Annual Plan of Work
Accomplishment Report for 2003

Michigan Agricultural Experiment Station
Michigan State University

March 2004

Guide to Acronyms in This Report

AFB_1	Aflatoxin B_1
AoE	Area of Expertise
ARS	Agricultural Research Service
BARD	Binational Agricultural Research and Development
BSF	Binational Science Foundation
CCT	Comparative Cervical Skin Test
CFT	Caudal Fold Tuberculin
CHES	Clarksville Horticultural Experiment Station
CRP	C - Reactive Protein
E. coli	Escherichia coli
EPA	Environmental Protection Agency
FACT	Families and Children Together
FAO	Food and Agriculture Organization
FDA	Food and Drug Administration
FFDCA	Federal Food, Drug and Cosmetic Act
FIFRA	Federal Insecticide, Fungicide and Rodenticide Act
FQPA	Food Quality Protection Act
GREEEN	Generating Research and Extension to meet Economic and Environmental Needs
HACCP	Hazard Analysis Critical Control Point
IFAS	Institute of Food and Agricultural Standards
IR4	Interregional Research Project #4
ISAR	Institut des Sciences Agronomiques du Rwanda
LCM	Laser Capture Microdissection
LFL	Living Field Laboratory
LTER	Long-Term Ecological Research
MAES	Michigan Agricultural Experiment Station
MCP	Methylcyclopropene
MDA	Michigan Department of Agriculture
MDCH	Michigan Department of Community Health
MSU	Michigan State University
MSUE	Michigan State University Extension
NIAID	National Institute of Allergy and Infectious Diseases
NIEHS	National Institute of Environmental Health Sciences
NIH	National Institutes of Health
NFSTC	National Food Safety and Toxicology Center
NRICGP	National Research Initiative Competitive Grants Program
NSF	National Science Foundation
OA	Osteoarthritis
PCR	Polymerase Chain Reaction
POW	Plan of Work
STEC	Shiga toxin *Escherichia coli*
SWMREC	Southwest Michigan Research and Extension Center
TB	Tuberculosis
TNRC	Trevor Nichols Research Complex in Upper Peninsula
UAP	United Agri Products
USDA	United States Department of Agriculture
UV	Ultraviolet
WNV	West Nile Virus

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Goal 1

An agricultural production system that is highly completive in the global economy.

Executive Summary

Michigan's agri-food sector accounts for $37 billion in annual state economic activity, including $27 billion from the farm input supply, farming ($3.4 billion), and food processing industries, and $10 billion from food retailing and wholesaling. The agri-food sector is the second largest industry in the state supplying 500,000 jobs (14% of Michigan's labor force) across farm input industries, food processing, retailing and wholesaling. In 2002, Michigan ranked first or second in 19 commodities. Michigan ranked among the top ten states in the production of 37 commodities (MSU Product Center for Agriculture and Natural Resources, 2004).

Michigan's turfgrass industry was responsible for 1.9 million acres of lawn and managed turf. Expenditures for maintenance exceeded $1.8 billion in 2002 while providing direct employment of 30,000 individuals (National Agricultural Statistics Service, 2003).

Animal agriculture accounts for approximately half of the farm gate receipts with dairy dominating this sector of the economy. However, significant production and processing facilities exist surrounding swine, beef, sheep, egg, turkey, and both race and pleasure horse industries (National Agricultural Statistics Service, 2003). Comprehensive nutrient and odor management is a serious environmental and social issue as the structure of Michigan's animal agriculture changes and interacts with a rapidly expanding suburban population.

Michigan's forests are the dominant land cover with slightly over half of the land area (19.3 million acres). These forests are a mosaic of hardwood, softwood, and mixed stands of varied commercial value. Forestry related industries and manufacturing employ 150,000 people and contribute $9 billion to Michigan's economy. The closely aligned natural resource - recreation industry contributes an additional $3 billion to Michigan's economy and employs 50,000 residents.

Michigan's diverse agriculture and natural resource base provide multiple avenues of prosperity. The evolution of a consumer responsive agriculture in Michigan will chart a locally based economy that is globally competitive. The Michigan Agricultural Experiment Station (MAES) in conjunction with MSU Extension (MSUE) has launched the Michigan State University Product Agriculture and Natural Resource Center to work in partnership with state agencies and non-governmental organizations to assist new entrepreneurs and established businesses to develop new value-added products. The commercialization of consumer-ready and fresh fruit and vegetable products has the potential to add new market outlets for Michigan's vegetable and fruit industries. As an example, market tests indicate that the lucrative fresh-cut apple slices will soon account for two-thirds of Michigan's fresh apple production. Without new markets and products, Michigan agriculture will struggle to compete with global competition. Michigan agriculture's future lies not with being the low cost producer, but with being the producer of high-quality, high-value agriculturally based products.

The integration of agricultural and engineering research is beginning to form the foundation of the future's biobased fuel, power, and products. Michigan's diversity in cultivated and native plants provides multiple feedstock options. Linking agriculture to Michigan's manufacturing industries has the potential to enhance the competitiveness of not only agriculture, but also the domestic automotive industry. Biobased materials that replace fiberglass and petroleum-based plastic automotive components will have complementary benefits to Michigan's environment.

Allocated resources

	FY 2003	FY 2004	FY 2005	FY 2006	FY 2007	FY 2008
Hatch Funds						
Hatch Regular	2,389,904	2,342,106	2,295,264	2,249,359	2,204,372	2,160,284
Multi-State Funds	543,447	543,447	543,447	543,447	543,447	543,447
Other CSREES Funds*	7,527,335	7,527,335	7,527,335	7,527,335	7,527,335	7,527,335
Other Federal Funds*	12,161,291	12,161,291	12,161,291	12,161,291	12,161,291	12,161,291
Total Federal Funds (est.)	22,621,978	22,574,179	22,527,337	22,481,432	22,436,445	22,392,357
State Match for Hatch Funds	2,933,352	2,885,553	2,838,711	2,792,806	2,747,819	2,703,731
Remaining State Appropriations	18,384,483	16,940,033	15,995,596	15,099,786	14,250,143	13,444,333
Self Generated Funds*	2,133,931	2,133,931	2,133,931	2,133,931	2,133,931	2,133,931
Industry Generated Funds*	4,362,325	4,362,325	4,362,325	4,362,325	4,362,325	4,362,325
Other Non-Federal Funds*	1,767,529	1,767,529	1,767,529	1,767,529	1,767,529	1,767,529
Total State Funds (est.)	29,581,619	28,089,370	27,098,091	26,156,376	25,261,746	24,411,848
Total Estimated Funds	52,203,596	50,663,550	49,625,428	48,637,808	47,698,191	46,804,205
Scientist Years	71.7	71.7	71.7	71.7	71.7	71.7

*Values extracted from Fiscal Year 2003 Funds and Manpower report

1) Improving fertilizer efficiency for blueberry production. HANSON

KEY THEME: plant production efficiency, agriculture profitability, small farm viability

A. Brief Description: Michigan ranks No. 1 in blueberry production in the United States, producing more than 64 million pounds annually. The cost of applying nitrogen fertilizers continues to increase, as does societal concern about groundwater contamination. MAES scientists are working to improve nutrient availability for blueberries.

   The researchers analyzed the timing of fertilizer application and measured the uptake of nutrients. They found that the plant was using only 30 percent of the applied nutrients with the traditional single application

B. Accomplishment Statement: MAES researchers designed a split application process. Continued research found blueberry plants take up nitrogen from early June to late August. Knowing how blueberries absorb nitrogen, one fertilizer application was done in early May after bud break, and the other was applied in early to mid June after bloom developed.

Implementing the split fertilizer application increased blueberry yield by more than 30 percent. Nearly 17,000 acres of blueberries in Michigan use the new fertilizer application protocol. Because of Michigan's success, blueberry growers in New Jersey have also adopted the protocol. This increase in production was achieved without increasing the amount of fertilizer being applied or additional land being developed as blueberry fields.

The MAES scientists believe this same methodology can also be used in the grape industry.

C. Source of Funding: MAES- Hatch, State, Michigan Blueberry Growers Association, Osmacote Fertilizer, Michigan Horticulture Society

D. Scope of Impact: MI, NJ

2) Management of athletic horses to reduce musculoskeletal injuries and improve performance. NIELSON

KEY THEME: animal health, agriculture profitability

A. Brief Description: Horse racing in Michigan adds nearly $1.2 billion to the state's economy and employs about 42,000 people. In the early '90s, racehorses began frequently breaking more bones and the industry received some negative publicity. Additionally, shin-buck injuries became common in high-value horses. MAES researchers concluded that quality horses were not able to meet their maximum potential due to skeletal injuries.

During training, housing horses in traditional stalls was considered the best practice so the horses would not be injured running around the pasture. MAES scientists conducted research to characterize normal values of serum markers of bone and collagen metabolism using young horses from birth to two years of age.

After gathering this basic information, the researchers determined whether type of housing and amount of exercise influences bone density and strength. Confined calves with forced daily exercise were compared to confined calves with no forced exercise and group-housed calves were used as the control. Calves were used as a model for horses.

The researchers also exercised a group of young horses at a walk and trot without additional weight, while exercising another group with additional weight.

B. Accomplishment Statement: More than 50 percent of two-year-old racing horses have injuries and more than 70 percent of the thoroughbreds have injuries. Injured horses require from 30 to 90 days rest without racing or training. The cost of injury is more than veterinary fees, lost training time and missed racing opportunities; once a horse has shin-bucks it is more susceptible to fractures. In 2002, Michigan racing farm operators spent nearly $31 million in trainer fees and $21 million in veterinary costs. All trainers who

implemented the new management practices reduced their shin-buck injuries to 0 percent, substantially reducing costs and improving the productivity and quality of life of the horses.

The initial research on serum markers provides basic information for other researchers.

The research on calves determined that short sprints of exercise caused beneficial changes to the skeletal system and was repeated on weanling horses with similar results.

Carrying extra weight was beneficial to bone formation in the third metacarpal bone, which is affected by shin-bucks.

Research showed that horses' bone mass actually increases with more intense training. This undercuts an earlier belief that frequency or duration of training influenced bone mass. MAES research recommends allowing horses out on pasture to run around in order to build bone mass.

The animals trained with the new management practices had better dispositions than stalled animals and performed much better. Decreasing skeletal problems reduces animal suffering and improves welfare. The scientists believe this work will have direct applications for dairy and beef animals, as some of their metabolic problems stem from a lack of exercise and lameness.

The majority of this research has been cited in national publications such as the *American Quarter Horse Racing Journal.* Most of the states with horse racing already have implemented the management techniques.

C. Source of Funding: MAES- Hatch, State, Mexiamerican-Canadian, Bioavailable Silicon, Grayson-Jockey Club, American Quarter Horse Association, All Research Initiative MSU Grant, Equicizer Systems

D. Scope of Impact: MI, TX, CA, NY, FL, OK, NM, KY

3) Integration of spring pasture lambing. - ROOK

KEY THEME: animal production efficiency, agriculture profitability, pasture management, small farm viability, grazing, organic agriculture

A. Brief Description: MAES scientists analyzed the traditional winter lambing system in which barn lambing takes place in February, and compared it to a spring pasture system in which lambing occurs outdoors in late April and May. There were many issues and concerns about switching to spring pasture lambing, which the scientists addressed.

The largest expense for sheep producers is feeding the ewe flock. The winter system requires using stored feed for six months during winter, which is about 50 percent of the total annual production expense, a significant cost.

B. Accomplishment Statement: MAES researchers evaluated the pros and cons of spring pasture lambing versus winter lambing and developed a system to make Michigan sheep farmers more profitable. In 2002, Michigan had more than 75,000 sheep; the average flock in Michigan and the Great Lakes region is about 20-30 head. However, larger commercial flocks of several hundred to several thousand head will benefit most because they have the potential to experience larger financial gains.

   By switching to a spring system of lambing, the cost of feed per ewe in the winter drops from $45-60 to $10-15. By lambing in the spring, farmers match the newly available, cheaper, high quality, new grass growth with the nutritional requirements of the lactating ewes. This greatly reduces costs without sacrificing feed quality.

   To feed the ewes during the winter months, the researchers conducted trials on various feedstuffs and found turnips and rape pastures provide a great source of feed for November to March grazing. In addition, summer-seeded and spring-seeded brassica pastures can help to reduce internal parasite risks by providing mid- to late-season grazing rotation to a parasite-free pasture. This reduces medication frequency, costs and also decreases parasite resistance to medications.

   Labor needs throughout the winter months are high, as are housing and manure storage needs. Flock expansion is more feasible with spring pasture lambing because of the reduced labor and facility needs. Lambing in the spring is also environmentally friendly because more grass is used.

   These feeding strategies optimize performance and are being used by Michigan producers to reduce costs. The impact of internal parasites on the performance of lambs and ewes was addressed in the form of practical parasite control programs that combine pasture management and strategic deworming schedules based on incidence and environmental conditions.

C. Source of Funding: MAES- Hatch, State, Michigan Sheep Breeders Association

D. Scope of Impact: Great Lakes Region, Ontario, eastern United States

4) Impact of feeder design on feed utilization by beef cattle. BUSKIRK

KEY THEME: animal production efficiency, agriculture profitability

A. Brief Description: Harvested feed is the highest cost in maintaining beef cows in the upper Midwest. Feed cost is the single largest variable influencing profitability of the cow-calf operations in this region. Most harvested feed is packaged, stored and fed as large round hay bales. Storage losses of large round bales can range from 2 to 30 percent. Before this research, little had been done to characterize losses of hay due to feeder design.

MAES scientists compared four types of feeder designs – ring, cone, trailer and cradle -- for feed utilization and feed cost control using160 beef cows to evaluate the quantity of hay loss and feeding behaviors associated with different feeders.

B. Accomplishment Statement: Contrary to the MAES scientists' hypothesis, the cone feeder displayed the least amount of waste. The research indicates that cattle eating from the cone feeder were able to more closely mimic a grazing position, contributing to the reduced feed wastage.

   Feed waste from cows tossing feed over their backs or along their sides was reduced by allowing the animals to eat in a head-down, natural grazing position rather than from an elevated platform. In addition, the top rail on the cone, ring and trailer feeders helped to limit the animal's ability to throw its head and toss feed.

   The percentage of hay waste in this trial ranged from 3.5 to 14.6 percent. Scientists observed that cows feeding from a cradle feeder had nearly three times the agonistic interactions and four times the frequency of entrances compared to cows feeding from the other feeder types. Furthermore, feed losses were positively correlated with agonistic interactions, frequency of regular and irregular entrances, and feeder occupancy rate.

   Conservatively, when savings were calculated based on an 18 beef-cow operation, the cone hay feeder saves more than $600 annually in hay costs because of the reduction in hay wasted. These savings average $33 per cow.

   This data has been published nationwide through various outlets, as well as statewide and presented in extension programming.

C. Source of Funding: MAES- Hatch, State, Weldy Enterprises

D. Scope of Impact: MI, ND, SD, WI, MN, NY

5) Developing partnerships for the fruits and vegetable industry. – BUSCH

KEY THEME: agriculture competitiveness, agriculture profitability

A. Brief Description: Several changes occurred in the global market place causing MAES scientists to create the program, Partnerships for Food Industry Development. These key changes included a new global trade regime, improved transportation and communications, increased urbanization, and a rising middle-class allowed for an accepting market. MAES scientists were particularly interested in creating a program that recognized the economic change from supply-oriented to demand-oriented marketing. In addition, the program takes into consideration the new emphasis on non-tariff trade barriers as the World Trade Organization phases out tariffs and quotas.

   The MAES scientists' research found that the top five U.S. supermarket chains account for 40 percent of the market. Many other countries' supermarket chains make up nearly

70 percent of their market. These chains consider a three percent profit margin acceptable, making it a very competitive market. Product differentiation sets the supermarket chains apart, which is commonly achieved through fresh produce. Improved food quality is another outcome of the demand driven economy with tight supermarket profit margins.

Based on this information, MAES scientists realized the potential for higher farmer profits by identifying market opportunities for sale of fruits and vegetables produced by small and medium scale growers with the focus on seasonal and tropical produce. In order to make this work, MAES works to establish partnerships with organizations to promote effective linkages between developing nation producers and downstream actors.

B. Accomplishment Statement: MAES scientists work to identify and remove supply chain obstacle, which include improving shipping time, changing packaging, considering cold chain breaks, implementing HACCP and Good Agricultural Practices, and ensuring product quality.

Training is very crucial in making the program work. MAES scientists provided direct in-the-field training for farmers, short courses targeting strategic issues, and distance education focusing on food law. In addition, degree training was offered in marketing and related topics for participants.

One of the successful partnerships included an investment by Royal Ahold in Ghana. Through the MAES program, they now export fresh-cut fruit to 300 stores in the Netherlands and pineapple to the European Union. In South Africa a partnership was made between the University of Fort Hare and Pick-n-Pay Supermarkets. Now 4 tons of fresh squash are shipped weekly to the Pick-n-Pay stores. In Guatemala the Honest Tea Company partnered with Cooperative El Limon for dried limes to make a new “chamolime” tea. The United States now partners with Nicaragua in February to deliver Kingston Produce of New York nearly 4 million pounds of onions.

C. Funding Source: MAES- Hatch, State, USAID, USDA, Rockefeller Foundation

D. Scope of Impact: Africa, Ghana, Netherlands, South Africa, Costa Rica, Nicaragua, Guatemala

Goal 2

A Safe and Secure Food and Fiber System

Executive Summary

The global nature of food safety increases the sense of urgency in extending consumers' knowledge and understanding about food safety agents, creating a need to not only design practical strategies that will control their presence in foods, but also to develop public policies and other social and legal mechanisms to ensure food safety. This is essential if we are to protect and improve health, increase social productivity, reduce the burden on healthcare systems, and enhance the quality of life for all.

A major portion of the Michigan Agricultural Experiment Station (MAES) research agenda focuses on understanding host-pathogen relationships and is conducted in conjunction with the National Food Safety and Toxicology Center (NFSTC) housed at Michigan State University. MAES scientists are studying the evolution of the *Escherichia coli* bacterium to understand how the deadly strain *O157:H7* developed from such a benign family. Knowledge of the evolutionary process of this pathogen may give insight how other pathogens evolved into their deadly forms as well. *Campylobacteriosis*, mainly food-borne or water-borne, is the most frequently occurring bacterial enteric disease in the United States and may lead in some cases to a debilitating, paralytic condition known as Guillain-Barré syndrome. MAES microbiologists are studying how natural transformation in *Campylobacter jejuni* is making it resistant to antibiotics. In addition, an assay to detect antibiotic-resistant *Campylobacter* in infected patients has been developed and patented.

One of the unique elements of NFSTC is the presence of both toxicological and microbiological perspectives. While traditionally toxins and bacteria have been studied in separate realms, MAES scientists within NFSTC are discovering ways in which they interact with one another to produce disease conditions. One example concerns endotoxins, toxic cell wall structures found in *E. coli*, *Salmonella* and *Shigella*. High levels have been reported in environments such as farms. Researchers have identified factors that lead to injury to the liver and other organs through inflammation, and that small, normally harmless doses of endotoxin markedly enhance the toxic effects of some food-borne contaminants. Without the collaborative efforts of toxicologists and microbiologists, this potentially serious condition would not have been discovered.

The concept of risk plays an important role in understanding food safety. MAES researchers affiliated with NFSTC are using risk assessment tools as a framework to assess risks associated with foods. Focus areas in risk assessment, risk management, risk perception and risk communication within the Center have been created.

Emerging and resurging infectious agents of humans and animals pose significant challenges to the biomedical and public health communities, and directly affect the health and well-being of people, domestic animals, and wildlife in Michigan; they may impact the state economy as well. Most of these pathogens are zoonotic, and emerge from wildlife or domestic animal populations. Some surface within agricultural production systems, others emerge from wildlife, still others have insect or tick carriers, and some are associated with natural or man-made aquatic

ecosystems. Despite the many recent examples of emergent and resurgent zoonoses, the dynamics of emergence are poorly understood within the context of evolutionary forces, ecological interactions, and epidemiolgic processes. Emerging agents challenge the physiological capacity of naive human and animal hosts to recognize and respond immunologically to them, and highlight the need to develop new molecular diagnostic tools, novel therapies based upon pathogen virulence factors, and vaccine-based means to protect these hosts. Better tools in the forms of sophisticated surveillance, reporting, and diagnostic technologies are needed to respond to these health threats.

MAES scientists have played a major role in the creation of the Center for Emerging Infectious Diseases at Michigan State University. The primary focus will be on zoonotic, enteric diseases, but other emerging agents will not be excluded should opportunities present themselves to study. Three primary core areas are being addressed: (1) development and application of diagnostic tools and surveillance networks designed to capture emergent and resurgent events in space and time, at the zoonotic animal/human interface. Specific disease systems relevant to Michigan will serve as models for this process, namely: West Nile fever and meningoencephalitis, bovine tuberculosis, leptospirosis, chronic wasting disease and Lyme disease; (2) a research core in functional genomics and proteomics to explore the innate and adaptive host response to pathogens and the parallel response of the pathogen to the host. Johne's disease in dairy cattle is currently being studied; (3) establishment of a research-intensive NIAID-funded Microbiological Research Unit to study the evolutionary, ecological, pathogenic and epidemiologic processes and interactions underlying emergence, with emphasis on virulence and antibiotic resistance properties of pathogens. The primary pathogens of interest are enteric pathogens of humans and animals within agricultural production systems and in aquatic ecosystems. The National Institutes of Health recently awarded a $10.2 million research contract to MAES scientists to support the program.

Similarly, intense efforts are directed toward disease control in plants and post harvest packaging of plant products.

Allocated resources

	FY 2003	FY 2004	FY 2005	FY 2006	FY 2007	FY 2008
Hatch Funds						
Hatch Regular	239,178	246,796	254,261	261,577	268,746	275,773
Multi-State Funds	67,753	67,753	67,753	67,753	67,753	67,753
Other CSREES Funds*	451,037	451,037	451,037	451,037	451,037	451,037
Other Federal Funds*	4,174,843	4,174,843	4,174,843	4,174,843	4,174,843	4,174,843
Total Federal Funds (est.)	4,932,812	4,940,429	4,947,895	4,955,210	4,962,380	4,969,406
State Match for Hatch Funds	306,931	314,549	322,014	329,330	336,500	343,526
Remaining State Appropriations	2,746,069	2,524,742	2,375,312	2,233,130	2,097,837	1,969,094
Self Generated Funds*	75,526	75,526	75,526	75,526	75,526	75,526
Industry Generated Funds*	353,682	353,682	353,682	353,682	353,682	353,682
Other Non-Federal Funds*	574,638	574,638	574,638	574,638	574,638	574,638
Total State Funds (est.)	4,056,846	3,843,136	3,701,172	3,566,306	3,438,183	3,316,466
Total Estimated Funds	8,989,658	8,783,566	8,649,066	8,521,516	8,400,563	8,285,872
Scientist Years	9.7	9.7	9.7	9.7	9.7	9.7

*Values extracted from Fiscal Year 2003 Funds and Manpower report

1) Understanding and developing control measures for *aflatoxin* B_1 to ensure a safe food system for animals and humans. – LINZ

KEY THEME: food safety, foodborne illness, foodborne pathogen protection

A. Brief Description: The fungus *Aspergillus parasiticus* produces the mycotoxin known as aflatoxin, which contaminates food and feed crops throughout the world. *Aflatoxin* B_1 (AFB_1) is the most abundant, mutagenic, tetratogenic and carcinogenic of the aflatoxins produced in culture and on plants. The Internal Agency for Research on Cancer has recognized AFB_1 as a human carcinogen. It is the most potent naturally occurring carcinogen in several animal models.

With the goal of eliminating AFB_1 from the food chain, MAES scientists set out to develop a fundamental understanding of the molecular mechanisms that regulate expression of genes involved in AFB_1 biosynthesis.

B. Accomplishment Statement: Aflatoxins in food and feed present significant health risks to humans and animals, generating huge economic losses annually to animal and plant production.

In the United States alone, aflatoxin costs more than $425 million each year due to the costs of screening, animal sickness and FDA regulations. U.S. farmers pay these costs to provide a quality product for human consumption, which is why U.S. human health problems from this toxin are minimal in comparison to other nations.

MAES scientists have confirmed two novel transcription factors, CREB and NCBP, bind to specific cis-acting sites and regulate expression of one gene in the aflatoxin pathway.

In addition, the scientists discovered two aflatoxin proteins, OmtA and VBS, localize to specific organelles during aflatoxin synthesis on solid growth media. Identifying these regulators allows for the development of effective intervention strategies to block aflatoxin synthesis by the fungus in association with susceptible crops in the field and during storage.

The information is applicable for corn, fruit, nut, tree nut and cotton growers.

MAES scientists have found that some plants produce natural aflatoxin inhibitors, CO_2 and ethylene, which work at low concentrations and are rather inexpensive. The researchers are analyzing how these inhibitors work at the molecular level and how to make them applicable for use in the field and greenhouse by looking at the quantity and timing of application.

C. Source of Funding: MAES- Hatch, State, National Institutes of Health, Michigan Life Sciences Grant, Vice President for Research and Graduate Programs

D. Scope of Impact: MI, LA, WI, NC, China, Africa, Asia

2) Analysis of modified atmosphere packaging of produce. – CAMERON

KEY THEME: food handling, food quality

A. Brief Description: MAES scientists began their research in developing procedures to maximize the retention of post-harvest quality through the use of modified-atmosphere packages. Little was known regarding modified-atmosphere packaging prior to their research.

The researchers had to learn about plastics, but more importantly of what happens inside those plastics when used as modified-atmosphere packaging. MAES scientists learned that ethanol was produced as a result of fermentation respiration and that it accumulated in the package headspace. In addition, low levels of oxygen and higher levels of carbon dioxide allow produce to last longer. They looked at the respiration rate of the produce, the exchange of gases within the packaging, and the effects of changing temperature. With all of this background knowledge gained in the area of modified atmosphere packaging, MAES scientists made models and developed recommendations for using the packaging on various produce.

B. Accomplishment Statement: Through their research, a comprehensive data set was empirically established for sweet cherries. Models were developed to simultaneously track ethanol production and browning of cut lettuce. These models are useful for predicting when modified-atmosphere packaging should be applied and more often where it may not work due to physical limitations. The scientists have found that many products cannot use the packaging due to physical limitations. Numerous companies and industries have saved tremendous amounts of money by using this data, which determined for them that modified atmosphere packaging would have failed for their produce.

Cut lettuce is one of the few products that can withstand modified atmosphere packaging. Washington's cherry industry used the concepts from this research to create a database for shipping their cherries far distances while maintaining post harvest quality.

The scientists continued efforts now reach outside the food produce industry. Their models are being used by the horticulture industry; research found that 1-methylcyclopropene (MCP) stops the production of ethylene, which deteriorates the quality of flowers. This information is now being used for potted flowers, cut flowers, orchids, carnations and ornamentals.

Worldwide, nations are using this information to make educated decisions about proper packaging for their products and the best shipping methods for importing and exporting products. MAES scientists continue to hold conferences and meetings globally to educate decision makers on these topics.

C. Source of Funding: MAES- Hatch, State, Crop and Food Bioprocessing Center Research Excellence Fund, DOW Chemical, BARD Grant, MCP Western Greenhouse Growers Association, Project GREEEN, USDA Special Grant, Binational Agriculture Research Development

D. Scope of Impact: MI, CA, New Zealand, Australia, Netherlands, Thailand, Germany, Kenya, England

3) Evolution and adaptation of pathogenic E. coli. - WHITTAM

KEY THEME: food safety, foodborne pathogen protection

A. Brief Description: MAES research focused on Shiga toxin-producing *Escherichia coli* (E. coli) or STEC. These bacteria are a major cause of food and waterborne outbreaks of disease, and contribute to sporadic cases of foodborne illness around the world. The E. coli strain 0157:H7 causes 73,000 cases of infection and 61 deaths in the United States each year. STEC can cause damage to blood cells and kidney tissues resulting in kidney disease. STEC infection is a leading cause of kidney failure sometimes resulting in death, particularly, of the elderly and children. One of the main goals is to organize and characterize the more than 100 different types of STEC. Analyzing the disease-causing characteristics of 0157:H7's and understanding its process of natural mutation, can lead to future developments to suppress this occurrence in other potential pathogens.

The molecular evolution of virulence factors is also being researched. By sequencing representative alleles of these mobile virulence factors, MAES scientists can infer the history of lateral gene transfer and the mode of action of natural selection on surface molecules.

Research is being conducted on stress response and adaptations in pathogenic bacteria that allow them to persist in external environments outside of the mammalian host. In

particular, MAES scientists are interested in the evolution of mechanisms for acid resistance, adaptations that may be critical for a low infective dose and enhanced ability of pathogenic strains to survive in water and food processing.

B. Accomplishment Statement: MAES scientists collaborated to establish the STEC Center at The National Food Safety and Toxicology Center at Michigan State University to facilitate research on the Shiga-toxin producing E. coli. The STEC Center provides investigators worldwide with a standard reference collection of well-characterized strains and a central online database. The STEC Center acts as a repository of STEC from new outbreaks and environments as they are identified. Additionally, MAES researchers are able to use the repository to conduct rapid characterization of STEC based on genetic markers and are then able to further subtype strains. In the past three years the STEC Center has received more than 125 different strain requests accounting for 4,624 cultures being sent worldwide.

   Recently, The National Institutes of Health awarded a $10.2 million research contract to MAES scientists to explore the microorganisms that cause food and waterborne infectious diseases.

   MAES researchers have fostered a relationship with Michigan Department of Community Health (MDCH). MDCH established a network of hospitals to collect samples, which are then analyzed by MAES and compared to the STEC Center repository.

   Further research is being conducted in conjunction with the University of Maryland to develop an animal model that shows the same kidney disease response as humans. A rabbit breed was discovered that meets qualifications. Researchers are in the process of characterizing and comparing animal E. coli strains to human E. coli strains. Future research will focus on designing therapeutic treatments such as vaccines to prevent children from kidney disease as a result of an E. coli infection.

C. Source of Funding: MAES- Hatch, State, National Institutes of Health, Odwalla

D. Scope of Impact: global, MI, WA, NJ, University of Maryland, NY

4) *Phytophthora infestans* analysis to improve potato industry quality and economics. – KIRK

KEY THEME: food security, food quality

A. Brief Description: *Phytophthora infestans* (Phytophthora) causes potato late blight, which is a devastating disease that affects all potato growing regions in the world. Phytophthora was the cause of the 1845 potato famine in Ireland. Potatoes remain the fourth most important food crop as a staple food item. Annually, worldwide there are 4.1 million hectares of potatoes grown; 25 percent of these are waste due to Phytophthora, which translates into $2.75 billion lost. In addition, 25 percent of total fungicide usage is

targeted to controlling Phytophthora. In the United States more than $77 million is spent on fungicides to control the disease.

MAES researchers have specifically analyzed the genotype US8 of Phytophthora, which is the predominant genotype that is aggressive and able to survive cold. US8 attacks United States potato varieties more than any other genotype.

B. Accomplishment Statement: MAES scientists found that the risk for Phytophthora is increasing and that the pathogen is changing. The risk increase is a result of increased precipitation days, increased temperatures and the pathogen's adaptation to cooler temperatures.

Knowing the increased Phytophthora risk, MAES plant pathologists worked with the MAES potato breeder in developing and testing new potato varieties. They developed the new variety, Jacqueline Lee, resistant to the US8 genotype of Phytophthora. Commercial potato breeders are using MAES-developed varieties in developing new late blight resistant lines.

Fungicide application method and timing was also analyzed. Liquid fungicide seed treatment was found more efficient and healthier for the applicator than dusting or spraying. Over the last nine years Michigan potato growers have decreased their fungicide purchases from $250 per acre to $100 per acre due to implementation of the MAES application techniques.

MAES operates a renowned late blight research/training facility where growers and scientists can come and learn. MAES scientists spend time training international students on managing the disease through the Institut des Sciences Agronomiques du Rwanda (ISAR) program. MAES scientists also provide additional management training by doing "home visits" to potato growers. Extension has been teaching management techniques and advising throughout Michigan. Seminars are held at the Michigan Potato Winter Conference and at the Great Lakes Vegetable Show.

MAES implemented a free Web site announcing late blight risk warnings. The Web site analyzes the weather conditions for late blight risk, late blight location and management recommendations.

The scientists continue their research on clarification of genetic controls underlying the resistance of potatoes, and the genetics of the pathogen's ability to infect varieties of tubers.

C. Source of Funding: MAES- Hatch, State, Project GREEEN, Michigan Potato Industry, National Potato Council, ARS, CREES- Special Grant, North Central IPM, Syngenta, BSF, DuPont, DOW, Bayer, Griffen, Nufarm, Gustafson, UAP, Arvasta, IR4, Frito Lay

D. Scope of Impact: Multi-State: MI, WI, ND, MN and Belfast, ID, ME, TX, CO, VA

5) Epidemiology and risk analysis of bovine tuberculosis in wild and domestic animals in Michigan. - KANEENE

KEY THEME:

A. Brief Description: Bovine tuberculosis (TB) in Michigan is being recognized as more prevalent in wildlife and livestock species than originally thought. The current combination of active and passive surveillance programs, as well as control and eradication efforts, have shown that more interdisciplinary research is needed to provide information needed to deal with the problem.

Since there is currently no cost-effective treatment for TB in livestock, the only option available for control of infection is the isolation of suspect or exposed individuals, and slaughter of infected animals. The best source of information to design effective TB control programs for Michigan livestock is through risk analysis that integrates information from different disciplines – particularly epidemiology and economics.

The current diagnostic tests along with gross and microscopic examination of tissue are adequate for detection of TB, however, they take considerable time, effort and are expensive.

MAES researchers conducted epidemiological studies to determine the major factors influencing TB transmission in free-ranging deer and livestock, and to develop risk analysis models for TB in livestock and wild deer.

B. Accomplishment Statement: A matched case-control study of cattle in the TB-affected area was conducted to identify herd management factors and environmental conditions associated with herd TB status, which was published. A stochastic risk assessment model for herd TB status was developed based on the study and is being validated with data from cattle herds that were not a part of the study. In addition, a method to examine the trade-offs between expected benefits and expected costs of biosecurity management practices and investments was developed. This model is directly applicable to Michigan livestock operations under risk of TB infection and provides a basis for informed and economically viable decisions.

Currently approved diagnostic screening tests for *Mycobacterium bovis*, which causes TB include the caudal fold tuberculin test (CFT), comparative cervical skin test (CCT), and the whole blood gamma interferon assay. In the MAES epidemiological studies, it was observed that the CFT and CCT tests, the major tests used in TB surveillance, needed evaluation. MAES scientists found an association between *Mycobacterium paratuberculosis*, which causes Johne's disease in cattle and a false response to the CFT. MAES scientists continue to study the relationship between cattle and cattle herds infected with *M. paratuberculosis* and response to diagnostic screening tests for *M. bovis*. New testing regulations for TB in Michigan will allow testing on herds with a known high incidence of infection with *M. paratuberculosis.*

The effect of specific vaccines on the reliability of TB diagnostic tests is also being analyzed by MAES scientists. By understanding the potential effect of vaccines on the TB diagnostic screening tests is critical to reduce the number of false positive or negative test results and potential misclassifications of individual animals or herds. They are using a modified-viral vaccine as models for the study.

MAES scientists used state of the art technologies to identify diagnostic targets for detection of cattle with TB. They chose polymerase chain reaction (PCR) and DNA microarray analysis. Preliminary results on the effect of sample handling and transport details were presented to the Tuberculosis Committee of the United States Animal Health Association. The development of quantitative real-time PCR and DNA microarray analysis of gene analysis expression offers new technologies that can be used to improve and/or expedite diagnostic testing for TB.

Research continues in the development of a Laser Capture Microdissection (LCM) equipment and techniques resulting in increased sensitivity for postmortem detection of TB.

Additional TB information is being gathered by MAES scientists to determine where in the environment *M. bovis* exists, and the length of time it survives and remains infective to cattle and wildlife. This is fundamental to understanding the epidemiology of TB in Michigan. The combination of bacteriologic culture and DNA-based isolation techniques will allow for the determination of both presence and viability of *M. bovis* in the environment. This will provide research-based guidelines for environmental cleanup and time required prior to re-population of farms, and intervention strategies to reduce or eliminate indirect transmission of TB.

C. Source of Funding:

D. Scope of Impact: MI

Goal 3

A Healthy, Well-Nourished Population

Executive Summary

To achieve a healthy and well-nourished population, it is essential to provide integrated research approaches that range from behavioral modification of dietary patterns to fundamental elucidation of mechanisms associated with chronic diseases and other health anomalies. The research conducted under this goal encompasses the breadth and depth required to achieve a significant impact on the health status of the people of Michigan with implications on a national and global scale.

MAES scientists are actively engaged in cross-university programs that are centered on food and health, particularly the relevance of nutritional immunology to health. We are creating a Center for Nutritional Immunology at Michigan State University to increase awareness among health care providers of the degree to which suboptimal nutriture which accompanies many chronic diseases can impair immune defense. Some specific MAES projects in this area include (a) dietary zinc: its effect on host defense and gene expression of cells of the immune system; (b) role of vitamin A in development and maintenance of immune dentritic cells; (c) obesity induced cardiovascular diseases - effects of leptin on C-reactive protein (CRP) and anti-inflammatory nutrient effects on CRP; (d) tree nut food allergy - therapeutic and prophylactic evaluation of dietary modification with immune modulators in a mouse model; (e) potential role of probiotic lactobacilli in modulating Th1 and Th2 responses by differential activation of tall-like receptors: implications for allergies and inflammatory diseases; (f) colon epithelial cells condition the immune response to bacterial pathogens: integration of signals from cytokines and probiotic bacteria.

These studies augment other “nutriceutical” studies reported earlier and that follow this summary. Dry beans have been found to reduce the incidence of colon cancer in laboratory rats, while anthocyanins in tart cherries may have the potential to reduce, or prevent, colon cancer. This information is consistent with trends linking food intake with human health, and complements the anti-inflammatory action seen in cherry products such as juice concentrates and pills.

These biochemical nutritional studies complement the community nutrition programs at Michigan State University. The goals of these programs are to (a) apply nutrition and social sciences to identify, prevent and ameliorate dietary risk and manifestations of chronic disease, e.g., diabetes, obesity, hypertension, cancer; (b) create linkages between various stakeholder groups in local communities to achieve improved health and visible outcomes; and (c) educate future leaders and advance the application of nutrition and behavioral sciences to human health.

A number of key MAES scientists continue to capitalize on federal funding for behaviorally based research with emphasis on “food, health and society”. Target research themes in key agencies include child obesity, reduce health disparities, and increase intakes of fruit, vegetables, and low fat dairy foods to reduce dietary risk for chronic diseases. Collaborating units include MSU Extension, Institute for Children, Youth and Families, and Healthy U.

Allocated resources

	FY 2003	FY 2004	FY 2005	FY 2006	FY 2007	FY 2008
Hatch Funds						
Hatch Regular	118,828	122,612	126,321	129,956	133,518	137,008
Multi-State Funds	44,156	44,156	44,156	44,156	44,156	44,156
Other CSREES Funds*	139,864	139,864	139,864	139,864	139,864	139,864
Other Federal Funds*	1,499,465	1,499,465	1,499,465	1,499,465	1,499,465	1,499,465
Total Federal Funds (est.)	1,802,313	1,806,098	1,809,806	1,813,441	1,817,003	1,820,494
State Match for Hatch Funds	162,984	166,769	170,477	174,112	177,674	181,165
Remaining State Appropriations	1,219,790	1,119,211	1,051,203	986,485	924,893	866,274
Self Generated Funds*	5,340	5,340	5,340	5,340	5,340	5,340
Industry Generated Funds*	91,887	91,887	91,887	91,887	91,887	91,887
Other Non-Federal Funds*	102,807	102,807	102,807	102,807	102,807	102,807
Total State Funds (est.)	1,582,808	1,486,014	1,421,715	1,360,631	1,302,601	1,247,472
Total Estimated Funds	3,385,121	3,292,111	3,231,521	3,174,072	3,119,604	3,067,966
Scientist Years	4.7	4.7	4.7	4.7	4.7	4.7

*Values extracted from Fiscal Year 2003 Funds and Manpower report

1) Value-added products working to improve human health. - NAIR

KEY THEME: medicinal plants

A. Brief Description: Several plants were studied for their anti-parasitic and anti-inflammatory activities. These plants were screened for their effects on the disease called *schistosomiasis*, caused by a parasitic worm known as schistosoma. *Schistosmiasis* is rampant in Africa, South America, Caribbean, China and Korea. It is second behind malaria in numbers of infections and deaths.

New methodologies for the treatment and prevention of schistosoma infections are needed quickly because schistosoma has generated drug-resistant strains to the current treatment drugs. Also, schistosoma is now being detected in the food chain of affected nations, particularly in beef, pigs and poultry.

MAES scientists studied components of the daylily that could be refined and used in prevention/treatment of *schistosomiasis*. The daylily is used as a treatment for *schistosomiasis* in Asia; however the active compounds have not been fully characterized. In addition, using the daylily roots is dangerous due to toxic side effects and deaths associated with the administration of the root extracts.

B. Accomplishment Statement: MAES scientists were able to pinpoint two precise compounds in the daylilies that can be further developed as forms of treatment. Compound 3 immobilized all cercariae within 15 seconds, however upon removal of the compound, 20 percent of the immobilized cercariae recovered after 24 hours. Compound 6 immobilized the cercariae within 12 -14 minutes. Following removal of the compound,

all cercariae died within 24 hours. The adult worms were immobilized within 16 hours by both compounds.

The compounds will also be tested on other parasitic problems.

This research will help to improve the health of millions of people worldwide, especially low-income people in developing countries. Currently the disease afflicts more than 200 million people, killing nearly 1.5 million annually. The World Health Organization estimates another 600 million are at risk.

C. Source of Funding: MAES- Hatch, State, Center for Plant Products and Technologies, Biotechnology Research Technology Program, National Center for Resources, National Institutes of Health

D. Scope of Impact: MI, CA, FL

2) Understanding behavioral ecology of mosquitoes. - MILLER

KEY THEME: human health

A. Brief Description: The Food Quality Protection Act (FQPA) of 1996 amended the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA) and the Federal Food, Drug and Cosmetic Act (FFDCA). These amendments fundamentally changed the way the EPA regulates pesticides and was the precursor to this research. The goal of the research is decreasing conventional insecticide use.

To increase their understanding of mosquitoes, MAES researchers initially worked on a microsprayer system. The system was to reduce mosquito attacks on humans by drawing air through a DEET-impregnated screen by way of a fan. While the combination proved effective, the scientists recognized the importance of wind as a factor.

Past explanations for decreased mosquito attacks included environmental factors such as temperature, humidity and wind. Research suggested that wind limited the flight of the small insect. Few data were available on mosquito flight responses to manipulated wind velocities.

Carbon dioxide is the best-known mosquito attractant and was used as the sole attractant for the tests. The scientists' objectives were to quantify the mosquito response to fan-manipulated wind velocities under several carbon dioxide release rates and test the flight-limitation versus stimulus-dilution models for wind effects on mosquito host-finding behavior.

B. Accomplishment Statement: Diseases such as West Nile virus (WNV) and malaria are a driving force behind this research. Malaria continues to be the No. 1 disease worldwide. In 2002 in the United States, WNV infected 4,156 humans, with 284 deaths reported. In 2003, 6,411 people have been infected.

MAES scientists assessed the potential of wind generated by electric fans to reduce mosquito attacks in a backyard setting. Despite prevailing interpretations that mosquito orientation is limited by flight capacity, MAES data overwhelmingly supported a stimulus-reduction model. In addition, the researchers found that an increasing wind velocity decreased the mosquito response.

For all mosquito species encountered in this study, wind alone uniformly and dramatically reduced captures in traps. In many Michigan locations there are 10 species present at any given time. Artificial wind used as a barrier between people and mosquitoes does not have to be aimed directly at people, but used to dilute the carbon dioxide people exhale.

Using this knowledge to create a safe and practical product for private use is being assessed.

C. Source of Funding: MAES- Hatch, State, Ford Motor Company, USDA

D. Scope of Impact: MI

3) Strengthening the cherry market while improving nutritional awareness. - NAIR

KEY THEME: nutricuetical

A. Brief Description: Before MAES research, demand for cherries was low. Traditionally, cherries were used mainly in desserts. As people became more concerned about healthy eating, demand for desserts decreased.

MAES research looked into developing new markets for cherries. To increase the demand for cherries the scientists studied the nutritional benefits of eating cherries.

B. Accomplishment Statement: Scientific data gathered by MAES researchers demonstrated the health benefits of eating cherries.

The researchers studied the impact of cherry consumption on animals and found that the cherry's red pigment contains components that reduce colon cancer; work as an anti-inflammatory that reduces pain caused by headaches, gout and menstruation; and antioxidants.

Because the health benefits of cherries were widely publicized, demand exceeds supply. Michigan's cherry industry is valued at $140 million and producers receive a premium price. Michigan is the No. 1 producer of tart cherries nationally and globally. Many value-added cherry products have been developed, such as the cherry burger. In addition, juice producers have used the data in advertising and promotion. The Cherry Marketing Institute also continues to use the information in their literature.

The data collected have also been transferred to other fruits, including blueberries, strawberries and cranberries.

C. Source of Funding: MAES- Hatch, State, National Institutes of Health, USDA, Midwest Food Manufacturing Alliance, Cherry Marketing Institute

D. Scope of Impact: MI, UT, WI, NY, PA, CO, OH, OR, WA

4) Increased understanding of bacterium to prevent animal and human illnesses. – LINZ
KEY THEME: human health

A. Brief Description: The bacterium, *Campylobacter jejuni*, causes 2 to 4 million cases of food-borne illness and more than 100 deaths each year, costing billions of dollars. According to MAES scientists, in terms of sheer numbers, this pathogen is two to three times more prevalent than other food-borne pathogens. Approximately 90 percent of chicken meat contains *Campylobacter jejuni* bacteria, according to MAES scientists. While most people infected with *campylobacteriosis* recover relatively quickly, some do become seriously ill and ultimately die. *Campylobacteriosis* is difficult to fight because the bacterium can be resistant to even the toughest antibiotics and can transform itself from one "bug" to another.

B. Accomplishment Statement: MAES scientists conducted thorough research on Campylobacter to increase the understanding level. They found that if there are 1 billion Campylobacter bacteria in a given area and one is resistant to antibiotics, then that one bacterium can pass resistance to its neighboring bacterium, thus spreading resistance through the populations in the laboratory.

MAES scientists developed a molecular assay to the bacterium using real time PCR. This molecular assay has a patent and through fecal samples can give results within 48 hours indicating the presence of the bacterium. Specifically, this assay was designed to identify resistant bacterium in people. If the assay finds them, physicians can be alerted to treat them with other antibiotics. Antibiotic resistance is an important issue for people more susceptible to pathogens, such as older people, diabetics and the immunocompromised. MAES scientists note that antibiotic resistance can come from animals. In the '90s producers treated chickens with antibiotics and when Campylobacter became resistant to these antibiotics, infected people became resistant to the antibiotics as well.

Currently, the scientists continue to study the antibiotic resistance of the bacterium. They are learning the bacterium's method of natural transfer at the molecular and genetic level. The scientists have identified genes and can stop it from transferring in the laboratory. One of their next goals is to develop an animal vaccine that can lower or eliminate the bacterium in meats such as chicken and, therefore, reduce human illness.

C. Source of Funding: MAES- Hatch, State, Pharmacia, MSU's Food, Safety and Toxicology Center

D. Scope of Impact: MI

5) Prevention of cartilage degradation. - ORTH

KEY THEME: human health

A. Brief Description: *Osteoarthritis* (OA) is the leading cause of lameness and decreased performance in horses and is a debilitating, lower extremity disease in humans. OA is the result of degradation exceeding synthesis. As cartilage in joints breaks down, it can cause joint inflammation, pain, decreased mobility and reduce athletic performance in humans, horses and dogs. Once clinical signs of OA are detected, the disease is considered irreversible, so attention has turned to OA prevention, symptom treatment and slowing the disease's progress. Traditional treatments, including surgery, non-steroidal anti-inflammatory drugs and corticosteroids, have limited success and often have significant side effects preventing long-term use.

   Glucosamine is a potential anti-arthritic compound currently being marketed. It is a naturally occurring, nontoxic compound that when given orally decreases pain and improves mobility in osteoarthritic joints. Previous studies have evaluated the ability of glucosamine to relieve pain but have not evaluated its affect on cartilage degradation.

   Oral supplements that prevent cartilage degradation and/or joint injury are an attractive solution to OA in humans and domestic animals.

B. Accomplishment Statement: Glucosamine has the potential to prevent or reduce cartilage degradation. Research in horses provides biochemical evidence supporting the increased anabolic activity while simultaneously suppressing the effects of cartilage degradation, and suggests disease-modifying characteristics for the compound.

   While other compounds can inhibit cartilage degradation, most are toxic if taken orally.

   Glucosamine is widely available, relatively inexpensive, absent of known side effects, has a high oral absorption rate and is readily transferred to cartilage tissue.

   Currently arthritis affects 70 million Americans, making it one of the most prevalent diseases in the United States as well as worldwide. As the population ages, this number will increase dramatically without preventative products such as glucosamine being introduced.

C. Source of Funding: MAES- Hatch, State, Nutramax Laboratories, Grayson-Jockey Club, USDA Animal Health Funds

D. Scope of Impact: MI, ND

Goal 4

Greater harmony between agriculture and the environment.

Executive Summary

Michigan Agricultural Experiment Station (MAES) researchers are nationally recognized as intellectual leaders in discovering the biological basis of sustainability and developing mechanistic models to guide public policy development. Research efforts encompass the social, political and macroeconomic dimensions of agricultural sustainability. Research contributions have excelled in developing a fundamental understanding of the influence of agro-ecosystems on soil macro and microorganism habitats and food sources. The W.K. Kellogg Biological Station near Battle Creek, Michigan is the home of the National Science Foundation established Long-Term Ecological Research (LTER) and Living Field Laboratory (LFL). This site is the only agricultural landscape in a national network of ecological monitoring sites.

Advances by MAES scientists have resulted in increased efficiency of plant agriculture inputs. Crop producers evaluating an improved nutrient management record-keeping program developed by a MAES researcher experienced savings between $5 and $20 per acre without a decrease in yields. A non-till pumpkin production system using nitrogen fixing legume cover crops has reduced nitrogen fertilizer needs by 110 pounds per acre. If this system were applied across Michigan's 6,000 acres of pumpkin, 330 tons less synthetic nitrogen fertilizer would be required. The adoption of weather based disease prediction models field-tested with asparagus and carrot growers in a single western Michigan county resulted in a combined reduction of fungicide costs of over $100,000 without increased disease incidence by timing applications to match peak pathogen conditions.

Local food systems are being strengthened through MAES research on a unheated tunnel organic production system that permits the production of high value nutritious vegetables throughout the winter. These fresh products receive premium prices because of their availability during a time of the year when fresh local produce is not generally available to consumers and the organic production system. Students associated with the Michigan State University Organic Farm have formed a community farm association by selling shares to Michigan State University personnel. The students have adopted the tunnel production system to provide their members yearlong fresh vegetables.

Farmer markets are being strengthened through research by MAES nutrition and economic researchers working with sustainable agriculture organizations. The success of these markets increases the profitability of producers while providing a means of linking urban consumers to local producers.

MAES research stations and scientists partner with local food banks to distribute vegetable and fruit crops produced through research projects. MAES as part of a state-wide network of producers donated a total of 29,500 pounds of sweet corn, 52,000 pounds of tomatoes, 158,800 pounds of apples to Michigan food banks for the benefit of adults and children without the economic means to purchase food.

Allocated resources

	FY 2003	FY 2004	FY 2005	FY 2006	FY 2007	FY 2008
Hatch Funds						
Hatch Regular	909,331	938,292	966,673	994,488	1,021,745	1,048,458
Multi-State Funds	208,839	208,839	208,839	208,839	208,839	208,839
Other CSREES Funds*	3,934,420	3,934,420	3,934,420	3,934,420	3,934,420	3,934,420
Other Federal Funds*	6,829,702	6,829,702	6,829,702	6,829,702	6,829,702	6,829,702
Total Federal Funds (est.)	11,882,292	11,911,253	11,939,635	11,967,449	11,994,707	12,021,419
State Match for Hatch Funds	1,118,170	1,147,131	1,175,512	1,203,327	1,230,585	1,257,297
Remaining State Appropriations	7,909,357	7,248,469	6,800,307	6,373,702	5,967,593	5,580,971
Self Generated Funds*	612,751	612,751	612,751	612,751	612,751	612,751
Industry Generated Funds*	1,777,463	1,777,463	1,777,463	1,777,463	1,777,463	1,777,463
Other Non-Federal Funds*	2,111,013	2,111,013	2,111,013	2,111,013	2,111,013	2,111,013
Total State Funds (est.)	13,528,753	12,896,826	12,477,046	12,078,255	11,699,403	11,339,494
Total Estimated Funds	25,411,044	24,808,078	24,416,680	24,045,703	23,694,110	23,360,914
Scientist Years	40.1	40.1	40.1	40.1	40.1	40.1

*Values extracted from Fiscal Year 2003 Funds and Manpower report

1) Management of onion pests. – GRAFIUS

KEY THEME: IPM

A. Brief Description: In the 1980s, insecticide resistance had built up to high levels in the onion maggot and serious crop losses to Michigan onion growers were common. Growers treated the onions at planting with a granular insecticide (fonofos or chlorpyrifos) followed by an average of 6 to 12 and up to 33 foliar sprays of parathion or other organophosphate insecticides. In 1993 a very cool, wet spring was conducive to onion maggot problems with damage, in spite of all control efforts. An estimated average of 9.6 percent crop loss was reported by many growers with one or more fields having more than 40 percent loss. Control costs and losses to the Michigan onion industry in 1993 totaled nearly $2.7 million.

B. Accomplishment Statement: Research by MAES scientists identified the insect growth regulator cyromazine as a new approach to onion maggot management, and conducted the initial field and laboratory research. Cyromazine gives excellent control of onion maggots resistant to organophosphate, carbamate and organochlorine insecticides and has minimal impact on beneficial insects. Research evaluated cyromazine formulated as a seed treatment for onions and resulted in full federal registration of cyromazine in 2001.

During this same period, research identified that foliar applications of insecticide were ineffective at controlling onion maggot and likely increased insecticide resistance problems in onion maggot and onion thrips, while killing potentially beneficial insects. A demonstration/extension program was initiated to encourage growers not to spray at all for onion maggot and to spray only if treatment was needed to control onion thrips.

Growers obtain highly effective control with cyromazine applied as a seed treatment at 50 g/kg seed (about 50 g cyromazine/A) compared to 1-pound (453 g) chlorpyrifos per acre. This is a reduction of 3,400 pounds of active ingredient of insecticide per year for the current 3,900 acres of Michigan onions. No significant losses to onion maggot have been reported in recent years, in spite of cool, wet spring weather in 2003. Foliar sprays have been reduced from an average of approximately nine per year, primarily aimed at controlling onion maggot, to four to six per year for control of onion thrips based on crop scouting and economic thresholds, a further reduction of 9,750 pounds of active ingredient of insecticide per year.

Cool, wet spring and early summer conditions like those in 1993 occur once every five to 10 years. Assuming that losses similar to those that occurred in 1993 would appear at least once per 10 years, average losses could have been $259,000/year if cyromazine had not been registered for onion maggot control. Taking into account the reduction in onion acres in Michigan over the past 10 years (7,100 acres harvested in 1993 vs. 3,900 acres harvested in 2002), and the current crop value ($8.96 million), this amount would be $86,000 per year (9.6 percent loss, one year in 10). Net savings including protection from onion maggot damage, the higher cost of cyromazine treatment vs. chlorpyrifos, and reduced cost of foliar insecticides are estimated as $203,000 per year.

Ontario and New York have been interested in this research and will be implementing the management approach.

C. Source of Funding: MAES- Hatch, State, Michigan Onion Research Committee, Michigan Vegetable Council, USDA-CES IPM Competitive Grants Program, New York Agricultural Experiment Station, USDA-CES Competitive Grants Program, Ceiba-Geigy Chemical Company

D. Scope of Impact: MI, NY

2) Management of Colorado potato beetle. -GRAFIUS
KEY THEME: IPM, pesticide application

A. Brief Description: In the early 1990s, Colorado potato beetle had developed high levels of resistance to all insecticides used for its control. From 1991-1994, the Michigan potato industry experienced severe crop losses in spite of very expensive control efforts using multiple applications of insecticides. During this period, losses were $3 to $9 million per year (3 to 13 percent of crop value) and control costs were $5 to 7 million per year. Losses and control costs totaled $8 to 14 million per year (9 to 20 percent of total crop value).

B. Accomplishment Statement: MAES researchers along with others identified imidacloprid as a highly effective insecticide for control of Colorado potato beetle resistant to organophosphate, carbamate and organochlorine insecticides. This information was

presented to the EPA and full federal registration was granted in time for the 1995 field season.

Growers obtain highly effective control with one at-planting application of imidacloprid. Thiamethoxam has subsequently been registered for this use and is equally effective. Now growers almost never need to apply additional insecticides for control of Colorado potato beetle. In addition, the amount of insecticide applied to potatoes in Michigan has been reduced by 387,000 pounds of active ingredient per year (81 percent).

MAES research continues to monitor the status of insecticide resistance in Colorado potato beetle. High levels of resistance to imidacloprid have developed on Long Island NY, Delaware, Massachusetts, Maine, and Pennsylvania. In addition, high levels of resistance to imidacloprid have been created in the laboratory by selecting beetles collected originally from Michigan demonstrating that our beetles have the capacity to develop resistance in the field. Research continues on resistance status and management for this important insect.

Control costs have decreased from an average of $290 per acre during 1991-94 to $60 per acre in 2002. Yield losses averaged nearly $6 million/year from 1991-1994; growers report little or no yield losses in recent years. Savings to the Michigan industry are estimated at more than $17 million per year in reduced control costs and losses.

Approximately 80 to 90 percent of potato acreage in the northeastern and north central United States and most of the acres in eastern Canada are treated with imidacloprid.

C. Source of Funding: MAES- Hatch, State,, Michigan Potato Industry Commission, Potato Growers of Michigan, USDA's National Potato Research Program and NC Regional IPM Competitive Grants Program, Michigan Energy Conservation Program, Bayer Corp.

D. Scope of Impact: MI, NY, DE, MS, MA, PA

3) Improving the blueberry industry through sustainable management of the Japanese beetle. - ISAACS

KEY THEME: biological control, IPM, sustainable agriculture

A. Brief Description: The Michigan blueberry industry in 2001 named the Japanese beetle as the No. 1 pest management challenge facing the $55 million industry. This invasive pest has spread throughout the blueberry production region in the state. A majority of the blueberries produced in Michigan are harvested with machines, creating a risk of contamination by beetles. The Japanese beetle has caused producers to increase their use of conventional insecticides, while the continued implementation of the Food Quality Protection Act threatens to restrict availability of insecticides in the future. This has the potential to create a disastrous combination of processor zero tolerance standard, reduced control options and an increasing pest population.

MAES research objectives were to understand the beetle's location, determine what chemicals worked to kill the beetle and develop ways of removing the beetles from the harvested blueberries.

Besides its damage to the blueberry industry, Japanese beetle implications are widespread as it attacks a number of plants, including fruit, field crops, turf, and nursery and landscape plants.

B. Accomplishment Statement: MAES scientists discovered that there is a high density of Japanese beetle grubs in and around blueberry fields and fields with grass between rows. Cultivated blueberry fields were found to have a 90 percent reduction in grub density.

Based on the research, it was recommended to blueberry producers to cultivate the fields. It has been estimated that an additional 40 percent of producers are cultivating. Unfortunately clean cultivation is difficult for some producers to implement, as many fields are bogs, which makes driving the machinery in the fields difficult. Due to this complication, research is analyzing alternative ground covers that have fewer beetles/grubs to become a component of an integrated pest management program.

MAES researchers were able to demonstrate that a soil insecticide registered for turf was effective against the beetle in blueberries and obtained emergency registration for the last two years. The insecticide is useful for land where grass can't be cultivated and is applied once a year. While the insecticide is expensive it has reduced the beetle by 90 percent.

As an alternative to applying additional insecticides, the scientists are testing organic and biological products that can be used just before harvest to remove the beetle. This data has obtained one emergency registration and full registration on others.

Harvesting machines were also analyzed and developed to detect and remove more than 95 percent of beetles.

In addition, a Web site was created to track the beetle across the Midwest using the public, extension agents and researchers to input data as soon as the beetle is detected. This information will show the movement and speed of infiltration of the beetle across the region. The Web site also allows growers to integrate all of the management tools to suppress beetle populations and reduce pesticide use.

Implementing these long-term management strategies works to solve the problem of Japanese beetles in Michigan blueberries and maintain the zero tolerance policy. Michigan blueberry processors and marketers estimate they have already lost nearly $10 million of processed blueberry sales during the past two years due to Japanese beetles.

C. Source of Funding: MAES- Hatch, State, North Central Region Integrated Pest Management, USDA Crops at Risk Program, Project GREEEN, Michigan Blueberry Growers Association

D. Scope of Impact: MI, IL, East Coast and Midwest, with widespread implications for a number of plants on which the beetle feeds.

4) Linking crop and livestock producers in nutrient management. BLACK

KEY THEME: agriculture waste management, nutrient management, soil quality

A. Brief Description: As fertilizer costs continue to rise and regulations on their use tighten, MAES scientists have focused on nutrient management among producers. The initial focus of their research assessed the benefits of nutrient management to crop and livestock producers in Michigan.

Linking these two groups of producers seems to create a win-win situation for both parties according to results from this study. A waste product, manure, from the livestock industry is a containment and disposal issue for livestock producers. At the same time, crop producers are trying to improve yield while decreasing fertilizer application to soil.

MAES scientists found a perfect partnership between potato and poultry producers.

B. Accomplishment Statement: For the last two years, MAES scientists have seen a 12 to 15 percent increase in potato yield after poultry manure treatments. These gains are large enough that the new concern among Michigan potato producers is the manure suppliers raising prices. The potential joint gains to livestock and poultry producers (suppliers) and potato producers (potential users) are in the range of $500,000 to $900,000 per year for Michigan. The results may generalize to other areas in the United States with similar soils and livestock and poultry operations.

This research had long-term impacts of improved organic matter, improved yield, improved irrigation efficiency and reduced fertilizer application.

Research continues in developing sound contracts between the two industries in order to continue to improve the harmony between agriculture and the environment.

C. Source of Funding: MAES- Hatch, State, EPA, USDA IFAS

D. Scope of Impact: MI, ME, IA

5) Microbial ecology of soil and biodegradation. - TIEDJE

KEY THEME: hazardous materials, water quality

A. Brief Description: Chlorinated chemicals used as pesticides and fumigants are important to the agricultural industry. In the environment, these chemicals can have toxic effects on organisms and humans. Prior to MAES research in this area, there was no perfect solution to clean aquifers polluted by these chemicals. The previous best method used to clean

aquifers was the “pump and treat” method. This method is very costly, takes many years and is never 100 percent successful.

B. Accomplishment Statement: During the research project MAES scientists found a new metabolism in microbes, halorespiration that results in the dechlorination of chemicals and the generation of energy for microbe growth. The researchers found an organism using halorespiration that grows on some of the problematic solvents.

   The researchers introduced the specific microbes into field trial areas with contaminated aquifers. Within six weeks, the microbes achieved 100 percent removal of the chlorinated chemicals from the aquifer. This method proves to be a cost effective way to remove environmental contaminants, is 100 percent successful, fast, and introduces only natural organisms into the environment.

   Companies such as DOW, DuPont, and the U.S. Air Force are using this information. Halorespiration is also being implemented and promoted by companies hired to clean up the environment such as Regenesis and Geosyntech.

   MAES scientists are continuing their research in this area to develop DNA-based molecular diagnostic technologies, which allows for more reliable management of these environmental clean-up processes. This additional research information will be able to measure microbe occurrence indicating how well the treatment condition is stimulating growth for the microbe.

C. Source of Funding: MAES- Hatch, State, Department of Defense, EPA, NIEHS

D. Scope of Impact: MI, GA, OK

6) Bioavailability of soil contaminants to bacteria, plants and humans. – BOYD

KEY THEME:

A. Brief Description: Organic contaminants and pesticides enter soil and adhere to soil particles, which influences the way contaminants move and their availability to bioremediation. MAES scientists have discovered a method of bioremediation using bacteria in the cleanup of contaminants. In order for the cleanup to work, the contaminants must be available to the bacteria. As the contact time increases between the soil and the contaminant there is reduced bioavailability, this lapse in time is considered “aging”.

   The bioavailability not only impacts the bioremediation methods, but also the absorption of the contaminants by plants and humans.

   Many are concerned about their child’s consumption of soil. It is estimated that each child eats an aspirin size of soil per day, which is a large quantity based on body mass. The organic contaminants and pesticides have the potential ability to cause cancer and are

suspected to cause reproductive health defects and premature births. Therefore, more information is needed to help determine the bioavailability to humans.

B. Accomplishment Statement: The bioavailability information gathered by MAES scientists will be used in determining acceptable levels of contaminants and the regulations for cleanup.

   To date, MAES scientists have analyzed old orchards at MSU which are no longer active. This was prompted because many of the old orchards in our fruit production areas of the state are being developed. The development of this land is of great concern to the children living there. There focus was on the historic pesticide contaminants applied to old orchards. They found that 50 percent of the samples were over the state levels.

   MAES scientists are measuring what the effects are on absorption based on the contaminants bioavailability. They are using a simulated digestive fluid extraction system to measure the bioavailability on humans, and established a method to measure the bioavailability of the contaminants on bacteria and plants.

   The data collected by MAES will help refine the state's risk assessment and develop appropriate state levels. It ensures the regulations are protective and that money is spent appropriately on sites that are needed.

   This information will dictate the cost and solution needed for cleanup. Currently cost for cleanup can range from $1,000-100,000 per acre at 1 foot depth based on the type of cleanup required.

C. Source of Funding: MAES-Hatch, State, NIH, NIEHS – Super fund basic research program, USDA Grant- NRICGP

D. Scope of Impact: MI

Goal 5

Enhanced economic opportunity and quality of life for Americans.

Executive Summary

Research addressing children, youth and family well-being, economic development and natural resources and environment are critical areas of work and impact for the well-being of Michigan families and communities. Research conducted under this goal spans multidisciplinary programs and community engagement approaches that Michigan Agricultural Experiment Station (MAES) researchers use to address complex social, environmental and economic issues.

The MAES has established a university-wide coalition of scientists, the Family and Community Together (FACT) Coalition, as a mechanism for coordinated and innovative work. The FACT Coalition serves to link research and extension faculty and specialists in interdisciplinary teams around families and health, education, child and youth development, and community vitality. During this past year in partnership with the MI Commission on Child Care and the MI Department of Community Health we identified early literacy as a priority issue for Michigan children. MAES scientists formed a timely and responsive collaboration between MSU, state agencies and community organizations to study early childhood, literacy and parenting. Their goal was to improve school readiness by involving parents, reaching vulnerable populations, training for child care providers, and developing and mobilizing community involvement.

Obesity, a growing public health problem that significantly impacts quality of life is a focus of MAES research. Michigan has the eighth highest rate in the United States for adult obesity (22.4 percent) and is second among the states in being overweight (38.7 percent). At MSU, experts who address obesity through their research and outreach work, include MAES faculty focused on basic science, prevention, intervention, treatment and policy. MAES research on public opinion and related policy issues found that two-thirds of Michigan residents perceive obesity as a personal issue, even though government agencies, the health community and education experts have identified it as a growing public health problem. Michigan adults were more supportive of proactive approaches to curb obesity, such as investing in recreational facilities and encouraging physical activity at work, rather than punitive measures like taxing fast food or increasing insurance premiums.

MAES researchers examine family and health issues across the life course. An innovative MAES program focused on nutrition education for toddlers has shown that good eating habits established in early childhood can lead to a lifetime of good health and nutrition. With support from National Institutes of Health, MSU faculty and extension staff are now expanding a research-based nutrition education program to 23 Michigan counties to help parents of toddlers make healthy food choices. MAES is also supporting a multidisciplinary, cross university team to implement and assess a health and fitness program for children in partnership with elementary and middle school principals. This project examines how to help students apply health promotion and disease prevention concepts to personal, family, and community health issues. The initiative is part of a shared vision with the Michigan Department of Education that also strives for students to use goal setting and decision making skills to enhance health. Work involving older

Michigan families includes the Michigan Seniors Farmers' Market Nutrition Pilot Program that encourages seniors to improve their diets, while helping America's family farmers increase their markets for locally-grown fruits and vegetables. Approximately 7,500 Michigan seniors will receive $20 in Project FRESH coupons to be redeemed at local farmer's markets.

Michigan, like so many states, has been challenged with rising unemployment rates, job loss, and state budget shortfalls. Our MAES research faculty is working closely with industry, government and communities to promote greater economic growth, prosperity and vitality. New work related to economic development and the environment includes research on corporate environmental management and business-led environmental initiatives, and research on identification, measurement and management of environmental costs in business, and implications for corporate strategy.

Tourism and recreation are a key factor in economic and community development in an amenities-rich state such as Michigan. Our MAES scientists are working with the state Department of Natural Resources, Travel Michigan, the USDA Forest Service and U.S. Army Corps of Engineers on economic development and tourism, with a focus on outdoor recreation and commercial recreation. Recent MAES projects are examining the valuation and demand for recreational fishing, economic impact of instate travelers and the role of welcome centers, and the economic impact of recreational enhancements in national forests and parks through such programs as rails to trails.

Allocated resources

	FY 2003	FY 2004	FY 2005	FY 2006	FY 2007	FY 2008
Hatch Funds						
Hatch Regular	233,447	240,882	248,168	255,309	262,307	269,164
Multi-State Funds	57,563	57,563	57,563	57,563	57,563	57,563
Other CSREES Funds*	1,163,218	1,163,218	1,163,218	1,163,218	1,163,218	1,163,218
Other Federal Funds*	227,529	227,529	227,529	227,529	227,529	227,529
Total Federal Funds (est.)	1,681,758	1,689,193	1,696,479	1,703,620	1,710,618	1,717,475
State Match for Hatch Funds	291,010	298,445	305,732	312,872	319,870	326,728
Remaining State Appropriations	1,944,302	1,780,395	1,669,166	1,563,281	1,462,476	1,366,501
Self Generated Funds*	11,686	11,686	11,686	11,686	11,686	11,686
Industry Generated Funds*	63,731	63,731	63,731	63,731	63,731	63,731
Other Non-Federal Funds*	173,909	173,909	173,909	173,909	173,909	173,909
Total State Funds (est.)	2,484,637	2,328,166	2,224,224	2,125,479	2,031,671	1,942,554
Total Estimated Funds	4,166,395	4,017,359	3,920,703	3,829,098	3,742,289	3,660,029
Scientist Years	6.7	6.7	6.7	6.7	6.7	6.7

*Values extracted from Fiscal Year 2003 Funds and Manpower report

1) Measuring Michigan's small scale farming. BINGEN
KEY THEME: community development

A. Brief Description: Development pressures remove some 75,000 acres of Michigan farmland per year. Much of this loss comes from mid-sized family farms. Michigan's small family farms are on the increase. They now number some 29,000 (about 60 percent of total farms) and offer enormous potential for more diversified and locally based economic activities.

   Many small-scale farmers tailor their production to meet consumer demand for locally produced food, which is increasingly available through farmers' markets.

   Until now, there was no collective information regarding Michigan's small-scale farmers (less than 40 acres), organic farmers or farmers' markets. MAES scientists characterized these target populations. The following information was collected by MAES researchers about Michigan's small-scale farmers: who they are, how many there are, their location and what they produce. The collected information allows for the target populations to come together in developing policy, setting standards and discussing the gathered information. The information increases awareness within interest groups and sparks additional conversations among the target population.

B. Accomplishment Statement: The information gathered helps to establish current trends and enhance the contributions that local food and farming can make for Michigan residents. MAES researchers provided the basis for addressing the following issues faced by Michigan agriculture: locally-grown food, food equity and access, assistance for new farmers, seasonal agricultural labor and the development of new farm-community alliances.

   Michigan's small-scale farmers came together and pushed for information to be gathered on the farmers' markets. The research set a stage for the market managers to have a forum and discuss issues facing the industry.

   The research has enhanced communication among small farmers, improved economic strategies, and resulted in the development of vendor and consumer surveys. MAES scientists have used the data to create a concept of socio-ecological geographical analysis and identified "geographically-based agri-food systems." For the first time, digital maps were created comparing land use and the location of farmer markets, and crop diversity to the location of small-scale farmers and farmers' markets. Knowing Michigan's agriculture diversity and the specific regional characteristics can be the foundation for enhancing rural development. This information is useful for enhancing profit opportunities and in managing land preservation.

   The information collected by the scientists will be extremely important in creating public policy more conducive for small-scale farmers and giving them a voice in the process.

The same information gathering process is being implemented in Kenya in collaboration with the FAO.

C. Source of Funding: MAES- Hatch, State, USDA, Grades and Standards National Science Foundation, U.S. Agency for International Policy, Overseas Development Institute in London, International Service for National Agriculture Research

D. Scope of Impact: MI, Kenya

2) Mediating exposure to environmental hazards through textile systems. -SLOCUM
KEY THEME: consumer management

A. Brief Description: MAES scientists use dosimeters to compare the effectiveness of clothing types to minimize UV exposure. Of particular interest to the scientists was whether regular clothing could provide protection against UV exposure. Experiments were conducted on subjects wearing various clothing types.

Currently there are specialized garments on the market to reduce UV exposure, but they are expensive, warm to wear, and have little consumer demand.

According to the American Cancer Society, 50 percent of Americans do not practice any form of sun protection. UV rays are also considered to be the most important and preventable factor in the development of skin cancer. Skin cancer is the most common of all cancers. In 2002 there were 7,400 deaths caused by skin cancer with another 1.3 million Americans discovering they have various types of carcinoma.

MAES scientists are using the experiments, computer simulation and surveys to develop functional and acceptable clothing for consumers that improve protection against UV rays.

B. Accomplishment Statement: MAES scientists discovered that heavier clothing does provide protection against UV exposure.

The computer simulation has pinpointed specific attire that provides appropriate coverage and is popular with consumers. The simulation was able to project and calculate the area of the shadow provided by various hats for different sun angles and positions in relationship to the sun.

Through surveys, MAES scientists gathered information from consumers to gain an understanding of their needs and acceptance of proposed attire. The surveys also exposed the need for education among consumers in selecting the most protective attire.

The information collected by MAES scientists will be useful to designers of protective clothing and to educators.

C. Funding Source: MAES- Hatch, State

D. Scope of Impact: Multi-state: OK, CA, NY

3) Kinship care analyzed to promote healthy living. – FARRELL

KEY THEME: children, youth and families at risk and child care/dependent care

A. Brief Description: The U.S. Census Bureau documented that there are a growing number of grandparents and relative caregivers in the state. In 2000, 2.2 million children in the United States lived with a grandparent or other non-parent relative; in Michigan, there were approximately 66,000 grandparent caregivers. This national trend toward kinship care occurs from abuse, poverty or neglect and faces a host of legal, financial, emotional and health challenges. The information collected by MAES scientists focused on rural and suburban areas unlike the urban areas normally studied. In Michigan, more than 60 percent of the kinship families live in non-metropolitan areas.

   Specific areas of concern were identified by the kinship care providers, including:
   - Need for respite care.
   - Need for increased financial support.
   - Need for affordable and accessible legal services.
   - Need to consider the impact of care giving on grandparents' health.

B. Accomplishment Statement: MAES research recently uncovered information about these families' needs, and a community-based resource center is setting new directions for policy programs. The initial pilot program has grown into a long-term kinship care project. Scholarship has been built, knowledge has increased about kinship care in Michigan and, most importantly, the establishment of a kinship care resource center in Michigan. The center is a partnership with the MSU Chance at Childhood Program, an integrated curriculum for law and social work students. With a toll-free hotline and consulting services, the center answers legal questions, runs workshops and trainings and offers written materials to assist kinship families.

   The center offers policy recommendations and serves as an information and referral network to help kinship families gain access to critical financial, legal and health-related support for services such as child care and respite care.

   MAES researchers conducted the research and policy analysis to establish programs and services that people in the community asked for in the research. A kinship care resource guide was developed and distributed to more than 1,500 agencies statewide. The first statewide conference on kinship care was held, bringing together more than 250 kinship providers and professionals to exchange ideas on issues such as adoption, family dynamics, support groups and research and legal questions.

A local support group was also formed, Relatives as Parents Program, and has grown into a network that reaches across the state. Today the annual meeting draws more than 1,500 people from 31 counties.

C. Source of Funding: MAES- Hatch, State, FACT Grant

D. Scope of Impact: MI

4) Michigan seasonal agriculture labor markets. - Rosenbaum

KEY THEME:

A. Brief Description: A recent report by the Michigan Nursery and Landscape Association estimates the annual economic contribution of nurseries, plant production, and landscaping segments at $3.7 billion with more then 347,000 employees in Michigan.

To gain a better understanding of these segments and Michigan's seasonal agriculture labor markets, MAES scientists analyzed the segments utilizing a seasonal workforce. A survey was conducted with the partnership of The Michigan Nursery and Landscape Association and The Michigan Turfgrass Foundation.

B. Accomplishment Statement: The MAES research molded a new industry, the green industry, which is a group of diverse segments that share a commonality of activities. These segments include nursery, greenhouse growers, landscape related firms, golf course management, garden and home centers as well as several smaller segments. Many states along with Michigan now have organizations to address the common needs of this industry. The Michigan Green Industries Coalition is a principal group uniting diverse segments in Michigan.

Based on the survey conducted by MAES, the green industry has a significant economic impact because of their labor-intensive nature. More than half of the jobs within the green industry are seasonal, which presents a challenge for employers in hiring and retaining skilled staff. The green industry has come together and recognizes common issues. The industry has 37 percent of jobs vacant needing employees with 80 percent of those being seasonal. MAES researchers are responding to their requests and are developing "best practice" training methods for the industry including possible employment changes from seasonal part-time to seasonal full-time.

MAES researchers also calculated the economic impacts of a seasonal worker on local economies. They estimate that each worker positively impacts the local community between $19,000-20,000. MAES scientists quantify the benefits of seasonal workers for communities around the state and annual presentations.

C. Source of Funding: MAES- Hatch, State, Julian Samora Research Institute

D. Scope of Impact: MI

Allocated resources

ALL GOALS TOTAL FUNDS

	FY 2003	FY 2004	FY 2005	FY 2006	FY 2007	FY 2008
Total Hatch Regular Funds	3,890,688	3,890,688	3,890,688	3,890,688	3,890,688	3,890,688
Total Multi-State Funds	921,759	921,759	921,759	921,759	921,759	921,759
Total Other CSREES Funds	13,215,874	13,215,874	13,215,874	13,215,874	13,215,874	13,215,874
Total Other Federal Funds	24,892,831	24,892,831	24,892,831	24,892,831	24,892,831	24,892,831
Total Federal Funds (est)	42,921,152	42,921,152	42,921,152	42,921,152	42,921,152	42,921,152
Total State Match for Hatch Funds	4,812,447	4,812,447	4,812,447	4,812,447	4,812,447	4,812,447
Total Remaining State Appropriated Funds	32,204,001	29,612,850	27,891,585	26,256,383	24,702,942	23,227,172
Total Other State Funds	14,218,215	14,218,215	14,218,215	14,218,215	14,218,215	14,218,215
Total State Funds (est)	51,234,663	48,643,512	46,922,247	45,287,045	43,733,604	42,257,834
Total Federal and State Dollars	94,155,815	91,564,664	89,843,399	88,208,197	86,654,756	85,178,986
Total Scientist Years	132.90	132.90	132.90	132.90	132.90	132.90

*Values extracted from Fiscal Year 2003 Funds and Manpower report

Stakeholder Input Process Section

Actions taken to seek stakeholder input that encourages their participation
Industry and community needs continue to be addressed by linking together research, education, extension and stakeholders. The collective input has been instrumental in meeting the MAES mission.

Area of Expertise (AoE) Teams: These teams serve as an educational delivery system for plant and animal agriculture. They were formed as a direct result of stakeholder demands in the plant and animal industries in Michigan. The AoE teams focus on meeting the needs set by stakeholders in producing programs and products that are timely and customer-focused with a multidisciplinary systems approach. This team approach meets the need for joint planning and programming, collaborative professional activities, resource allocation and communication between organizations. The stakeholders do not distinguish between research and extension programs.

CANR Stakeholder Advisory Board: The CANR dean serves as chairperson and appoints 30 members to serve staggered three-year terms. These stakeholders represent broad interests in the agriculture and natural resources industries.

FACT (Families and Communities Together): Created to provide an ongoing tie to stakeholders, this team engages in issues affecting families and communities. Due to the extent of MAES programs, stakeholders also include faculty members, the MSU Provost's Office and the Vice President's Office for Research and Graduate Studies.

Plant Industry Coalition: The coalition holds biannual meetings with stakeholders including plant commodity groups and industry leaders. They discuss research and extension priorities with MAES faculty members and administrators, MSUE specialists and administrators, CANR department chairs of plant-related departments, the state department of agriculture and agricultural organization representatives. Research/extension programming under Project *GREEEN is a major focus of discussion at the meetings.*

Southwest Michigan Research and Extension Center (SWMREC): This board is select based on commodity and geographic distribution. Comprised of 15 members, the board meets four to six times per year with SWMREC field station administrators, research faculty members and MSUE specialists.

Process used by the recipient institution to identify individuals and groups who are stakeholders and to collect input from them
Our stakeholders are identified as individuals who benefit from our programs and are considered an integral part of MAES. With the stakeholders input MAES provides research aimed at the betterment of Michigan's future. MAES developed a visionary approach in assessing Michigan's needs and then engaged in discussion with MAES faculty members from five MSU colleges, field station administrators, state governmental units, both rural and urban, to identify individuals and groups as stakeholders. These selected stakeholders work with MAES in futuristic planning.

Stakeholder input is gathered through various methods:

AoE Teams: Stakeholder input is required in determining a program/project, direction and evaluation. They are invited to attend the AoE meetings or project activities to provide program/project evaluation. The stakeholders participate on a regular basis in educational programming by AoE Teams. Their feedback is requested on emerging needs and issues facing the industry or interest group to give direction to the teams. The stakeholders are also involved in the hiring process of AoE Team members.

CANR Stakeholder Advisory Board: These stakeholders represent a wide range of agriculture and natural resources industries. They meet a minimum of three times per year and are quite active in major stakeholder conference days, held annually.

FACT (Families and Communities Together): They hold annual forums which include MSU and MAES faculty members, MSUE and community grant seekers from across Michigan. At these forums attendants can exchange research ideas and find partners for their work.

Plant Industry Coalition: These stakeholders made up of commodity groups and agribusiness representatives summarize and document their research and extension priorities and needs at their biannual meetings. These documents are placed on the Project GREEEN Web site.

Southwest Michigan Research and Extension Center (SWMREC): Members of the board are appointed by local fruit and vegetable grower commodity groups and organizations and the university. Recently this board appointed a minority grower.

How collected stakeholder input was considered

As earlier outlined, stakeholder input provides the foundation to much of the research and extension activities developed by MAES and MSUE. The success of MAES is predicted on the university-state government-stakeholders model, which has been in effect for more than 20 years. Stakeholders help decide the future direction for MAES through programs like Project GREEEN, Animal Industry Initiative, FACT, commodity group advisory boards and the AoE Teams. Due to stakeholder input in recent years more focus has been placed on non-traditional agriculture. This direction has also caused traditional agriculture to include the human element of rural and urban communities, the environment, land use issues, biotechnology, and the new emerging green industries.

Examples:

CANR Stakeholder Advisory Board: At each meeting the stakeholders are asked questions for their input. The collected stakeholder feedback is used to make decisions regarding the effectiveness and impact of CANR, MAES and MSUE programs. At one meeting, stakeholders were asked to consider the five programmatic themes when answering these questions:

1) Are the CANR, MAES and MSUE working on programmatic themes that best serve Michigan?
2) What are the most important programmatic ideas to carry out in each theme?

3) Given the tight budgets, give guidance on creating a “what not to do list.”

FACT (Families and Communities Together): MSU faculty, administrators, and Extension faculty and community partners are facilitating, participating and supporting two self-directed work groups. These work groups focus on the topics of children, youth and nutrition, and youth development. Each group develops research and outreach initiatives to advance work in their area. In addition, these groups create and implement a plan for the collective betterment of work in each area, promote professional development activities and measure the impact of their efforts.

Plant Industry Coalition: The stakeholders’ priorities outlined in Project GREEN are the basis in considering research project funding.

Program Review Process

There have been no changes in the program review process since MAES submitted the 1999-2004 POW.

Evaluation of the Success of Multi and Joint Activities

Multidisciplinary and integrated research/extension activity

Project GREEEN (Generating Research and Extension to meet Environmental and Economic Needs)

Did the planned programs address the critical issues of strategic importance, including those identified by the stakeholders?

Thirty-nine Michigan agricultural commodity and agricultural interest groups annually submit their research/extension proposals to Project GREEEN. The proposals are posted on the Project GREEEN Web site (www.greeen.msu.edu) in a searchable database. Most contemporary challenges being addressed by plant agriculture are multidisciplinary in nature and require integrated approaches that rely on the combined skills of Michigan Agricultural Experiment Station researchers and Michigan State University Extension educators. These proposals are the launching point for the $3 million annual grant program, which addresses industry priorities as a prerequisite for consideration. Projects that address cross-commodity priorities are given preference. Commodity group representatives, Michigan Department of Agriculture and leaders from farm organizations participate in the proposal review panels that recommend project funding. The Plant Coalition (department heads and representatives of plant agricultural commodity groups) annually reviews Project GREEEN and suggests changes to enhance the effectiveness and impact of the program. A summary is prepared annually for the Michigan legislature to communicate program impact and fiscal stewardship.

Did the planned programs address the needs of under-served and under-represented populations of the State?

Project GREEEN serves as a mechanism that allows the Michigan Agricultural Experiment Station to aggressively build partnerships with under-served and under-represented populations of Michigan's plant agriculture. Programs initiated through Project GREEEN provide certificate programs in greenhouse management for Spanish-speaking employees. Graduates from this program are being promoted into supervisory and management positions in greenhouse companies.

Hispanic fruit farmers are the fastest growing segment of new farmers in Michigan. A pest scout-training program was initiated in concert with an Environmental Protection Administration grant to provide cross-cultural educational experiences and instructional materials in both English and Spanish languages. Farm owners who completed the program indicated that the education resulted in increased profitability on their farms. One Hispanic female started her own private pest scouting business.

Project GREEEN continues to be instrumental in expanding research and extension programming tailored to meet the needs of organic producers. As a result, Michigan Agricultural Experiment Station has the nation's largest organically certified research apple orchard, which is used to address producer research priorities and serves as a living laboratory for extension programs.

Did the planned programs describe the expected outcomes and impacts?
All Project GREEEN projects are required to have an impact assessment plan as an integral component of the overall project. Training programs are offered annually by Michigan Agricultural Experiment Station communications specialists to assist researchers and graduate students in preparing meaningful impact statements.

Did the planned programs result in improved program effectiveness and/or efficiency?
Project GREEEN helps the Michigan Agricultural Experiment Station and Michigan State University Extension to integrate research and extension efforts. Through Project GREEEN funded proposals, faculty and extension educators develop working relationships that carry over into Hatch and Smith Lever funded programs. Project GREEEN programs are responsible for obtaining more than $7 million in matching funds. Combined, these funds complement federal and state allocated dollars and enable a larger total program than would be possible through allocated funds alone.

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: Michigan State University
State: Michigan

Check one: ____ Multistate Extension Activities
__X_ Integrated Activities (Hatch Act Funds)
____ Integrated Activities (Smith-Lever Act Funds)

	Actual Expenditures				
Title of Planned Program/Activity	**FY 2000**	**FY 2001**	**FY 2002**	**FY 2003**	**FY 2004**
__Integrated Appointments_____	**__0____**	**78,628**	**157,199**	**155,628**	**155,628**
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Total	_____	_____	_____	_____	_____

_____ _____
Director **Date**

Form CSREES-REPT (2/00)