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

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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 research over the past year examined the effect of broodstock diet on egg quality of captive Atlantic halibut broodstock.
- In a study of the effects of contaminants on early life stages of finfish and shellfish, MAFES researchers have found that juvenile clams exposed to 2,4-D (phenoxyacetic acid herbicides) showed an initial delay in growth compared to control clams, but at the end of the second year were significantly larger than the control clams showing a possible hormetic effect.
- MAFES scientists are continuing to increase the efficiency of oyster culture efforts in Maine through a selective breeding program for enhanced cold-water growth and disease resistance and exploring the efficacy of hatchery-based production of mussels with unique morphological features in order to increase the market price commanded by Maine mussels.
- Using previously collected survey data, MAFES economists identified the grocery store characteristics that consumers identified as important when choosing stores for shopping trips.
- MAFES economists continued their work on demand relations between the American lobster and the spiny lobster in the U.S. market.
- Continuing their participation in a multistate trial network, MAFES scientists evaluated new fresh, processing, and specialty potato clones bred in the East, which will result in the selection, development, and commercialization of improved pest-resistant, early maturing, high-quality potato varieties for Eastern producers.

- MAFES scientists evaluated potato seed treatments for their abilities to prevent seed-borne late blight.
- As part of a multistate project on the conservation and utilization of plant genetic resources, MAFES researchers are looking to China as a source of new ornamental plants.
- MAFES research on blueberry fertilization has results in new recommendations for growers, who will be advised not to apply fertilizers containing Cu or Fe if leaf samples indicate Cu is below the current 7 ppm standard or Fe is below the 50 ppm standard.
- MAFES researchers found that a two-specie inoculant and a mixed homo/hetero inoculant could increase silage bunk life and result in an economic increase in milk production on a farm-scale.
- Results from the past season on the development of grain-based lobster baits showed that although the grain-based baits worked as well as herring in relatively shallow water, when samples were given to commercial fishermen who fish in deeper water, the bait did not fish well. Researchers hypothesize that the pressure from the depth of water seems to limit dispersion of the attractants.
- MAFES researchers continued exploring methods to purify bovine placental lactogen.
- MAFES research has shown that total hemoglobin production by *Frankia* is enhanced under hypoxic conditions.
- MAFES entomologists found greater than twice as many native bees in organic fields than in conventional fields.
- MAFES scientists have clarified the phylogeny of the Rosaceae family of plants and translated the phylogeny into a new classification system that will be useful to a wide range of scientists and the public as well.
- In a series of laboratory, greenhouse, and field experiments to investigate locomotory behavior of potato aphids, buckthorn aphids, and green peach aphids, MAFES entomologists found that all three species of potato-colonizing aphids were capable of surviving off host plants for 24 to 48 hours and of walking on the soil surface between potato plants.
- MAFES researchers looking at cold hardiness among cultivated potato species (*Solanum tuberosum*, cv. Red Pontiac, Superior, Russet Burbank) and wild species (*S. commersonii, S. boliviense, S. chacoense, S. trifidum*) by membrane-injury method showed quantitative variation for low temperature tolerance among species and cultivars.
- As part of a multistate project, MAFES researchers continued investigating harvest and storage protocols for maintaining optimum fruit quality based on conditions and varieties grown in Maine. The results of this project will enable growers to market high-quality apples with minimum loss to superficial scald.
- MAFES entomologists sampled a wide range of crop species for aphid species, with particular interest in the soybean aphid, as this is a new and increasing pest species in Maine.
- MAFES scientists continued their investigation on the effects of environmental toxins on embryonic and adult finfish.
- As the fisheries and aquaculture industries continue to expand in the state of Maine, disease control methods and diagnostic tests will be needed. MAFES scientists continued studying the role of innate immunity in zebrafish, and explored ways to modulate this immune function to upregulate host response to infection.

- MAFES scientists continued working on the development of a method to detect maggot-infested blueberries, which would allow more flexibility for both producers and processors relative to decisions concerning integrated pest management.
- The applied vegetable production research at the station's Highmoor Farm is presented to more than 100 vegetable growers in Maine and more than 500 farmers throughout New England. The growers report that the vegetable-trialing information helps them to make decisions when choosing new varieties to grow.
- MAFES scientists are evaluating hoop house tomatoes. The results of the variety trial as well as the demonstration of proper cultural management and planting density has lead to several growers making changes in their hoop house production practices.
- A MAFES systems study indicates that cover-cropping strategies that include periods of mid-summer soil disturbance reduce the number of germinable weed seeds in the soil.
- MAFES researchers are evaluating alternative herbicides and methods of application for rotation in order to lessen the blueberry industry's reliance on a herbicide that is found in groundwater.

Scientist years:	18.5
Hatch Funds:	$667,000
Multistate Research Funds:	$273,000
State Funds:	$3,848,000
Total Funds:	$6,222,000

Key Theme—Plant Production Efficiency

a) Increasing the efficiency of photosynthesis is essential for improvement of crop productivity. Using the marine organism *Elysia chlorotica* (sea slug) and its symbiont algal (*Vaucheria litorea*) chloroplasts, MAFES scientists are studying a model system that provides a unique opportunity to determine how genetic and biochemical components from two extremely divergent organisms can form a functional and productive photosynthetic union. This research also provides a means to identify the mechanisms that limit photosynthetic efficiency and productivity. Research during the past year focused on chloroplast stability, horizontal gene transfer, and developing procedures to culture the organisms in the laboratory on a continuing basis. Their experiments on isolated algal chloroplasts revealed that the plastids are more robust than typical land plant chloroplasts, and this robustness may facilitate survival during incorporation of the plastids into the animal cytosol and contribute to their long-term functioning in the foreign cytosol. Ultimately, this may add to the information necessary for maintaining isolated organelles in culture for long periods of time, enabling large-scale production of chloroplast secondary products in isolation and/or the development of alternative forms of photosynthetic energy production. Also during this past year, an undergraduate student in the lab succeeded for the first time in rearing sea slugs from eggs and establishing the symbiotic association in the laboratory. The scientists now have the tools in place to carry out feeding studies, follow chloroplast uptake, examine the complete sea slug development, and explore coordination of photosynthetic carbon reduction in the animal.

b) Impact—Using this model system, the researchers are able to address the genetic and biochemical autonomy of the chloroplast in ways not possible before. The scientists will better understand the molecular mechanisms that regulate photosynthetic efficiency and productivity in plants and algae. Furthermore, the ability to culture sea slugs in the lab will help to preserve and protect a natural species and their native environment. The availability of lab-reared animals will also provide a source of a previously rare living organism for the marine aquarium trade, for academic teaching at all levels, for biomedical and pharmaceutical research, and as a model research organism for a number of disciplines (developmental biology, plant biochemistry, molecular biology, genomics, evolution, etc.).

c) Source of Federal Funds—Hatch

d) Scope of Impact—State specific

Key Themes—Niche Market/Managing Change in Agriculture/Agricultural Profitability

a) In the wake of increasing corporate control and the corresponding vulnerabilities in the food system, an alternative agricultural paradigm has emerged to challenge the wisdom of conventional production agriculture on a global scale. Some growers, processors, distributors and retailers are seeking to re-localize production through a diversity of strategies. One strategy is direct marketing of local products to households, stores, restaurants, and institutions. Another is linking value-adding components of food production at the local level. These kinds of agriculture and food endeavors are engines of local economic development, fostering a greater community capacity for entrepreneurship, business development, and cooperation for mutual benefit. Socially, food system activities that are smaller in scale and more localized increase the opportunities for individuals and families to participate in shaping the food system they depend upon. They also provide spaces for community interaction and cultural expression. Also, by strengthening or maintaining local agriculture, these initiatives enhance the aesthetic and environmental aspects of rural landscapes. As part of a multistate project, MAFES economists are evaluating the appropriateness of alternative food systems to serve specific market areas in Maine.

b) Impact—As part of this project, MAFES scientists have provided the Governor's Steering Committee on Natural Resource-based Industries with considerable data and working concepts on the Maine food and agricultural system, resulting in passage of legislation to increase the Maine Department of Agriculture's support of local agriculture and to lay the basis for a state food policy that will be considered by the 2006-07 Maine legislature. The researchers are also working closely with Farm Fresh Connection, a project of the non-profit Maine Sustainable Agriculture Society that connects local farmers to institutional food markets, primarily colleges and restaurants, and to local independent food stores. The project provides detailed information to the researcher who provides guidance to the project. The observations and findings to date are consistent with findings from similar projects: the relationship between buyer and seller price points and farm size is a critical component to the success of local marketing systems. Both larger and smaller farms can participate in local food networks with both lower and

higher price points, but the coordination of those transactions within such a system is critical and challenging.

c) Source of Federal Funds—Multistate Hatch

d) Scope of Impact—Multistate research with CA, KS, MA, ME, MI, MN, MO, NH, NJ, NY, OR, PA, PR, VT, WA, WI, WV

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 scientists developed and evaluated an extruded taffy-like confection for phytochemical stability, antioxidant activity and consumer acceptability. They found that the addition of rosemary extract enhanced anthocyanin retention.
- Studies by MAFES scientists on the effectiveness of different processing line washes on pesticide (and microorganism removal) have indicated that plain water is as effective a removal tool for most residual pesticides as chlorinated and low concentrations of natural organic acids.
- Study of the drift patterns of propiconazole (fungicide) and phosmet (insecticide) demonstrated that aerial spraying of these pesticides contributed to drift areas that far exceeded scientific expectations.
- Using new techniques MAFES scientists monitored surface water from various agricultural areas in Maine and found little in the way of residual pesticides.
- MAFES food scientists continued their investigation of the physical characteristics of the Jonah crab mince, the first step in the development of value-added products such as crabmeat nuggets and/or sausages.

Scientist years:	1.9
Hatch Funds:	$89,000
Multistate Research Funds:	$25,000
State Funds:	$332,000
Total Funds:	$467,000

Key Theme—Foodborne Pathogen Protection

a) Food safety and control of foodborne pathogens have become a central concern in modern food science due to outbreaks of foodborne infections/intoxications and the potential of bioterrorism attacks. Foodborne illnesses account for billions of dollars of economic losses annually. Since safety of the public food supply is a major concern, MAFES food scientists are focusing on destruction, detection, and control of foodborne pathogens as a way to improve food safety and security from farm to fork.

b) Impact—As part of this project, the researchers investigated the anti-microbial effects of the edible fruit of the Japanese cornel dogwood (*Cornus*), which contains tannins and has been used as a tonic in traditional Chinese medicine. They looked at the effects of Cornus fruit extracts on four foodborne pathogens: *E. coli* O157:H7, *Salmonella* Typhimurium, *Staphylococcus aureus,* and *Listeria monocytogenes,* in both water and growth media. The researchers determined that Cornus fruit extract had significant killing and suppression effects on the foodborne pathogens tested, with greater efficacy for gram-positive than gram-negative pathogens at 7C and 21C, and that this extract may be considered for food applications.

c) Source of Federal Funds—Hatch

d) Scope of Impact—State specific

Key Theme—Food Quality

a) Modern analytical instruments and techniques are enabling scientists to discover, characterize, and quantify many natural and man-made chemicals found in both our environment and food supply. MAFES food scientists are developing and using these new tools to help Maine farmers and food processors in many ways.

b) Impact—MAFES scientists have worked closely with a small Maine company in their development of an enzyme immunoassay (EIA) for the detection of capsaicinoids (pungent compounds in hot peppers). The food scientists, working in conjunction with collaborators from this company as well as a researcher from the USDA, have found new ways to quickly and inexpensively quantify capsaicinoids levels in a number *Capsicum* genotypes. Even more interesting, their research led to the discovery that a large number of heat-processed commercial salsas suffer from a great variability in pungencies. The scientists found a number of salsas that were labeled mild or medium in heat that were actually higher in capsaicinoids than those marked hot. This often held true within the same brand. This finding holds an exciting opportunity for the small Maine EIA developer to market its product worldwide to salsa manufacturers for their quality assurance/quality control programs.

c) Source of Federal Funds—Hatch

d) Scope of Impact—State specific

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:

- As part of a multistate project, Maine was one of four states to test the technical feasibility and acceptability of an online format of the print materials developed for a nutrition intervention targeting young adults.
- MAFES nutritionists are continuing their investigation of manganese, arterial functional properties and metabolism as related to cardiovascular disease.
- As part of a multistate project looking to increase consumption of fruit and vegetables by older adults, a MAFES nutritionist examined the fresh fruit and vegetable purchasing patterns of 97 Maine Senior Farm Share participants.
- MAFES researchers continued their investigation into the role of anthocyanins in health maintenance.

Scientist years:	1.4
Hatch Funds:	$22,000
Multistate Research Funds:	$55,000
State Funds:	$167,000
Total Funds:	$290,000

Key Theme—Human Nutrition/Human Health/Nutricueticals

a) Very little is known about the role of many foods compounds in human health. This project studies the absorption, distribution, metabolism, and excretion of non-nutrient compounds in foods and botanical products in order to advise consumers about consumption of these products for better health.

b) Impact—With Type 2 diabetes on the rise in Maine, UMaine scientists are studying the ways in which blueberries, cranberries and strawberries might help fight this disease. These foods, with an annual crop value of more than $75 million in Maine, contain chemicals known as anthocyanins. Anthocyanins are pigments that give purple and red fruits their bright colors. Research suggests that they may help prevent diabetes in adults who are at risk for developing the disease. This Hatch-funded research has led to the establishment of a clinical research laboratory that has already brought in more than $60,000 in funding from a private foundation.

c) Source of Federal Funds—Multistate Hatch

d) Scope of Project—Multistate research with AZ, CA, CO, CT, IN, KS, MA, ME, MI, NE, NM, OK, OR, WA

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:

- In research on the adverse environmental and economic impacts of non-point pollution in aquatic systems, MAFES scientists have sampled the Penobscot River over a 20-fold range of hydrologic discharge from a low of 3500 cfs to a peak flood stage of 68,700 cfs. They have found that variations in hydrologic fluxes are strong drivers of nutrient exports, and are developing a model to predict cumulative nutrient exports as a function of combined hydrologic and biogeochemical factors.
- Marine researchers at MAFES 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.
- The dynamics of calcium, supplied by ion-rich groundwater, were influenced by the strength of both groundwater and wetland connections, according to MAFES scientists, which suggests that the effects of climate-driven changes in hydrologic connections on lake chemistry cannot be easily decoupled in lakes associated with extensive wetlands.
- As part of a multistate research project, MAFES entomologists have demonstrated the potential for managing the long-term persistence of a biocontrol agent with augmentative applications, as opposed to only short-term gains from spraying a biopesticide. This has significance to the cost/benefit of biological materials compared with conventional insecticides.
- MAFES research has demonstrated that Deuterium and Oxygen isotopes are not useful for distinguishing between possible sources of salt in ground water.
- While many studies have quantified the organic carbon stored in terrestrial soils, the role of estuarine soils has been largely overlooked in carbon sequestration studies. To gain an understanding of organic matter storage potential in estuarine soils in the Gulf of Maine, MAFES scientists are quantifying the total organic carbon (TOC) in the subaqueous soils of Taunton Bay estuary (Hancock County, Maine).
- MAFES scientists have found that crop species play an important role in determining the levels of dissolved organic matter in soil solution. They found a clear relationship between the level of soil phosphorus in solution and the amount of dissolved organic matter, which means that choices farmers make in crop selection can impact the amount of phosphorus available to plants.
- In a long-term project that evaluates alternative pest management systems (IPM-based vs environmentally friendly) and soil management systems (non-amended vs one that uses

manure), MAFES researchers found that the amended soil management system had equal or higher yields than the non-amended in 12 of the last 13 years. The also found that yields in amended plots were less variable due in part to improved soil characteristics that buffered rainfall deficits.

- MAFES scientists continued their participation in the National Atmospheric Deposition Program. Data from this site in combination with other sites throughout the network continues to provide critical data for the US regarding precipitation inorganic chemistry.
- As part of a multistate project on hydropedology, a MAFES soil scientist is quantifying land use impacts to Maine estuaries. Despite the importance of estuaries to the state economy, this research program is the only one within the UM system that is dedicated to describing the soil-landscape relationships.
- MAFES scientists found that compost and manure additions increased both soil organic matter and pH in amended plots.
- MAFES wildlife biologists continued their investigation of the role of harbor and gray seals in the Gulf of Maine ecosystem.
- In surveys of 80 wetlands, MAFES scientists found that most of the marsh bird species (Least Bitterns, Soras, Virginia Rails, American Bitterns, and Pied-billed Grebes) found in these wetlands have remained stable or increased over the last 15 years, except for the Least Bittern, which appears to have declined considerably.
- A MAFES scientist is co-chairing the Downeast Initiative, which was formed by a coalition of fishermen, government and academic scientists, community members, and various local and state organizations. Its goal is to develop ecosystem-based community co-management in the biologically distinct northeastern part of the Gulf of Maine, an area known as Downeast Maine.

Scientist years:	10.0
Hatch Funds:	$406,000
Multistate Research Funds:	$70,000
State Funds:	$1,679,000
Total Funds:	$2,847,000

Key Theme—Soil Quality

a) Land application of biosolids has caused concern because of perceived potential negative environmental impacts. Currently, composted biosolids are unregulated as waste materials. Some long-term biosolids applications have resulted in increased concentrations of metals in soils and additions of metals as metal salts with soluble organics or in biosolids have resulted in increased metal concentrations in groundwater. Applications have been found to increase the mobility of metals in soil due to a combination of high ionic strengths of the soil solutions, high background concentrations, and complexation of metals in the soils and biosolids by dissolved organic compounds. In addition, application of biosolids to soils has resulted in elevated concentrations of nickel (Ni), Cu, chromium (Cr), Zn, cadmium (Cd), and manganese (Mn) in plants growing in those soils. When biosolids are applied to soil surfaces, the leachable metals in the biosolids are transported down into the soil profiles with precipitation. The greatest concentrations of metals are found in the surface horizon, and metal concentrations

decrease with depth. Complexation of metals with biosolids organic matter facilitates the movement of the metals through the soil profile and beyond. MAFES soil scientists designed a column study to determine if application of composted biosolids to land may have a considerable negative impact on groundwater quality. They collected and analyzed the leachate from two biosolids treatments, one topsoil treatment, and a set of untreated (control) columns. Concentrations of ammonium nitrate and metal cations were measured. Biosolids application also resulted in increased NH4+ and NO3- leaching. Nitrate leachate exceeded ammonium leachate, indicating a well-aerated environment. Metals in leachates from undisturbed profiles may be considerably higher because leachates follow macropores and bypass much of the sites of soil CEC.

b) Impact—Results of this study indicate that leachates from biosolids mixed with sand had higher metal concentrations than those from biosolids applied on top of sand. These results support the suggestion of other researchers that metals in sewage sludge may be more mobile in course-textured soils. Mixing biosolids with coarse materials improves structural integrity, compaction resistance and permeability. This practice should be minimized in close proximity to drinking water wells.

c) Source of Federal Funds: Hatch

d) Scope of Research: State specific

Key Themes—Endangered Species/Wildlife Management

a) Wildlife conservation and management often do not directly consider adaptive variation. Likewise, the implications of conservation and management schemes for adaptive variation are largely untested. MAFES researchers are characterizing potential adaptive variation in Maine salmonids and using simulation and biological model systems to understand the management implications for preserving adaptive variation.

b) Impact—Looking at the endangered Atlantic salmon, the scientists have shown that the subpopulations that constituted the Gulf of Maine distinct population segment (DPS) differ sufficiently from one-another in important adaptive traits, such as morphology and reproductive investment, to merit independent management within the context of the larger recovery program. The researchers have used insights from this work to assist the U.S. Fish and Wildlife Service in designing a broodstock management plan for Maine's salmon. Their work on Arctic Charr in Maine has provided strong evidence that Maine's indigenous populations differ in traits linked to their feeding (trophic) ecology. Furthermore, they have evidence from a translocated population suggesting that some of these differences can arise on short time scales. In three years the scientists have individually measured and marked more than 1000 fish in this population. The state of Maine, particularly the Inland Department of Fish and Wildlife (IDFW), is extremely supportive of this work for its value for managing Maine's charr populations. Local adaptation is critical to the productivity and persistence of populations, but it is rarely addressed directly in conservation and management. This research on locally adaptive variation in Maine salmonids is now providing direct insights into the state's genetic resources. Furthermore, the scientists have employed animal and simulation models of

evolutionary processes to explore ways in which evolutionary principles can play a role in conservation. In combination, these approaches are now allowing for evolutionarily informed management and conservation strategies that seek to preserve the evolutionary legacy and value of Maine's (and the nation's) fish resources.

c) Source of Federal Funds—Hatch

d) Scope of Research—State specific

Key Themes—Hazardous Wastes/Waste Management

a) There are various hazardous wastes in the household and municipal waste streams. These waste pose a human and environmental health risk. In response to state needs, MAFES economists analyzed alternative options to investigate systems to collect, treat, and dispose of waste material found in the municipal waste stream.

b) Impact—The researchers found ways to reduce the costs of processing Maine's biomedical wastes and construction and demolition debris. While Maine had been shipping all of its biomedical waste out of state, their analysis showed the benefits of an in-state facility for treating solid waste from Maine hospitals, which the state then constructed. This facility will save Maine citizens close to $500,000 dollars per year. It also insulates Maine's hospitals from cost uncertainty, creates local employment, and processes Maine's biomedical waste in a more environmentally friendly manner. Their research on construction and demolition debris (CDD) has shown the financial benefits of municipalities working together to process and recycle CDD. Based on assumptions outlined in the analysis, such a facility is economically feasible with a minimum waste stream of 15,600 tons per year of debris at a tipping fee of $60 per ton for sorted waste and $85 per ton for unsorted waste, plus revenues from sales of processed aggregate and mulch. Results from this study caused a group of Maine communities to create the legal structure for owning and operating a facility, scheduled to be built in the mid-coast region in 2007. This CDD recycling facility will help the state preserve precious landfill space, save money, and provide local employment.

c) Source of Federal Funds—Hatch

d) 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:

- MAFES scientists are developing spatially explicit models of land-use change. The scientists are linking these landscape changes to demographic change, household and firm (farm) location, the management of forest and agricultural resources, nature-based tourism, and habitat protection.
- MAFES economists are evaluating the long-run economic incentives for integrating crop and livestock systems using the environmental policy impact calculator. Their

preliminary results indicate that the financial and risk-reducing benefits evolve over time and that the short-run benefits are site specific. Long-run benefits are more broadly observed highlighting the trade-off between economic and environmental benefits.

- As part of a multistate research project on rural communities, MAFES economists have investigated the effects of industry clusters, a widely used economic development strategy, on investment decisions. Their results demonstrate the relationship between industry stability and entry decisions.
- In a hedonic study of national wildlife refuges (NWR), MAFES researchers have found that proximity to a NWR increases the value of nearby residential properties and that these households value NWR more highly than they do other types of open space in their communities.
- MAFES economists are researching the benefits of protecting rural households from exposure to arsenic in well water. They have collected data to estimate hedonic property value models and averting-behavior models.

Scientist years:	2.01
Hatch Funds:	$44,000
Multistate Research Funds:	$47,000
State Funds:	$200,000
Total Funds:	$754,000

Key Themes—Agricultural Competitiveness/Agricultural Profitability

a) Agriculture's contribution to Maine's economy has declined, in real terms, by more than 25% in the 10-year period ending in 1997. One alternative to slow or arrest this decline is to identify new opportunities in which Maine farming systems may exhibit a comparative advantage over regional and international competitors. MAFES economists are investigating ways to improve the targeting of technological innovation and to better understand the technical, economic and social tradeoffs inherent in agricultural decisionmaking.

b) Impacts—The project has focused on cost-of-production analyses and risk assessments for Maine's dairy industry and for potatoes and wild blueberries. Commodity industry groups such as the Maine Wild Blueberry Commission and the Maine Potato Board have used the outcomes from this project. The Maine Department of Food, Agriculture and Rural Resources has used the research findings in two task forces: the Agricultural Water Management Committee and the Governor's Task Force on the Sustainability of the Dairy Industry.

c) Source of Federal Funds—Hatch

d) 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

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

MAFES continued to seek the input of stakeholders during CY 2005. 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 (AGCOM) to identify needs of all sectors of the agricultural community. Additionally MAFES seeks input from Maine's Agriculture in the Classroom Association.

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 four years. All these events allow researchers and administrators to learn more about the needs of the stakeholder groups in attendance.

b) Process used to identify stakeholders and to collect input:

The process used to identify stakeholders in CY 2005 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.

c) How collected input was considered:

In January 2004 the Board of Agriculture submitted the Maine Agricultural Center Long-Range Plan Update to the Maine Legislature. The ultimate purpose of the update was to identify the issues that MAC, UMCE and MAFES should address to provide maximum benefit to the agricultural community. Based on the input received and the priorities set by the Board, the three areas identified for expansion were profitability of agriculture, agrosecurity and food safety, and sustainable water use and irrigation as funding permits. Since the report was completed, substantial progress has been made in addressing many of the issues that were highlighted in the report. As agriculture is a dynamic industry that is continually changing, there is a need to update the long-range plan again so that the Board of Agriculture can provide the University of Maine System, the Maine Legislature, and the citizens of Maine with information about the research

and extension needs that are becoming crucial to the agricultural industry. The Board has committed to update the long-range plan in 2006.

The Maine Agricultural Center Long-Range Plan update will parallel the update of AGCOM's Strategic Plan for Maine Agriculture. One of the priority goals of AGCOM is a commitment to identifying needs that can be addressed by research and extension activities, and the Maine Agricultural Center is actively involved in the implementation of AGCOM's strategic plan.

Based on the recommendations of the Governor's Dairy Task Force on the Sustainability of the Dairy 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, works 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. This past year the team has continued under the theme of risk management in working with issues facing the dairy industry.

The data obtained from a forestry survey of Maine adults in 2002 was analyzed further in 2005 and has been discussed with forestry groups, including the Forest Resources Advisory Committee (FRAC). 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, UMaine's Department of Forest Ecosystem Science and Department of Forest Management will come together this summer to form the new School of Forest Resources. The transition provides new opportunities for communication and collaboration with the many people and organizations that depend on Maine's forests. By consolidating the two departments, we are creating a single point of contact for forest resource information and education.

In addition to the formation of the School, a new Center for Research on Sustainable Forests has been created. An independent research center with close ties to the School of Forest Resources, the center will be the new home for UMaine's forestry-related research programs, improving upon a long tradition of forestry and forest ecosystems research at the university. The creation of the 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

a) 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, on the issue of increasing the competitiveness and profitability of Maine's agricultural industries, MAFES researchers participate in NE-1014, *Development of New Potato Clones for Improved Pest Resistance, Marketability, and Sustainability in the East*, NE-1008, *Assuring Fruit and Vegetable Product Quality and Safety Through the Handling and Marketing Chain*, and NC-140, *Rootstock and Interstem Effects on Pome and Stone Fruit Trees*. The researchers in these projects collaborate on techniques, products, and new varieties to help Maine farmers remain competitive and profitable.

As part of W1002, *Nutrient Bioavailability—Phytonutrients and Beyond*, MAFES food scientists are looking at nutricueticals and human health as they investigate the effects of anthocyanins found in Maine wild blueberries, cranberries, and strawberries and their affects on diabetes in Maine adults. This research addresses issues important to the state and its citizens who are dealing with a dramatic increase in the prevalence of diabetes.

To address concerns about the impact of change on rural communities, MAFES economists participate in NE-1011, *Rural Communities, Rural Labor Markets and Public Policy.*

b) 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, MAFES nutritionists participate in two multistate projects in the area of human nutrition, NE-1023, *Improving Plant Food (Fruit, Vegetable and Whole Grain) Availability and Intake in Older Adults*, and NC-219, *Using Stage-Based Interventions to Increase Fruit and Vegetable Intake in Young Adults*, which address nutrition needs of the elderly and young adults, both of which are non-traditional stakeholders.

c) 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.

d) 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.

a) 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.

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

The equine industry has become one of the larger components of Maine agriculture, yet it is underrepresented in terms of service and research by the public sector. In a survey of Maine agricultural groups conducted the Board of Agriculture for the Maine legislature, the highest research priority identified by the Maine Equine Industry Association was the production of horse-quality hay. There is a growing demand for horse-quality hay, which is not being met by current hay producers. Hay producers like to harvest hay in large round bales, rather than small rectangular bales, because it costs less harvest and store the round bales. Small-scale livestock owners who buy hay prefer small, square bales, even though they cost more per pound, because these bales can be handled manually. UMaine scientists are investigating the economic advantages to hay producers if they rebale large round bales in small square bales to meet this demand. By providing a clearer picture of the costs and potential benefits of rebaling hay, this project will help to improve the profitability of Maine's hay and horse industries.

Some of the MAC projects have also served new, non-traditional stakeholders. For example, responding to the heightened level of interest in Maine agritourism, UMaine scientists are working with staff from the Maine Department of Agriculture to study Maine farmers who are currently involved in agritourism. Results from this research will help Maine farmers determine the economic feasibility of developing agritourism activities on their farms, and, by establishing benchmarks, it will enable analysis of changes over time.

c) 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 Web site.

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

- Keeping the food supply safe depends on our ability to rapidly detect foodborne pathogens and the development of reliable control methods. UMaine scientists are developing new, rapid methods for detecting foodborne pathogens and creating new strategies for reducing and controlling these pathogens. Focusing on *Escherichia coli* O 157:H7, *Salmonella* spp., and *Listeria monocytogenes*, they are also studying food additives from natural sources to control or eliminate these pathogens. Researchers discovered that synergistic effects of cranberries and wild blueberries have significant antimicrobial effects to control foodborne pathogens. The outcomes of this research have been shared with Maine cranberry and wild blueberry industry through extension and outreach activities. The results have also been presented at state, national and international conferences.
- Quinoa, from a plant native to the Andes, is the seed of a leafy plant that is used as a grain. Initial experiments at the University of Maine's Highmoor Farm, demonstrate that quinoa can be grown in Maine as a commercial crop and be used successfully in rotation with potatoes and corn. Quinoa, a high-quality and high-value crop, can replace oats or rye, both low-value crops currently used in traditional rotations. Faced with a number of barriers to adapting quinoa strains developed in the West to Maine, UMaine researchers have begun developing a Maine strain of quinoa, along with production management techniques specific to Maine. The initial development phase of Maine quinoa strains is expected to be complete in two to three more years at which time a group of row crop farmers will start small plot trials. Strain selection will continue on growers' farms to develop elite strains.
- Horticulture is the fastest-growing sector of American agriculture, and in 2004 Maine ornamental plant sales were valued at $114 million. One of the challenges facing commercial growers, however, is powdery mildew, a common fungal disease that spreads quickly under high-moisture conditions such as those found in greenhouses and during Maine's summer growing season. While it is impossible to assign a value to the financial loss caused by powdery mildew, individual growers lose part or all of specific crops due to this disease every year. UMaine researchers are investigating the possibility of controlling powdery mildew through use of plant-growth regulators rather than fungicides. The researchers established three field trials at the University of Maine, and evaluated the effects of different plant-growth regulators on 'Frans Schubert' summer phlox and 'UMaine' daisy (*Rudbeckia*). Results from this research indicate that plant-growth regulators can control powdery mildew infection on herbaceous plants during the growing season. The findings from this research will be used to develop practical recommendations for Maine's horticulture industry.
- In an example of UMaine's joint mission to conduct research relevant to the state while educating its young people, UMaine scientists combined a study of weed-seed predators with a hands-on experience in science education for future teachers. Looking at alternative, ecologically based weed-management systems, the scientists are investigating the ability of insects that eat seeds to control the population of weed seeds in the soil. Along with this project, the scientists created a unique outreach activity that showed secondary students ways in which such studies of basic biology and ecology can be applied to problems in agriculture. Twenty-five high school students from Maine and New York City who were part of a Future Teachers of America summer course

formulated and tested hypotheses as to how cover-cropping systems may affect weed seed predators. They also learned to identify several important weed-seed predators using guides developed as part of this project.

- Disposal of livestock carcasses on farms continues to be a growing concern among Maine's dairy farmers. Since BSE ("mad cow disease") has been found in the U.S.A., changes in slaughtering and rendering regulations have made it difficult for dairy and livestock farmers and custom butchers to dispose of animal carcasses in a safe, economical fashion. The Maine Compost Team (a collaborative effort of UMaine Cooperative Extension, the Maine Department of Agriculture, and the Maine Department of Environmental Protection) has identified composting as a viable method for disposing of animal carcasses in both routine and catastrophic events. In demonstration trials at Highmoor Farm, UMaine scientists determined that animal carcasses can be successfully composted in a variety of media as long as the compost pile reaches temperatures (131^{o} F) proven to kill most pathogens. The researchers identified the conditions that are most conducive to rapid and sustained heat: porosity, carbon:nitrogen ratio, and age. Several states and Canadian provinces have used these composting methods in rules for handling routine mortalities and in disaster management plans. As a result of attending outreach programs about this project, at least 15 Maine farms now compost on-farm mortalities.

d) 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 six years, the number of faculty with joint appointments in the experiment station has increased by 100 percent.

In CY 2005, MAC funded seven projects that had co-principal investigators from MAFES and UMCE. About $33,000 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 FY05 Hatch allocations, our target for integrated activities was $221,778. We are certifying a total of $327,768 expended on integrated activities for FY 2005. 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
Actual Expenditures of Federal Funding for Multistate Extension and Integrated Activities
(Attach Brief Summaries)
Fiscal Year: 2005

Select One: ☐ **Interim** **X Final**

Institution: Maine Agricultural and Forest Experiment Station

State: Maine

	Integrated Activities (Hatch)	Multistate Extension Activities (Smith-Lever)	Integrated Activities (Smith-Lever)
Established Target %	12.8% %	%	%
This FY Allocation (from 1088)	$1,732,640		
This FY Target Amount	$221,778		
Title of Planned Program Activity			
Maine Agricultural Center	$327,768		
Total	$327,768		
Carryover			

Certification: I certify to the best of my knowledge and belief that this report is correct and complete and that all outlays represented here accurately reflect allowable expenditures of Federal funds only in satisfying AREERA requirements.

Bruce Memra — **Director**

3/17/2006 — **Date**

Form CSREES-REPT (Revised 09/04)

ATTACHMENT D