant BMI differences found between groups. Higher risk scores overall were found among participants who received home delivered meals versus participants who came to the congregate meal sites.

) Impact—This research shows that consumption of wild blueberries may have an anti-inflammatory effect of decreasing platelet aggregation. Additionally a lack of increase in nutrition risk over time (as measured by DETERMINE checklists and BMI) among elderly in the Nutrition For Seniors Program suggests this program is effective in maintaining nutritional health of Maine's seniors.

) Source of Federal Funds—

) Scope of Project—Multistate research with CT, DC, ME, MD, MA, NH, NY, RI

Goal 4—Greater harmony between agriculture and the environment

To achieve greater harmony between agriculture and the environment, MAFES scientists are working to protect soil and water quality, to preserve wetlands, to develop ecologically friendly waste management systems, to design sustainable agricultural systems, to develop biological pest controls, and to better manage our wildlife and other natural resources. The following are highlights of this year's accomplishments:

- Results of a MAFES analysis of watershed exports of carbon, nitrogen, and other nutrients in Maine rivers indicated that the study watersheds are large sources of soluble carbon and nitrogen, have variable exports of suspended sediments, and exhibit relatively low exports of soluble phosphorus.
- MAFES researchers studying *Ascophyllum nodosum*, an important seaweed harvested for its phycocolloids, food (fodder) and fertilizer properties, throughout the North Atlantic, have developed dispersal and recruitment methodologies for rockweeds that are being used by other marine algal and ecological research groups in North America and Europe
- Results of MAFES research on seepage lakes suggest that dissolved organic carbon (DOC) and true color in seepage lakes with stronger connections to wetlands, respond directly to climatic shifts over short (1 to 3 year) time scales.

- MAFES wildlife biologists documented the nature and frequency of seal predation at finfish aquaculture facilities in Maine and whether the severity of seal predation was related to the proximity of farms from one another and nearby harbor seal haul-outs.
- MAFES research on Black Terns and their habitat has implications for the management of large wetlands in Maine where this endangered species occurs and has provided information that will be essential for developing conservation strategies for the recovery of Black Tern populations in Maine.
- In a study on the role of small wetlands in the landscape, MAFES scientists assessed the role of aquatic, local forest, and landscape in determining breeding population size of wood frogs (*Rana sylvatica*) and spotted salamanders (*Ambystoma maculatum*).
- A MAFES scientist is chairing a group of fishermen, scientists, and community and government leaders engaged in the design of a fundamentally new approach to ocean fisheries management in New England. The fishery will rely upon new local governance institutions designed to assure local access and a strong sense of stewardship.
- In a study of cover-cropping practices, MAFES scientists are finding that soil quality differences between treatments are becoming more apparent each year. Soil quality testing in pre-tillage broccoli plots in 2004 showed that water-holding capacity increased as the intensity of cover cropping increased. At the same time, bulk density decreased in the intensely cover-cropped system, indicating an improved environment for root growth as compared to the conventional system.
- For Maine's wild blueberry industry, MAFES scientists evaluated alternative herbicides and methods of application that will reduce the industry's reliance on a herbicide that is found in the groundwater.
- In a study on fungal pathogens of lowbush blueberry, MAFES researchers found that mowed plots had significantly higher levels of leaf spot than burned plots in the prune year, but that the amount of fertilizer or sulfur treatment had no effect on level of leaf spot.
- MAFES scientists are investigating whether root length differs significantly between four rotation crops or between crops growing in manure-amended and unamended soil.
- MAFES soil quality research included a study of Polyacrylamide (PAM) as a soil amendment used to reduce soil erosion in agricultural fields. The results indicate that PAM additions to potato fields will reduce soil erosion and associated loss of soil organic matter.
- MAFES researchers have begun a study to screen cover crops for Maine with increased cold tolerance, as this has consistently been a weakness in promoting increased cover crop use in Maine.
- A MAFES project found that applying either paper fiber mulch or compost after the second hilling of potatoes helped conserve water. Gravimetric water samples reveal a 15% water savings with a thick mulch applied.
- Examining waste management issues for the state of Maine, MAFES economists are studying the technical and economic feasibility of using bioreactors in Maine. Bioreactors are entire landfills or landfill cells which recirculate leachate or otherwise increase the liquids in a landfill to foster faster materials biodegradation, reduce the volume of landfill space necessary, generate alternative energy and potentially reduce green house gas emissions.

- A MAFES study of conservation easements provides important information to decision makers in public agencies and private businesses on the benefits of protecting farmland from development. This information can be used to stimulate protection programs, identify how much land should be protected and the types of parcels that should receive the highest priority for protection.

Scientist years:	11.1
Hatch Funds:	$396,000
Multistate Research Funds:	$67,000
State Funds:	$1,536,000
Total Funds:	$2,900,000

Key Theme—Integrated Pest Management/Sustainable Agriculture

) Striped cucumber beetles and Colorado potato beetles are both important economic pests of Maine's vegetable crops. Current control practices for these insect pests depend largely on synthetic insecticide applications, but there is a recognized need for alternatives to the insecticide-based approach to insect pest management. MAFES researchers have been working to determine the sensitivity of adult striped cucumber beetles (SCB) to the allelochemicals (chemicals that are significant to individuals of a species different from the source species) azadirachtin, limonin, and amyrin and to determine the effects of attractants (semiochemical—chemicals that mediate interactions between organisms—and plant cultivars) and allelochemicals on SCB and Colorado potato beetle (CPB) field colonization, within field trivial movements, feeding, mating, oviposition, and dispersal to over-wintering sites. Additionally the scientists are determining the optimal timings, placement patterns, and dosages for the applications of the attractants and allelochemicals to best disrupt SCB and CPB field colonization, within field 'trivial' movements, feeding, oviposition, and dispersal to over-wintering sites. The researchers found no significant differences in egg mass and small larvae densities between plots bordered by attractant-treated trap crops and conventionally managed plots, but there were significantly fewer large larvae and adult beetles in conventionally managed plots than in plots bordered by untreated and attractant-treated trap crops. Plant canopy area of conventionally managed plots was significantly higher than in plots bordered by either type of trap crop.

) Impact—MAFES researchers found they could apply 44% less insecticide to plots bordered by attractant-treated trap crops without affecting the crop yield compared to conventionally managed plots. These preliminary results serve as a basis for further development of attracticide formulations for Colorado potato beetle control. Management of this important pest using naturally occurring behavioral chemicals offers a biorational alternative to conventional insecticides and may decrease the rate at which CPBs develop resistance to pesticides.

) Source of Federal Funds—Hatch

) Scope of Research—State specific

Key Theme—Endangered Species

a) Although the current distribution of Maine's two rarest mussel species, the yellow lampmussel and tidewater mucket, are well documented, conservation efforts are hampered by lack of knowledge of the fish hosts, population age and genetic structure, and effects of disconnected or deteriorating habitat quality on mussel distribution. MAFES researchers are looking at the factors that affect the distribution, population structure, and viability of these species in Maine to aid in their conservation. MAFES researchers have found significant differences in population genetic structure of yellow lampmussels and tidewater muckets between most populations in the three river drainages where these species occur in Maine. The scientists used these results to determine translocation sites for mussels that will be affected by the pending removal of the Ft. Halifax dam on the Sebasticook River. Range-wide taxonomy of these species confirmed that the yellow lampmussel and tidewater mucket are monophyletic species (a group of species that all have a single common ancestral species) throughout their Atlantic slope range from Nova Scotia to Georgia. Yellow lampmussels were found to hybridize with two congeneric (of the same genus) species; one in the Potomac River drainage in West Virginia and Maryland and another in the St. Lawrence River drainage in Vermont. Our results cast doubt on the taxonomic status of these congeners, suggesting that they may be conspecific. As a result of these taxonomic uncertainties and extensive hybridization, state and federal status of the target species, as well as of the congeners must be reevaluated for conservation planning. We are developing a DNA key to identify all 10 species of mussels in Maine. Potential fish hosts are being sampled at various field sites where yellow lampmussels and tidewater muckets occur. The DNA key will be used to identify glochidia larvae on fish gills, as larvae are difficult to identify to species morphologically. Following up on laboratory-based fish host experiments, we now plan to identify fish hosts actually used in the wild by this method.

b) Impact—These data will form the basis for a management plan in Maine for the tidewater mucket and yellow lampmussel—two species that are listed as threatened in Maine. The genetic analyses are already being used within Maine to help make decisions about translocations, as dams are being removed in the Kennebec River drainage. The range-wide taxonomic analysis will be valuable for developing a conservation plan at the federal level. These species are listed as threatened, endangered or of special concern in many states throughout their range, and the discovery of extensive hybridization in some regions will only add to their perilous conservation status.

c) Source of Federal Funds—Hatch

d) Scope of Research—State specific

Key Theme—Natural Resources Management/Wetlands Restoration and Protection/Soil Erosion

a) A significant portion of Maine's coastline is sheltered embayments occupied by estuarine ecosystems. All of the fresh water flowing to these estuarine ecosystems is from watersheds in which human land use has altered the upland landscape. However, there is

a paucity of research quantifying land use impacts to Maine's estuaries. With increasing inputs of nutrients from upland land use and pen aquaculture in the coastal zones, estuaries are experiencing significant losses in seagrass meadows. Seagrasses provide nursery habitat for economically important fisheries species. Once these rooted plants are gone, there can be mobilization of significant amounts of sediment from the estuary bottom. MAFES soil scientists have completed the soil genesis, morphology, and classification research for Taunton Bay, an estuary located in Hancock County, Maine. It exchanges water with Frenchman's Bay, the body of water north of Mount Desert Island. This bay is representative of the small estuarine embayments that are common along Maine's 4,800 miles of coastline. Researchers collected bathymetry measurements and water level (tide) data for the estuary and completed a bathymetric map of the Taunton Bay estuary. The bathymetric map was used to create the slope class map. Researchers used these maps, combined with aerial photo interpretation and field reconnaissance, to create the first drafts of the landform and soil maps. Researchers collected and analyzed soil samples and used the soil physical and chemical data to identify differences between submerged soils supporting the present vegetation and those soils where the eelgrass vegetation has died-off. While it does not appear that the soils are controlling the distribution of eelgrass, the researchers found that eelgrass cover seems to control the chemical as well as physical environment. In soils that have recently experienced eelgrass die-offs, the time since eelgrass loss is correlated with the presence and absence of particular ions in soil solution. In addition to developing a soil map, researchers completed a study of heavy metal contamination of estuarine sediments in Taunton Bay, identifying metals deposited in the bay at the time when mining for silver and copper was the major upland land use (1880-1910). The metal contamination was present in greater quantities and at greater depths than contamination from air pollution.

) Impact—One application of subaqueous soil survey maps created by MAFES researchers would be the identification of the best sites for seagrass meadow revegetation projects. A better understanding of the local seagrass-sediment system will help land mangers identify the sites where revegetation efforts can be most successful.

) Source of Federal Funds—Hatch

) Scope of Research—State Specific

Goal 5—Enhanced economic development and quality of life for Americans

The following are highlights of this year’s accomplishments:

- In a study of labeling programs for genetically engineered food, MAFES researchers found that both the message contained in genetically modified (GM) labels and the organization doing the labeling may have significant impacts on how successful a labeling program might be and how consumers perceive GM foods.
- MAFES economists studying the forces affecting investment in rural areas have found that county-industry and municipality-industry location quotients have a positive effect

on an establishment's probability of purchasing new equipment, and the dollar amount purchased per worker.

- MAFES researchers have designed a study to provide empirical estimates of individuals' willingness to pay (WTP) for reductions in the probability of contracting foodborne illnesses and to determine whether WTP varies across pathogens and food products.
- Using the U.S. Food and Drug Administration's Food Safety Survey, MAFES scientists are measuring consumer reactions to alternative food technologies: irradiation, genetic modification and organic. The goal of this project is to combine 16 years of the FDA Food Safety Survey data to analyze trends in food safety awareness, knowledge and behavior.

Scientist years:	1.95
Hatch Funds:	$40,000
Multistate Research Funds:	$26,000
State Funds:	$230,000
Total Funds:	$609,000

Key Theme—Impact of Change on Rural Communities/Consumer Management

a) The number of independent supermarkets and small grocery stores decreased by 17.2% and 35.9%, respectively, between 1990 and 2000. While consumers have experienced little impact in food prices, rural communities may feel the results in several areas including accessibility to food products, declining sales in other retail sectors, and shrinking market accessibility for small agricultural producers. It is possible that improving business management practices, offering specialized products such as prepared or organic foods, or forging new relationships with local producers may strengthen rural food retailers. This project uses Maine as a case study to evaluate opportunities for maintaining and enhancing the economic and social vitality of rural communities by focusing on food retailers and the local growers and producers who may supply them. Market structure and consumer research, technical assistance for rural food retailers, and improved mechanisms for connecting local food producers to retailers, will be employed to support and strengthen food outlets in rural communities and investigate the degree to which those outlets can benefit by marketing products from local producers. MAFES economists surveyed eight Maine communities and found that independent grocery stores serve as the primary retailer for approximately 8% of respondents, and a second or third source for an additional 32% or respondents. When asked to rate stores on 41 characteristics involving convenience and shopping environment, payment options, personnel, price, selection, and service, independent stores had only one major strength over the Hannaford stores (the dominant chain grocery), "store is not usually crowded." The researchers conclude that independent grocery stores are failing to compete with chain supermarkets and superstores because they fall short in the areas of product selection and quality. The researchers also identified the characteristics of those who choose to do the majority of their grocery shopping at independent grocery stores and found that the independent grocery store shopper is older and more frugal than the average chain supermarket shopper. This consumer spends less on groceries and is often willing to research advertised specials and stock up on sale items. Although this shopper

may purchase value-added produce and/or meats regularly, she/he is unlikely to purchase ready-to-eat/ready-to-heat products or frozen entrees. This shopper is also unlikely to purchase health-related foods or natural, organic, and/or local foods. The researchers found that the population of independent grocery store shoppers is small and it is aging. To survive, the industry must be able to attract a broader segment of the community.

) Impact—Results from the consumer surveys have identified the major differences in how consumers view small and independent grocers compared to the larger regional and national retailers. These results will be used to develop training programs to assist small and independent grocery retailers to devise business plans that will help them increase or stabilize their businesses. Linkages between local producers and retailers will be established to evaluate models of mutual benefit for both parties as well as local consumers.

) Source of Federal Funds—Hatch, Fund for Rural America

) Scope of Research—State specific

Assessments of Accomplishments

As discussed in the Stakeholder Input Process section, the Maine Agricultural and Forest Experiment Station shares the preproposals for all research projects with the Board of Agriculture and the Forest Resources Advisory Committee and the Cooperative Forestry Research Unit advisory board. In addition, as discussed in the Program Review section, all MAFES research projects are peer-reviewed. We believe that these two steps ensure that our research is good science and is meeting the needs of the state.

STAKEHOLDER INPUT PROCESS

) Actions taken to seek stakeholder input and encourage their participation:

MAFES continued to seek the input of stakeholders during CY 2004. Research faculty and administrators attended meetings of stakeholder groups and assessed the needs expressed at the meetings. MAFES continued to work with the Agricultural Council of Maine to identify needs of all sectors of the agricultural community.

MAFES also continued to work with the Forest Resources Advisory Committee and the Board of Agriculture to seek their input on stakeholder needs. MAFES also has expanded its “field days” where stakeholder groups observe the demonstration and research plots at MAFES research farms. Field days were held for apples, small fruits and vegetables, potatoes and wild blueberries, along with field days to demonstrate IPM, weed control and other special areas of interests of growers. Field days have been developed for master gardeners, landscape horticulture and greenhouse growers during the last three years. All these events allow researchers and administrators to learn more about the needs of the stakeholder groups in attendance.

) Process used to identify stakeholders and to collect input:

The process used to identify stakeholders in CY 2004 was a continuation of the process used in previous years. MAFES maintains a list of all known stakeholders related to agriculture and forestry, and these groups are contacted on a regular basis. Personal visits and telephone conversations are used most frequently to collect input from these groups.

) How collected input was considered:

With the assistance of the Board of Agriculture, the input received on agricultural issues was used to update the Maine Agricultural Center's Long Range Plan. Based on the input received and the priorities set by the Board of Agriculture, the three areas identified for expansion are profitability of agriculture, agrosecurity and food safety, and sustainable water use and irrigation as research funding permits. The Board approved the updated plan and members of the Board presented it to the Agriculture, Conservation and Forestry Committee of the Maine Legislature in 2004.

Based on the recommendations of the Governor's Diary Task Force on the Sustainability of the Diary Industry in Maine, the Maine Agricultural Center created a Dairy Task Force Response Team to develop and deliver educational programs for Maine dairy producers. The team, which consists of both research and extension faculty at UMaine, will work with the Maine Department of Agriculture, Food and Rural Resources and the Maine Dairy Industry Association, which represents the state dairy community, as well as several agribusinesses, to identify high-priority issue areas.

The data obtained from a forestry survey of Maine adults in 2002 was analyzed further in 2004 and has been discussed with forestry groups, including the Forest Resources Advisory Committee. The information is being used to assess future research and outreach needs as viewed by the public. It has been suggested that more research is needed on ways to improve the public perception of forestry and improving the overall business climate in the state. More specifically, new research is needed to address the biological and socioeconomic uncertainties facing the forest resource during the coming years. Based on the assessment of future research needs, the creation of the School of Forest Resources and Center for Research on Sustainable Forests has been proposed. The creation of the proposed School and Center has been strongly endorsed by the Forest Resources Advisory Committee. MAFES is also working with members of forestry groups to develop a long-term media and public relations outreach campaign to improve the public perception of forestry.

PROGRAM REVIEW PROCESS

The external scientific peer review process described in our 2000-2004 Plan of Work continues to be used to evaluate all MAFES projects, regardless of funding source. Preproposals are also shared with MAFES advisory committees to ensure that the projects are relevant and address needs of the industry.

EVALUATION OF THE SUCCESS OF MULTI AND JOINT ACTIVITIES

Multistate Activities

) Do they address key issues, including those identified by stakeholders?

Multistate projects continue to be an important component of the MAFES research portfolio, contributing to many of the key themes identified earlier. For example, three multistate projects supported by MAFES, NE-183, *Multidisciplinary Evaluation of New Apple Cultivars*, NE-1000, *Improved Weed Control Through Residue Management and Crop Rotation*, and NE-1012, *Sustaining Local Food Systems in a Globalizing Environment*, contribute to the important issue of economic profitability identified above by improving production efficiencies, developing new production methods that reduce cost, and/or increasing yields. Multistate project, *NE-1014, Development of New Potato Clones for Improved Pest Resistance, Marketability, and Sustainability in the East*, also contributes to the issue of profitability by developing new potato varieties with improved pest resistance and marketability. As a result of this research, scientists have developed a new potato variety known as Monticello that will be valuable for farmers who sell to potato chip processors.

Multistate project, W-1133, *Benefits and Costs of Natural Resource Policies Affecting Public an Private Lands*, provides measures of the amenity benefits that agriculture provides through open space and desirable scenes. Measurement of the amenity values makes it possible to investigate socially acceptable methods to compensate landowners for these values, thereby improving the economic viability of agriculture. This conservation easement study provides important information to decision makers in public agencies and private businesses on the benefits of protecting Maine's farmland from development.

Another multistate project supported by MAFES addresses priority issues identified by the horticultural industry, the fastest growing segment of Maine agriculture. As part of multistate project NE-009, *Conservation and Utilization of Plant Genetic Resources*, MAFES researchers are exploring effective propagation methods to prevent depletion and possible extinction of wild plants and to produce quantities of native plants for horticultural trade.

) Do they address the needs of under-served and under-represented populations?

Research results are not specific to a given population. All research results obtained through MAFES funded projects reside in the public domain and are available to any individual or group. Some multistate projects address needs of a specific population, such as the elderly or other non-traditional stakeholders. For example, two multistate projects in the area of human nutrition supported by MAFES, NE-172, *Nutritional Risk and Antioxidant Status in the Elderly*, and NC-219, *Using Stage-Based Interventions to Increase Fruit and Vegetable Intake in Young Adults*, address nutrition needs of the elderly and young adults, both of which are non-traditional stakeholders.

) Do the programs describe expected outcomes and impacts?

New multistate research projects are written in a format that includes a statement of expected outcomes and impacts. Older multistate projects have been revised to include expected outcomes and impacts. Multistate projects contribute to the outcomes and impacts listed in an earlier section of this report.

) Do they result in improved effectiveness/efficiency?

Multistate projects enhance effectiveness and efficiency by having faculty from different universities work together to generate more information and knowledge than can be obtained by a single person. The information also has broader applicability as the research is performed under different conditions, such as weather, soil type, or social/cultural conditions. Some of the research could not be done without multistate participation. For example, multistate project NE-1014, *Development of New Potato Clones for Improved Pest Resistance, Marketability, and Sustainability in the East*, could not be done without the participation of all eastern states that produce potatoes. Information is needed from all production areas to fully evaluate the performance of new clones.

Integrated Research and Extension Activities

All MAFES-supported integrated research/extension activities are managed through the Maine Agricultural Center (MAC). The Center has continued to emphasize joint research/extension positions and to support integrated research/extension projects. Each year, MAC supports several research/education projects that address high-priority needs that are conducted jointly by research and extension faculty.

) Do they address key issues, including those identified by stakeholders?

The integrated research/extension grants supported by MAC require a letter of support from the appropriate segment of the agricultural industry to ensure that the research/extension faculty have communicated with the industry and that the industry supports the project. Joint extension/research positions are presented to and approved by the Board of Agriculture before they are advertised.

) Do they address the needs of under-served and under-represented populations?

Interest in organic dairying in Maine is growing. However, until now dairy farmers have not been well served in the area of the costs and potential benefits of organic production.
In a joint project with the University of Vermont, UMaine scientists are undertaking a cost of production study for organic production. This new integrated research and extension study is the first project in the United States to look comprehensively at the economics of organic dairying and will provide information to several different stakeholders including dairy farmers, input suppliers, and especially lenders who have no financial information upon which to evaluate the credit worthiness of farmers interested in entering this market. It will provide Maine producers with a clearer picture of the costs and potential benefits of organic production and the expected difficulties associated with the transition.

Some of the MAC projects have also served new, non-traditional stakeholders. For example, variety trials for blackberries were conducted to help small and part-time farmers looking for crops with a market niche and the potential for high returns on investment. The first ever New England Maple Grading School, partially funded through a grant from MAC, taught participants to be better graders and samplers of maple syrup and is another example of a project that benefited a new stakeholder group in Maine.

) Do the programs describe expected outcomes and impacts?

All projects submitted for MAC funding must state the expected outcomes and impacts of the research/extension activity. Upon completion of the work a short final report is required and the actual outcomes and impacts are presented in the report. The reports are then placed on the MAC website.

Examples of outcomes and impacts from the MAC projects are summarized here:

- UMaine scientists conducted trials to evaluate "least toxic" strategies for homeowners and businesses for management of European fire ants, an aggressive nuisance to homeowners and a potential threat to the environment. They have found that continuous exposure to boric-acid-baited sucrose solution will effectively kill colonies over two months in the laboratory. Effective deployment of this strategy in the field is still under investigation. Field applications of bait formulations of an insect growth regulator plus a baited insecticide reduce but do not eliminate infestations. This MAC-funded research, a collaborative effort of research and extension personnel, led to the publication of a fact sheet on fire ant biology, ecology, potential spread and management that has been widely distributed. Over time, the impact of this process of raising awareness will also be gauged by the number of ants submitted for identification, accompanied by the mailing panel in the fact sheet.
- Currently, Maine sells 90% of its maple syrup crop at bulk prices to out-of-state dealers and processors. It is vitally important to Maine producers to have their syrup graded accurately in order to receive the most favorable bulk price possible. In 2004 thirty-three participants and instructors gathered for the first-ever certified New England Maple Grading School, a joint collaboration of Vermont Agency of Agriculture Food and Markets, University of New Hampshire Cooperative Extension, and University of Maine Cooperative Extension. The program was partially funded through a grant from MAC. Over the three-day program, participants from six states and the province of Quebec learned detailed aspects of grading maple syrup. The participants, who represented research institutes, producers, state and provincial departments of agricultural and maple packers, were exposed to all aspects of grading maple syrup. The course focused on key elements of grading: density, color, clarity, and taste. The program was an outstanding opportunity for the participants to pick up the skills needed to be better maple graders.
- Sweet corn is among the most important commercial fresh vegetable crops grown in Maine. While its popularity makes it a nearly essential item in the farm market, its high requirements for acreage, nutrients and pesticides create a significant drain on farm resources that is difficult to recover under current competitive pricing. Determining consumer preferences regarding the many types of sweet corn that are presently available can better focus marketing of this crop. In a study to determine how color might influence consumer preference, UMaine scientists conducted variety trials on four different corn color types (yellow, white, bicolor, red) that are now available and adapted to Maine growing conditions. The sensory analysis of the four different corn color types suggests that color did influence consumers enough to positively influence their preferences. This may indicate that providing new colors of corn could increase demand at local markets, and/or command higher prices than standard varieties. This in turn could allow farmers to raise prices to a more profitable and sustainable level while increasing both their corn market and sales of other crops often tied to fresh sweet corn sales. Data from this MAC

funded project will be used to suggest test markets for preferred color types to growers to develop or expand marketing niches.

- Another MAC funded project was designed to solve an apple industry problem. Honeycrisp is a new apple variety that, unlike many other varieties, remains crisp and juicy during the storage period and during unrefrigerated conditions that typically occur in marketing. Because of this, it has great appeal for both apple growers and consumers. The Honeycrisp apple is well adapted to Maine's climate and is currently being planted by many Maine apple growers for both farmstand and wholesale markets. However, its susceptibility to soft scald limits wide-scale production because it makes fruit unmarketable and can lead to big losses for growers. Current production of this variety in Maine is approximately 100 acres or potentially 40,000 bushels. Since this is only 0.5% of total production, most of it is sold within a few months of harvest. As production increases, the need for long-term storage protocol will increase as well. This study identified when to harvest Honeycrisp for long-term storage and a delayed cooling duration that does not impair fruit quality, but can potentially prevent soft scald.

) Do they result in improved effectiveness/efficiency?

Joint appointments are an effective way of ensuring that research and extension activities are integrated. Furthermore, it helps ensure that the research is relevant to stakeholders because of the close interaction that occurs between the faculty member with a joint appointment and the segment of the industry he/she serves. Supporting projects that have principal investigators from both MAFES and UMCE is also an effective way to integrate research and extension activities.

MULTISTATE EXTENSION ACTIVITIES

Not Applicable

INTEGRATED RESEARCH AND EXTENSION ACTIVITIES

The Maine Agricultural and Forest Experiment Station has continued to expand its integrated research and extension activities through the Maine Agricultural Center. Over the last five years, the number of faculty with joint appointments in the experiment station has increased by 100 percent.

In CY 2004, MAC funded eight projects that had co-principal investigators from MAFES and UMCE. About $31,000 was provided to support these projects.

The Maine Agricultural and Forest Experiment Station has met its requirement to spend at least 12.8 percent of its Hatch allocation on integrated activities. Based of FY04 Hatch allocations, our target for integrated activities was $222,417. We are certifying a total of $325,599 expended on integrated activities for FY 2004. Form CSREES-REPT is attached.

U.S. Department of Agriculture
Cooperative State Research, Education, and Extension Service
Supplement to the Annual Report of Accomplishments and Results
Multistate Extension Activities and Integrated Activities
(Attach Brief Summaries)

Institution: Maine Agricultural and Forest Experiment Station
State: Maine

Check one:

	Multistate Extension Activities
X	Integrated Activities (Hatch Act Funds)
	Integrated Activities (Smith-Lever Act Funds)

Title of Planned Program/Activity	Actual Expenditures FY 2000	FY 2001	FY 2002	FY 2003	FY 2004
Maine Agricultural Center	$229,645	$243,683	$284,702	$316,693	$325,599
Total	$229,645	$243,683	$284,702	$316,693	$325,599

Director

Date

Form CSREES-REPT (2/00)