# Annual Plan of Work
# Accomplishment Report for 2004


## Michigan Agricultural Experiment Station
## Michigan State University

March 2005

## Guide to Acronyms in This Report

| | |
|---|---|
| AoE | Area of Expertise |
| AAI | Animal Agriculture Initiative |
| APC | Adenomatous Polyposis Coli |
| AR | Antibiotic Resistance |
| ARS | Agricultural Research Service |
| CANR | College of Agriculture and Natural Resources |
| CCL | Contaminant Candidate List |
| CDC | U.S. Centers for Disease Control and Prevention |
| CILER | Cooperative Institute for Limnology and Ecosystems Research |
| CMI | Cherry Marketing Institute |
| CoK | College of Knowledge |
| CRP | C - Reactive Protein |
| DOE | U.S. Department of Energy |
| EAB | Emerald Ash Borer |
| EPA | U.S. Environmental Protection Agency |
| FACT | Families and Children Together |
| GIS | Geographic Information System |
| GPS | Global Positioning System |
| GREEEN | Generating Research and Extension to meet Economic and Environmental Needs |
| IPM | Integrated Pest Management |
| IPPSR | Institute for Public Policy and Social Research |
| MAAB | Michigan Asparagus Advisory Board |
| MAC | Michigan Apple Committee |
| MAES | Michigan Agricultural Experiment Station |
| MAGI | Michigan Asparagus Growers Inc. |
| MAP | *Mycobacterium avium* subspecies *paratuberculosis* |
| MDA | Michigan Department of Agriculture |
| MDCH | Michigan Department of Community Health |
| MDEQ | Michigan Department of Environmental Quality |
| MDOT | Michigan Department of Transportaion |
| MMP | Matrix Metalloproteinases |
| MSU | Michigan State University |
| MSUE | Michigan State University Extension |
| NFSTC | National Food Safety and Toxicology Center |
| NOAA | National Oceanic and Atmospheric Association |
| NPS | National Park Service |
| NRI | National Research Initiative |
| PAH | Polycyclic Aromatic Hydrocarbons |
| PCR | Polymerase Chain Reaction |
| POW | Plan of Work |
| RUSLE | Revised Universal Soil Loss Equation |
| SWMREC | Southwest Michigan Research and Extension Center |
| USDA | United States Department of Agriculture |
| USGS | U.S. Geological Survey |
| VFARs | Virulence-Factor Activity Relationships |

## Table of Contents Page

# Goal 1

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

*Executive Summary*

Michigan's agriculture and food industry generates $37 billion annually in economic activity, second only to manufacturing. The industry, which encompasses farm inputs, food processing, retailing and wholesaling, employs 500,000 Michigan residents.

Michigan leads the nation in the production of 11 commodities, including tart cherries, blueberries, Niagara grapes, cucumbers for processing, geraniums, impatiens, petunias, flowering hanging baskets, and three varieties of dry beans, and ranks in the top 10 of 30 other commodities. The state's 125 commercially-produced commodities make Michigan the second most agriculturally diverse state in the nation. (California is No. 1.)

About one-third of these commodities are exported annually, bringing $842 million into the state. In 2003, Michigan had a top 10 ranking both as a fruit and vegetable exporter. Soybean exports, the state's most exported commodity, were valued at $236 million.

Much of the Michigan Agricultural Experiment Station (MAES) success in fostering a globally competitive agriculture production system has come through its support of the state's plant industry initiative, GREEEN (Generating Research and Extension to meet Economic and Environmental Needs). GREEEN is a collaboration among the MAES, Michigan State University Extension, the Michigan Department of Agriculture and the state's plant-based commodity groups and business.

MAES scientists have provided the research underpinnings leading to several recent GREEEN agriculture success stories, from sugar beets to asparagus to fresh sliced apples. The common theme is applied research, directed at Michigan's here-and-now problems, and effectively delivered through the MSUE network of county-based educators.

The growing network of Michigan wineries is the last of these reported impacts. At the hub of this network is MAES scientist Stan Howell. In a career that's spanned more than 30 years, Howell's research has demonstrated that an increasing number of grape varieties can not only survive, but thrive in Michgan's cool and cloudy climate. Today, Michigan wineries compete on the world stage, generating jobs and economic activity for the state in the process.

## *Allocated Resources*

| | FY 2004 |
|---|---|
| Hatch Funds | |
| Hatch Regular | 2,444,241 |
| Multi-State Funds | 605,944 |
| Other CSREES Funds* | 6,333,232 |
| Other Federal Funds* | 14,829,443 |
| **Total Federal Funds (est.)** | 24,212,860 |
| State Match for Hatch Funds | 3,050,185 |
| Remaining State Appropriations | 16,700,453 |
| Self Generated Funds* | 2,508,988 |
| Industry Generated Funds* | 4,673,064 |
| Other Non-Federal Funds* | 1,362,832 |
| **Total State Funds (est.)** | 28,295,521 |
| **Total Estimated Funds** | 52,508,381 |
| **Scientist Years** | 95.1 |

* Values extracted from Fiscal Year 2004 Funds and Manpower Report

**1) Improving production in the Michigan sugar beet industry.**
KEY THEME: plant production efficiency, agriculture profitability, small farm viability

A. Brief Description: Michigan is the country's fourth largest producer of sugar beets and 3.4 million tons of the crop in were harvested in the state 2003. The health of the industry today is a contrast to the recent history of Michigan sugar beets. From 1984 through the late 1990s, yields dropped as did planted acreage of sugar beets. By 1997, the industry was at risk of going out business altogether.

MAES scientists provided research on new cultural techniques, varieties and pest control strategies as part of a collaboration between growers, processors and university researchers. The results are communicated annually to growers in a research publication and seminars held around the state. According to one follow-up survey, farmers who attended the seminars increased their revenue by approximately $30 per acre. The total increase to Michigan growers based on attendees and recipients of the research book may be $1 million annually.

B. Accomplishment Statement: MAES researchers developed a new schedule for spraying fungicide to control *Cercospora* leaf spot that can save growers $20 per acre to $136 per acre. *Cercospora*, which can cause beet leaves to turn black and reduce sugar yields and sugar content, is one of the most serious diseases affecting sugar beets. MSUE reports that two-thirds of Michigan growers have changed their leaf spot management practices because of this research.

MAES researchers also developed new spray schedules for micro-rate herbicide applications – applying herbicides in narrow bands over their emerging crops instead of across an entire fields. These new schedules improved safety and health of those working in sugar beet fields and on average reduced micro-rate herbicide applications by one-third. This reduction saved growers on average $40 to $60 per acre in herbicide costs. Additionally, the new spraying schedule increased sugar beet quality and yields by reducing early season crop injury.

MAES researchers also studied the cumulative effects of variety selection, previous crop in the field, cultivation practices and chemical controls to fight the *Rhizoctonia* fungus. Research results have helped to improve yield by as much as 5 tons per acre.

Additionally, MAES research revealed:

- That earlier planting dates can reduce seedling disease and improve stands and yields. Today, 27 percent of growers who used to plant in April now plant in the last week of March.
- That too much nitrogen can reduce beet emergence by 10 to 15 percent. Approximately one in five growers has altered nitrogen application based on these results.

C. Source of Funding: MSU, MAES, MSUE, GREEEN, USDA, Michigan and Monitor sugar companies, various agri-businesses (i.e., chemical companies)

D. Scope of Impact: MI, OH

**2) Growing Michigan's wine industry through research on grapes that thrive in Michigan's climate and winemaking.**
KEY THEME: adding value to new and old agricultural products, diversified/alternative agriculture, new uses for agricultural products

A. Brief Description: Wine production and winery tourism contribute $75 million and close to 1,000 jobs to Michigan's economy each year. The Michigan wine industry has made rapid strides in the last quarter century. In 1969, 95 percent of Michigan wines came from three varieties: Concord, Niagara and Delaware and most were grown in the southwest corner of the state.

MAES horticulture researcher Stan Howell has studied how to select vinifera cultivars (classic European grapes such as Chardonnay, Riesling, Gewurztraminer, Pinot Noir and Pinot Grigio) for cold tolerance and insect and disease resistance. For nearly three decades, Howell has improved and refined the varieties and cultural techniques that could produce economic success in Michigan's cool climate.

Howell has also evaluated rootstocks and studied the relationship between canopy management and fruit quality. Generally, grape growers want enough of a leaf canopy to support photosynthesis, but not so thick of a canopy that sunlight is prevented from

hitting the grapes. Sunlight reaching the grape clusters helps the fruit to mature. Additionally, Howell has studied flavor chemistry, yeast strains, fermentation, and the use of oak barrels and their contribution to the flavor.

Other MAES scientists have studied how to establish vineyards, space vines and maintain fruiting potential for tender varieties through Michigan's harsh winters. Additional research on screening and registering pesticides, developing proper integrated pest management (IPM) techniques for grape growers and fighting the leaf spot-causing *Phomopsis viticola* fungus has contributed to the heartiness of Michigan's vineyards.

B. Accomplishment Statement: Today, just 3 percent of Michigan wine is made from the pedestrian varieties (Concord, Niagara and Deleware) that were so common in the late 1960s. Almost 60 percent of Michigan wines are made from locally-grown vinifera grapes. Most of the rest of the wines are made from hybrid varieties, especially crosses between vinfera and grapes native to North America, such as Vidal blanc, Traminette, Chardonel, Chambourcin, Marechal Foch, Seyval and Vignoles.

In contrast to the initial clustering of the industry in southwest Michigan in the 1970s, commercial grape production now stretches from the Indiana state line to Northport, at the tip of the Leelanau Peninsula. There are commercial wineries in every county but one along the Lake Michigan shoreline. Several wineries have had vintages win international awards and the industry's economic contribution to the state continues to grow. According to research by Ed Mahoney and Don Holecek, MAES researchers in MSU's Department of Community, Agriculture, Recreation and Resource Studies, winery tourism generates direct economic impacts of $10.6 million and support 206 jobs, 195 of which are in non-winery businesses.

Educating the industry's current and future leaders helps to cement the partnership between the MAES and the Michigan wine industry. MAES researchers hold regular education programs during the year for growers, both on-campus and at the MAES field research stations around the state.

C. Source of Funding: MSU, MAES, National Grape Cooperative, Michigan Grape and Wine Industry Council, USDA National Viticulture Consortium-East

D. Scope of Impact: MI

**3) Helping Michigan's potato industry survive late blight.**
KEY THEME: agriculture profitability, plant health, plant production efficiency

A. Brief Description: Ireland's great potato famine was caused by the *Phytophthora infestans*. A little more than 150 years later, the late blight-causing fungus is still the No. 1 threat to potatoes and causes $2 billion in crop losses annually around the world.

Michigan's $110 million dollar potato industry is one of the top 10 in the nation. MAES researchers are exploring ways to protect the state's 46,000 potato acres from late blight.

One of these ways is to find and map late blight-resistant genes. Another is to conduct ongoing trials to evaluate different fungicide products.

B. Accomplishment Statement: MAES researchers are nearing the point where they can do gene-level screening of progeny produced by variety crosses. Before this advance, researchers couldn't tell whether a particular cross contained particular genes. Rather, they could just observe whether the cross was susceptible to late blight. Now, researchers will be able to breed more blight resistance into new potato varieties.

   For example, if researchers find two blight-resistance genes, they could breed both genes into a new variety. This double resistance would likely allow for less fungicide use because pathogens aren't likely to adapt to and overcome two sources of resistance.

   Even though potatoes with select single-gene improvements have yet to appear in Michigan's fields, MAES evaluations and recommendations concerning fungicides are today helping growers to improve yields and reduce costs. MAES researchers are evaluating multiple fungicides because the pathogen can easily become resistant to particular fungicide formulas.

   In 2003, growers representing around 75 percent of the state's potato acreage followed the MAES' fungicide recommendations, which were published at http://lateblight.org. The Web tool also predicts late blight risk by analyzing weather patterns. *Phytophthora infestans* is a water mold, and late blight can spread quickly through a crop in prolonged wet and warm conditions.

   Growers who used the Web site spent approximate $200 per acre. By contrast, growers that didn't follow the recommendations spent as much as $350 per acre. This unnecessary excess cost growers $1.73 million and released an additional 92,000 to 115,000 pounds of fungicide into Michigan's environment.

C. Source of Funding: MSU, MAES, USDA ARS, Michigan Potato Industry Commission

D. Scope of Impact: MI, Upper Midwest, Canada

**4) Spurring fresh market sales of Michigan asparagus.**
KEY THEME: adding value to new and old agricultural products, agricultural competitiveness, agricultural profitability

A. Brief Description: Like many other agricultural commodity producers, Michigan asparagus growers have faced the challenges of a changing national and world economy. They were hit especially hard in 2000 when changing U.S. trade practices drew a flood of low-priced South American asparagus to processors – a major outlet for Michigan asparagus.

MAES plant pathologist Mary Hausbeck joined with MSUE and the Michigan Asparagus Advisory Board (MAAB) to write a grant to conduct a fresh market feasibility study. The goal was to look at long-term, value-added and fresh market opportunities.

The study, funded through federal, state and private industry sources, showed that a potential did exist for fresh-market sales of Michigan asparagus. It also showed that, because it's easier than tapping the fresh market, growers too often sold to processors when prices were good and supplies were limited. This hampered the fresh market industry segment, which relies on a consistent supply of fresh product.

B. Accomplishment Statement: The producers took the study information to heart and formed a cooperative called Michigan Asparagus Growers Inc. (MAGI). Each member is required to buy stock in the cooperative and pay an annual performance bond. The bond is put into escrow and if the grower fails to deliver on the promised fresh tonnage, then the bond is lost.

With help from the MAES-supported MSU Product Center for Agriculture, the cooperative participated in the Michigan Department of Agriculture's (MDA) Select a Taste of Michigan marketing program. The program targeted the Grand Rapids area with advertising and promotional materials. The cooperative also registered two brand names – Michigan Tender Tips and Tender Tips Asparagus.

2003 was the first year of a successful effort, as the growers realized a $5 advantage over prices paid for competing states' product. According to MDA records, the promotional efforts increased product sales by 65 percent and kept the per-case price of Michigan product 27 percent above that of competing states (California, Washington and Ontario). MAGI sales went from 285,000 pounds in 2002 to more than double that (about 650,000 pounds) in 2003.

In 2004 was another good year. MAGI sales topped 1.1 million pounds, nearly half of the total fresh market in Michigan. Also in 2004, the price of fresh asparagus increased 6 percent, from $32 per 28 pound carton to $34 per 28 pound carton. The increase in production of fresh asparagus created 29 additional jobs during the harvest season, the MSU Product Center for Agriculture reported.

In addition, the grower price for fresh asparagus increased $.14 per pound. The retail value of fresh asparagus increased from $.99 per pound to $1.98 per pound as retailers in the Select Michigan markets gained confidence in MAGI's ability to meet market needs.

C. Source of Funding: MAES, MSUE, USDA Rural Development program, the Michigan Department of Agriculture and the Michigan Asparagus Advisory Board.

D. Scope of Impact: MI,

# Goal 2

## *A Safe and Secure Food and Fiber System*

*Executive Summary*

Just how essential is water to a safe and secure food system? Consider that even though it takes just 1 gallon of water to process one-quarter pound of hamburger, a steer consumes thousands of gallons of water before reaching the butcher. In fact, every food product, human- or nature-made, requires water for formation.

Much of the MAES water-related research directly impacts the safety and security of the state's food and fiber research. For example, MAES scientists are exploring the link between infestations of invasive zebra mussels and toxic blue-green algae. Several cases of blue-green algae poisoning have been recorded elsewhere, including 56 deaths in a dialysis center in Brazil in 1996. The center's patients died from Caruaru Syndrome, caused by the high concentration of blue-green algae toxins found in the water used in the patients' kidney treatments. The number of algal blooms in Michigan is increasing and appears to be associated with spread of zebra mussels.

MAES scientists are also studying how to detect viral pathogens and other elemental toxins in the water supply. Hundreds of different viruses can be excreted in high concentrations from humans and animals and then detected in sewage. These viruses are stable in the environment and can readily move into the groundwater. Recently, viral agents were believed to be the cause of intestinal disease outbreaks associated with septic tanks in rural Wisconsin. Elemental toxins – such as lead, arsenic and copper – are emerging and reemerging problems, as well. For example, the U.S. Environmental Protection Agency estimates that 20 percent of human exposure to lead is attributable to drinking water.

A third category of MAES research focuses on zoonotic diseases, or those that can be transmitted between animals and human beings. An MAES research team has found new type of antibiotic-resistant bacteria in soils containing manure from antibiotic-treated cows. As more animals and people are treated with antibiotics, certain pathogens such as *Campylobacter*, *Salmonella*, *Enterococcus* and *Staphlylococcus* may also acquire resistance. When these resistance pathogens are transmitted from animal hosts to humans, drugs normally used to treat the disease may not work, leaving people with limited treatment options.

Despite the importance of water, MAES research on food system safety and security is by no limited to water-related issues. MAES large animal clinical sciences researcher Dan Grooms, for example, is helping to build a statewide network to and respond to animal diseases that might threaten human health. The program, Vet Net, is a comprehensive education and training program geared toward the state's nearly 3,600 licensed veterinarians is aimed at improving awareness, preparedness and response to animal disease-related emergencies.

### *Allocated Resources*

| | FY 2004 |
|---|---|
| Hatch Funds | |
| Hatch Regular | 226,505 |
| Multi-State Funds | 30,976 |
| Other CSREES Funds* | 481,745 |
| Other Federal Funds* | 5,195,456 |
| **Total Federal Funds (est.)** | 5,934,682 |
| State Match for Hatch Funds | 257,481 |
| Remaining State Appropriations | 2,354,000 |
| Self Generated Funds* | 84,237 |
| Industry Generated Funds* | 480,740 |
| Other Non-Federal Funds* | 225,797 |
| **Total State Funds (est.)** | 3,402,255 |
| Total Estimated Funds | 9,336,937 |
| Scientist Years | 12.3 |

* Values extracted from Fiscal Year 2004 Funds and Manpower Report

**1) Exploring the connection between blue-green algae and zebra mussels.**
KEY THEME: food safety, foodborne illness, foodborne pathogen protection

A. Brief Description: Several species of cyanobacteria — including *Anabaena, Aphanizomenon, Microcystis* and *Oscillatoria* — produce a toxin that's harmful to people and animals that drink water with cyanobacteria in it. The toxin has been on the Environmental Protection Agency (EPA) contaminant candidate list for five years. The EPA is examining the toxin's effects on human health at various levels to decide if regulations are needed.

Canada already has regulations/guidelines on cyanobacterial toxins, as does the World Health Organization. With more blue-green algae blooms in Michigan, people are being exposed to higher levels than Canadian regulations permit. Open research questions include how and when the algae produce the toxin and if there is a way to stop the algae from producing it.

Determining the relationship between zebra mussels and blue-green algae blooms is anything but straightforward. The number of variables is high and scientifically-sound data are sometimes difficult to find.

Over the years, much work has been done to decrease the amount of pollution from fertilizers such as phosphorous. For example, Lake Erie, which at one time was highly polluted, has undergone a major reduction in point-source phosphorus loading.

High phosphorous levels are associated with algal blooms. Recent data from the western basin of Lake Erie indicate that phosphorus levels are currently low enough that cyanobacteria should not be the main type of algae bloom occurring over the summer. However, intense cyanobacterial blooms have been reported since the establishment of zebra mussels. Similarly, data from the Bay of Quinte in Lake Ontario show a dramatic increase in the biomass of the cyanobacterium *Microcystis aeruginosa* after zebra mussel establishment.

Toxic algal blooms in the Saginaw Bay and Lake Erie are disturbing, say MAES scientists, because the blooms come after many years of expensive reductions in nutrient loading to improve water quality. MAES scientists wanted to go beyond anecdotal information about the possible connection between mussels and algae.

B. Accomplishment Statement: MAES scientists conducted a survey of inland lakes in Michigan and found the presence of zebra mussels cancelled the expected relationship between high phosphorus levels and increased blue green algae blooms. In particular, there was a dramatic positive influence of zebra mussels on the amount of blue-green algae in lakes with phosphorus levels between 10 and 25 micrograms per liter, a normal range for most mussel-friendly shallow water habitats in the Great Lakes.

   Further MAES research has nailed down the association between zebra mussels and the increases in harmful cyanobacteria (and the corresponding decrease in water quality) in high-quality lakes. Most scientists think that zebra mussels feed on blue green algae to a lesser extent than other algae, giving the blue green species an advantage when mussels invade. Other MAES experiments demonstrated that the effect is reversible. If there was a way to eliminate mussels, harmful cyanobacteria would decrease in short order.

   Ongoing MAES research is characterizing the interactive effects of mussel invasion and nutrient input on harmful cyanobacteria. Zebra mussels may prove impossible to eradicate, but it is possible to alter nutrient inputs to lakes via management. Other research is exploring the temporal and spatial distribution of the toxins produced by these organisms to assess risk to humans in those regions – an important task given the severity of the harmful cyanobacteria problem in parts of the Great Lakes used for drinking water.

   The work has led to collaboration between MAES scientists and the Great Lakes Environmental Research Laboratory in Ann Arbor to study the zebra mussel-blue-green algae relationship in Lake Erie. MAES-affiliated researcher Joan Rose is collaborating with the Northwestern Michigan College's Water Studies Institute, the Leelanau Watershed Council and Bowling Green University on a three-year study of the impact and public policy implications involving zebra mussel infestations in some high quality oligotrophic lakes (those with abundant dissolved oxygen), particularly in the Leelanau County area in northwest Michigan.

C. Source of Funding: MAES, Sea Grant, CILER (Cooperative Institute for Limnology and Ecosystems Research) and the U.S. Environmental Protection Agency

D. Scope of Impact: MI, national, international

**2) Understanding how viral pathogens enter and move through the water supply; developing new techniques to screen for the pathogens.**
KEY THEME: food safety, food security, foodborne illness, foodborne pathogen protection

A. Brief Description: Safe drinking water in the United States continues to be a challenge as a result of emerging contaminants, more sensitive and specific detection methods, better investigations and more public awareness. The primary focus will be preventing microbial pathogens, including viruses and parasites that can cause serious illnesses, from contaminating beaches and drinking water. In the past, coliform bacteria were considered indicator bacteria and were used (and are still used by most) to determine whether water was safe. If those bacteria were not there, the water was presumed safe. But this thinking is changing.

It's now clear that the coliform indicator bacteria do not always provide the necessary measure of the microbiological safety of water, especially with respect to viral pathogens such as hepatitis A, and parasitic pathogens such as *Cryptosporidium* and *Giardia*. Both drinking water and recreational waterborne outbreaks, as well as the recognition of other potential waterborne pathogens, have been on the increase in recent years.

Viral pathogens in water continue to be a particular public health challenge. Hundreds of viruses can be excreted in high concentrations and then detected in sewage. They are stable in the environment and readily move into groundwater. Recently, viral agents were believed to be the cause of intestinal disease outbreaks associated with septic tanks in rural Wisconsin areas. In dealing with these outbreaks, the coliform indicator bacteria did not prove to be a sufficient measure of risk. And scientists don't know enough about the transport and exposure of these viruses as waterborne agents of disease.

The Safe Drinking Water Act amendments of 1996 required the EPA to identify new chemicals and microorganisms for potential regulation every five years. The contaminant candidate list (CCL) is based on information about known and suspected health risks and the occurrence of the contaminant in water. Currently there are 13 microorganisms on the CCL, including several enteric viruses of concern.

B. Accomplishment Statement: MAES research is supporting the use of genetic databases to identify microbial risks in water, called virulence-factor activity relationships (VFARs).

The conceptual approach is to use microbial genomic databases to identify new microorganisms, examine the potential human risks of microorganisms found in water, determine the occurrence (persistence, prevalence and magnitude) of the microbial contaminants in water and the potential for waterborne disease. The application of VFARs to water is defined as a measure of the potential to cause disease and incorporates the concept of environmental persistence in addition to pathogenicity.

MAES research is contributing to the ability to fully characterize viral infections in a community, particularly emerging viruses of concern. This research, integrated with new methods that can screen for hundreds of targets, will allow scientists and health officials to identify the disease source in water and link it to clinical cases.

C. Source of Funding: MSU, MAES, EPA, University of Michigan, Sea Grant, American Water Works Association Research Foundation, NOAA National Undersea Research Center, National Park Service, NSF

D. Scope of Impact: MI and other Great Lakes states

**3) Studying how antibiotics spread through the environment to address antibiotic resistance.**

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

A. Brief Description: The use of antibiotics to improve animal health and productivity has been increasing since the 1970s. According to a 2000 survey by the Animal Health Institute, 32.2 million pounds of antibiotics (64.5 percent of the total) were used in the United States for food products used for human consumption, 14.7 million pounds (29.5 percent) for therapeutic and non-therapeutic practices in livestock, and 3.1 million pounds (6 percent) for growth promotion. According to more recent data from the same group, the use of antibiotics as growth promoters rose to 13 percent of the total use in 2003.

The non-therapeutic use of antibiotics for animals has been reported in approximately 70 percent of large swine feedlot operations and in 25 percent of small feedlot operations. More than 70 percent of large cattle feedlots use antibiotics in at least 58 percent of their herds. Approximately 88 percent of large dairy operations administered antibiotics to up to 40 percent of their cows during lactation periods.

Correspondingly, both veterinary and human antibiotics are being detected in waters throughout the United States, and evidence of spread of antibiotic resistance (AR) is also emerging. Approximately 50 percent of streams were found to be contaminated with a range of antibiotics. Erythromycin-H20, a metabolite of erythromycin, was the most frequently reported by the U.S. Geological Service.

Antibiotics have been used as growth promoters in poultry, and some of these animals have been found to harbor antibiotic-resistant strains of *Campylobacter*, another water- and foodborne pathogen that causes gastrointestinal illness in humans. Other common zoonotic pathogens (pathogens that can be transferred from animals to humans) such as *Salmonella*, *Enterococcus* and *Staphylococcus* may also acquire resistance.

When these resistant pathogens are transmitted from their animal hosts to humans, drugs normally used to treat the disease may not work, leaving people with limited treatment options.

B. Accomplishment Statement: MAES scientists are addressing the issue of antibiotic resistance through research on the spread of antibiotics and genetic AR determinants through the environment and within communities of bacteria. Advances have been made in rapid detection devices, high throughput identification and quantification tools, and mathematical models to quantitatively integrate the information related to the production and use of antibiotics, their environmental fate and the presence of AR, both within the host and in the environment.

   Additionally, a research team at MSU has found new classes of tetracycline resistance in soils containing manure from tetracycline-treated livestock. Further measurements with new methods such as real-time PCR (polymerase chain reaction) tests showed that tetracycline resistance genes were present only in manured soils — they were not detectable in the adjacent non-manured soils.

C. Source of Funding: MSU, MAES

D. Scope of Impact: MI, national

**4) Advancing animal health and biosecurity through statewide network.**
KEY THEME: food safety, food security, foodborne illness, foodborne pathogen protection

A. Brief Description: Michigan's Vet Net is a comprehensive education and training program geared toward the state's nearly 3,600 licensed veterinarians aimed at improving awareness, preparedness and response to animal disease-related emergencies.

   When bovine spongiform encephalopathy (BSE) or "mad cow disease," was found in Washington state, government officials and private citizens began to worry that animal diseases could be used to compromise the security of the United States.

   MSU, the Michigan Department of Agriculture and the state's largest veterinarian organization have come together to form the Michigan Emergency Veterinary Network, or "Vet Net," as part of Michigan's homeland security efforts in the animal health and protection arena.

   One of the first programs of its kind in the nation, Vet Net includes two main components: a general education series for all veterinarians and an in-depth emergency preparedness training program for those who sign up to serve in the "corps." This volunteer corps will be a group of private veterinary practitioners from across Michigan trained to identify and handle a wide variety of animal diseases that will help supplement state and federal veterinarian/agency efforts and further ensure the health and safety of the state's livestock and domestic animals.

B. Accomplishment Statement: A resource binder and emergency contact information has been developed and distributed to licensed veterinarians in Michigan. Fact sheets on biosecurity, foreign animal diseases, bioterrorism agents and emerging infectious diseases of concern in Michigan and the United States are distributed on a quarterly basis.

When all the fact sheets are distributed, veterinarians in Michigan will have a resource binder with information on all diseases in Category A of the U.S. Centers for Disease Control and Prevention's list of possible bioterrorism agents and all diseases on the U.S. Department of Agriculture High Consequence Livestock Pathogens and Toxins list.

More than 60 veterinarians have been trained in the incident command system and biosecurity practices. They are now are certified members of the Vet Net corps and are considered "on call" in case of an animal health emergency in their local or regional communities.

C. Source of Funding: MAES, MSUE, MDA, Department of Homeland Security

D. Scope of Impact: MI

# Goal 3

## *A Healthy, Well-Nourished Population*

*Executive Summary*

MAES work promoting a healthy and well-nourished population ranges from research in the basic sciences to broad surveys about day-to-day human behavior. The scientists' work targets problems that afflict Michigan residents such as the startling rise in obesity, especially among children. Benefits of other research – particularly on colon cancer and vitamin A – spill well beyond the state's borders.

Last fall, scientists again expanded the borders of genomics research by sequencing the chicken genome. As the first bird and the first agricultural animal to have its genome sequenced, the chicken – the bird lived on the MSU campus – is paving the way for research on human diseases, as well as studies on chicken breeding to benefit agriculture. An international consortium of scientists that includes an MAES researcher analyzed the chicken genome and published a paper in the Dec. 9, 2004 issue of the British science journal *Nature*.

MAES food scientist Kate Claycombe is analyzing cherries, not chickens. Specifically, Claycombe is looking at flavonoids, the plant pigments in cherries and other fruits and vegetables that produce bright colors and also act as antioxidants and cholesterol-lowering agents. Claycombe's research suggests that flavonoids in Michigan tart cherries may be especially effective in fight cardiovascular disease. This is good news for the Michigan tart cherry industry, which is the largest in United States.

More good news comes from Claycombe's food scientist peer, Kirk Dolan. His research suggests that waste byproducts from today's food processing industry might be turned into nutrition-boosting supplements. Dolan's supplements fall into the burgeoning functional food category, a $20 billion market in 1999 that is expected to triple by 2010. So his work stands to boost health and help Michigan growers access a lucrative market.

MAES research also is accessing the genetic and molecular secrets of colon cancer and blindness-causing Vitamin A deficiency. An MAES food science and human nutrition scientist has documented how curcumin, found in the spice turmeric, helps stimulate potentially cancerous cells to differentiate and die as they should. Other MAES research is modeling the minimum amounts of Vitamin A needed for healthy embryonic and childhood development.

Perhaps no public heath issue received more attention lately than obesity, which the Center for Disease Control and Prevention says may overtake smoking as the United States' leading cause of death in 2005. Several MAES scientists are studying obesity, which is especially problematic in Michigan – one of the most obese states in the nation and home to Detroit, which just recently gave up "fattest city" mantle to Houston. MAES nutrition researcher Beth Olson has done significant surveying of obesity-related attitudes. Her results suggest how Michigan's public health approach to obesity might be improved.

### *Allocated Resources*

| | FY 2004 |
|---|---|
| Hatch Funds | |
| Hatch Regular | 172,927 |
| Multi-State Funds | 100,592 |
| Other CSREES Funds* | 257,692 |
| Other Federal Funds* | 2,347,885 |
| **Total Federal Funds (est.)** | 2,879,096 |
| State Match for Hatch Funds | 273,519 |
| Remaining State Appropriations | 1,328,815 |
| Self Generated Funds* | 26,965 |
| Industry Generated Funds* | 236,483 |
| Other Non-Federal Funds* | 80,011 |
| **Total State Funds (est.)** | 1,945,793 |
| Total Estimated Funds | 4,824,890 |
| Scientist Years | 9.7 |

* Values extracted from Fiscal Year 2004 Funds and Manpower Report

**1) Analyzing the chicken genome to benefit human health and agriculture.**
KEY THEME: health care, human health, human nutrition

A. Brief Description: Widely used in biomedical research, the chicken is an important model for vaccine production and the study of embryology and development, as well as for research into the connection between viruses and some types of cancer. Chickens and humans are, in some cases, infected by the same viruses, bacteria and parasites.

The first draft of the chicken genome was placed into free public databases for use by researchers around the world in March 2004. In December 2004, an international consortium of scientists that includes an MAES researcher analyzed the chicken genome and published the results in the British science journal *Nature*.

The bird whose genome was sequenced, a red jungle fowl (Gallus gallus) known by her wing band number, 256, lived on the Michigan State University campus in a facility that serves the lab of Jerry Dodgson, MAES microbiology and molecular genetics researcher, who has worked on mapping the chicken genome for the past 17 years. (The bird passed away of natural causes in early 2005.)

B. Accomplishment Statement: The chicken is the first bird and the first agricultural animal to have its genome sequenced. By unlocking the secrets of the chicken genome, scientists expect to uncover genes that enhance natural disease resistance in birds and then determine if those same genes are in humans. The sequenced chicken genome may allow

scientists to create better treatments or even new vaccines for the flu and other human ailments.

Having the chicken genome sequenced also is a fundamental tool for doing research in chicken genetics. Scientists can identify a particular desirable trait – why certain chickens lay more eggs than others or why certain broiler chickens may have less fat – and then determine which genes are responsible for them.

C. Source of Funding: MSU, MAES, State, International Chicken Genome Sequencing Consortium

D. Scope of Impact: MI, national, international

**2) Identifying nutrients that might reduce the risk of cardiovascular disease and heart attacks.**

KEY THEME: human health, human nutrition

A. Brief Description: Cardiovascular disease is the No. 1 killer in the United States and in Michigan. Obesity is considered to be a low-grade chronic inflammatory disease, and obesity-induced cardiovascular disease is strongly tied to elevated levels of C-reactive protein (CRP). Research has shown that obese people have higher levels of CRP.

CRP is a special type of protein produced by the liver that is present only during episodes of acute inflammation. It is part of the immune system's defense mechanism. Studies have shown that people with elevated levels of CRP have a significantly higher risk of heart disease.

Recent studies have shown that CRP can be a more sensitive way to predict a person's risk for cardiovascular disease than measuring only cholesterol levels. It's possible that about one-third of the people who don't have high cholesterol but are at risk for developing heart disease are falling through typical heart-health screens. These patients have low cholesterol levels and yet have elevated CRP levels. As a result, some physicians are starting to order CRP screenings.

B. Accomplishment Statement: Claycombe is studying the circumstances that cause CRP to be released in hopes of finding a way to lower elevated levels, much as statins lower cholesterol. She's looking for nutrients that can reduce CRP levels and in particular is testing the flavonoids of Michigan tart cherries.

Flavonoids are plant pigments, the substances responsible for producing the bright colors of fruits and vegetables. Many of them are also antioxidants and help lower cholesterol levels.

Claycombe is also studying omega-3 fatty acids and their ability to reduce inflammation and, consequently, CRP. So far, her results indicate that fish oil works better than antioxidant vitamins.

Claycombe recently published a peer reviewed paper (Harkins et al., Expression of interleukin-6 is greater in preadipocytes than in adipocytes of 3T3-L1 cells and C57BL/6J and ob/ob mice. J Nutr. 134:2673-2677, 2004) that showed significant contribution of fat tissue toward the obesity-associated systemic inflammation. This paper was chosen as one of the issue highlights (in the October 2004 issue of the *Journal of Nutrition*), and was presented in a national FASEB Summer Conference 2004 meeting with an acknowledgement of significant contribution in the field by the meeting organizers. This work is currently expanded to study anti-inflammatory effects of tart cherry, and omega 3 fatty acids.

C. Source of Funding: MSU, MAES, GREEEN, USDA Multi-state regional, seed grants from the MSU College of Human Ecology and the Cherry Marketing Institute (CMI)

D. Scope of Impact: MI (nationally and internationally through publication/presentation of peer-reviewed research)

**3) Studying cost-effective means to produce nutritional supplements from Michigan agricultural products.**

KEY THEME: nutraceuticals

A. Brief Description: Kirk Dolan, MAES food science and agricultural engineering researcher, and others have identified the health-promoting compounds in Michigan crops. They have focused on grapes, blueberries and onions because Michigan ranks in the nation's top 10 for producing these crops.

These crops also have high levels of phenolic compounds, a type of flavonoid (flavonoids are plant pigments). Flavonoids have been found to help lower cholesterol levels and many of them are also antioxidants.

B. Accomplishment Statement: By using seconds, culled and inedible material from the crops, such as grape or blueberry skins, Dolan has found ways to extract the flavonoids and produce them in a liquid concentrate or powder form. He is working on optimizing the processes for commercial production.

Dolan is working to be able to give processors production costs in dollars per milligram of beneficial compound. Several commercial companies are interested in his work. Because the processing uses parts of the crops that are normally disposed of as waste, Dolan's work has the potential to give Michigan growers a new, highly lucrative market for items that are now thrown away.

C. Source of Funding: MSU, MAES, GREEEN, USDA NRI grant

D. Scope of Impact: MI,

**4) Researching dietary compounds that may intervene to prevent colon cancer.**
KEY THEME: human health, human nutrition, nutraceuticals

A. Brief Description: In the United States, colon cancer is the fourth most common cancer in both men and women and the second leading cause of death among cancers, trailing only lung cancer. The American Cancer Society estimates that 146,940 cases of colon cancer will be diagnosed in the United States in 2004 and 56,730 deaths will occur.

Though less than 1 percent of colon polyps turn into tumors, removing polyps greatly reduces the risk of colon cancer, which is why so many people have this type of surgery. When polyps form, it's typically due to a defect in the adenomatous polyposis coli (APC) gene. APC plays a large role in colon cancer and may also be linked to breast and pancreatic cancer.

APC is a "gatekeeper" gene because it influences the rate at which other important growth control genes, known as "caretaker" genes, mutate and promote cancerous growth. One of APC's roles may involve cell death.

When the APC gene is normal, epithelial cells (those that line the colon) migrate and die the way they should by a process called apoptosis. If APC is mutated, other important genes also mutate, and cells fail to migrate and proliferate.

Colon cancer risk is known to be higher in people with inflammatory bowel diseases such as ulcerative colitis. This may be because normal epithelial cells make a large number of proteins, called chemokines, that send signals to the immune cells that patrol the colon. The immune cells normally recognize and kill cells that have become cancerous.

B. Accomplishment statement: Preliminary research data from Hord's lab indicate that precancerous cells may evade detection by immune cells because they make fewer of these proteins and smaller amounts of them. This could allow the precancerous cells to survive to form a polyp or tumor.

Research has shown that if the epithelial cells migrate, they will differentiate and then die as they are supposed to, even if they are mutated — the cells' failure to migrate is what causes colon cancer.

Hord is studying flavonoids to see if they can cause the cells to migrate even if the APC gene is mutated and the cells are abnormal. He's looked at curcumin, a compound found in the curry spice turmeric, to see if it causes the cells to migrate. Curcumin has been shown to prevent cancer in every stage. (In India, where curry dishes are very common, the prevalence of colon cancer is far lower than in the United States.)

Hord has shown that curcumin stimulates cell migration in cells that express mutated APC by stimulating enzymes called matrix metalloproteinases (MMP). These enzymes essentially clear the way for migrating cells to move up so they differentiate and die as they should.

Certain flavonoids in apples, onions and tea appear to have the same effect as curcumin on cell migration, and Hord is studying them to determine which are effective in inducing migration in precancerous cells. The native compounds from the plant appear to have a better effect than the pure flavonoid. So people may be better off eating an apple than taking a supplement in pill form.

While Hord's preliminary results show that the flavonoids are effective, he said it may take time for these results to translate into dietary recommendations and treatment plans. Many types of evidence (human studies to document the effective dose and any negative side effects) are needed to prove the effectiveness of dietary factors to prevent specific cancers. Basic scientists like Hord are just the first step in a long process to justify specific dietary recommendations to prevent cancer.

C. Source of Funding: MSU, MAES, National Cancer Institute

D. Scope of Impact: MI, national, international

**5) Researching ways to fight vitamin A deficiency.**
KEY THEME: birth weight, human health, human nutrition, infant mortality

A. Brief Description: Children with vitamin A deficiency are often deficient in multiple micronutrients and are likely to be anemic, have impaired growth, and be at increased risk of dying from common childhood infections such as diarrheal diseases and measles. Approximately 250 million children are at risk for vitamin A deficiency worldwide and about 4.4 million preschool-age children have visible eye damage due to this deficiency.

B. Accomplishment statement: Two MAES scientists –Maija Zile and Dean DellaPenna – have produced noteworthy results in their vitamin A research in recent years:

- Food science and human nutrition researcher Maija Zile has shown that quail embryos need vitamin A when heart development begins, about 30 hours into development (this corresponds to about 2 to 3 weeks of human embryonic development). Without vitamin A, the heart fails to develop an inflow track which it needs to join the vascular system. Congenital heart defects occur in approximately 12 out of every 1,000 live births. Pediatric heart defects account for 12 percent of childhood deaths, and 3 percent of all children have major heart malformations at birth. Scientists and medical researchers don't know the cause of these, and this research may help to better understand and eventually offer treatments for heart defects. (Research shows that in countries without good nutrition, there are more heart defects.)

- MSU, led by MAES scientist Dean DellaPenna, is the coordinating institution of the nutritional genomics team of HarvestPlus, a global research initiative to breed and disseminate nutritionally-enhanced crops. The first crops targeted for development by the HarvestPlus initiative are those most widely consumed in the developing world —

rice, wheat, maize, beans, cassava and sweet potato. There are three ways to fight micronutrient malnutrition: supplementation, fortification and food-based approaches. Currently, most efforts focus on providing vitamin supplements and fortifying food during processing. Unfortunately, in many developing countries, people eat only what they can grow — their consumption of processed foods and supplements is minimal. So HarvestPlus is positioned to be successful where other methods have failed.

C. Source of Funding: MSU, MAES, NSF, HarvestPlus (funded by an International Donor Consortium)

D. Scope of Impact: MI, Africa

**6) Measuring public attitudes about obesity to help inform public health policymaking.**
KEY THEME: human health, human nutrition

A. Brief Description: MAES nutrition scientist Beth Olson conducted surveys about how people view obesity. For three consecutive years (2002 to 2004), the surveys show that a majority of the state's residents see the issue as one of personal concern, not a public health problem.

Olson found that people are aware of obesity and concerned about their families (and especially their children) being overweight, but are much less concerned if people outside their families are overweight. People are concerned primarily with health problems for adults; for children, concerns include health, self-esteem and social problems. People were not supportive of punitive public health measures, such as higher taxes or higher insurance rates for obese individuals.

Although other research has identified barriers to healthy eating and physical activity, respondents generally did not identify these same barriers. People are aware of the obesity issue but do no appear to apply much of the information to themselves.

B. Accomplishment Statement: Olson has communicated these research results in a variety of presentations and the MSU Institute for Public Policy and Social Research (IPPSR) has posted summaries of the results on its Web site. The accomplishment is awareness-raising among those working in public health, Olson said. The public doesn't see the issue the same way as those working in public health. So those in public health-related positions (including teachers and regulators) have to change to the way they're communicating if they want public involvement in and support for efforts to fight obesity.

Also, relying on other MSU obesity research, MSUE and the Michigan Department of Education have developed a tool that schools can use to assess their environments, looking at everything from the types of foods in vending machines, to the types of rewards children liked the most. Ironically, pizza parties appear to be the most popular reward for excellence, but what kids value most is more recess time. The model has helped schools assess what they have and decide what they want to change.

C. Source of Funding: MAES, FACT (with support from MAES, MSUE and the MSU Office of the Provost)

D. Scope of Impact: MI, national

# Goal 4

## *Greater harmony between agriculture and the environment.*

*Executive Summary*

Large scale agriculture is the pillar of all modern societies. Gene manipulation, better management of soil nutrients, and improved weed control have greatly increased yields while mechanization has decreased farm labor requirements. But the costs of this agricultural progress, and all the associated economic activity it fuels, include splintered ecosystems, reduced biodiversity and polluted watersheds and soils. Several MAES-supported research projects are helping to bring these costs down.

One of these projects is providing high-tech tools to Michigan watershed managers. The MAES-supported Institute of Water Research has developed Web-based geographic information system (GIS) computer programs (available at www.iwr.msu.edu). The programs allow for easy mapping of the state's watersheds – geographically bounded areas that drain to a particular body of water. The programs assess soil erosion, and changes in runoff and non-point source pollution resulting from past or proposed development.

MAES fisheries and wildlife scientist Jack Liu is interested in development both in Michigan and around the world. In a 2003 article in *Nature*, Liu and colleagues at Stanford University examined how the twin global trends of increasing numbers of households and decreasing number of occupants per household are affecting biodiversity and resource consumption. Liu's work, which has received considerable media attention during the last several years, is changing public discourse about the need to protect valuable wildlife habitat and ecosystem services.

Other MAES scientists are servicing and rehabilitating resources that were never properly protected in the first place. Stephen Boyd, for example, showed that soaking soils with solutions rich in everyday minerals and salts might help soils more effectively soak up pesticides and other organic contaminants. Among its many potential benefits, Boyd's work may lead to more effective phytoremediation – the use of plants to remove contaminants from the soil.

MAES crop and soil scientist Clayton Rugh is demonstrating phytoremediation success today with one of Michigan's corporate icons, Ford Motor Company. Rugh is installing and maintaining plants at Ford's River Rouge complex that can degrade soil contaminants from an old coke oven. His work, which utilizes plants that are native to Michigan, may prove to be less expensive than traditional cleanup efforts.

While it's costly today to clean up the environment and improve resource management techniques, waiting and doing nothing will be exorbitantly expensive to future generations. This widely accepted maxim provides the backdrop against which the MAES work harmonizing environmental and agricultural interests should be viewed.

### *Allocated Resources*

| | FY 2004 |
|---|---|
| Hatch Funds | |
| Hatch Regular | 856,788 |
| Multi-State Funds | 171,027 |
| Other CSREES Funds* | 3,524,002 |
| Other Federal Funds* | 8,129,474 |
| **Total Federal Funds (est.)** | 12,681,291 |
| State Match for Hatch Funds | 1,027,814 |
| Remaining State Appropriations | 8,097,749 |
| Self Generated Funds* | 627,744 |
| Industry Generated Funds* | 3,018,359 |
| Other Non-Federal Funds* | 461,077 |
| **Total State Funds (est.)** | 13,232,742 |
| Total Estimated Funds | 25,914,033 |
| Scientist Years | 40.6 |

* Values extracted from Fiscal Year 2004 Funds and Manpower Report

**1) Developing high tech tools for watershed managers.**
KEY THEME: natural resources management, water quality

A. Brief Description: Millions of individual decisions affect water quality, from treating lawns with chemicals to building a mall with acres of parking lot. The use of GIS (geospatial information systems) provides a layered, big-picture look at the impacts of these decisions. For example, GIS can be used to help reach a decision about the location of a new housing development so that it has minimal environmental impact, is located in a low-risk crime area and is close to a population center. Unfortunately, at the county and local level, GIS technology is frequently underutilized. Setting up the technology and training staff to use it can be too expensive for local budgets.

B. Accomplishment Statement: The Institute of Water Research, which receives funding from the MAES, has developed several GIS programs for the entire Great Lake's Basin that are freely available on the Web at www.iwr.msu.edu. The programs allow watershed managers (or anyone who is interested) to map the watershed of a specific body of water. The programs assess soil erosion, and changes in runoff and non-point source pollution resulting from past or proposed development. The Institute of Water Research also provides training on how to use the software.

Specific accomplishments include:

- Collaborating with the U.S. Army Corps of Engineers and USDA Natural Resources Conservation Service to develop the first online soil erosion assessment tool. This tool

uses the Revised Universal Soil Loss Equation (RUSLE) to estimate soil erosion from a specific site on the basis of site data and information. The methodology has been generalized for use across the basin in Digital Watershed (www.iwr.msu.edu). Thousands of individuals have used the tool with 20% using it multiple times.

- The EZ-Mapper Site Locator web-based system was developed to assist farmers, planners, and citizens with the land use decision process. This tool allows the user to create their own digital maps of a user-selected area that contains aerial photos, streets, streams, and soils information. Users can zoom in and out to view the map area at varying levels, and may also download selected maps with soil boundaries, labels, and aerial photos.

- Using federally-funded deployment of GPS technology, more than 90 percent of the Type II wells (that provide water to restaurants, churches, rural schools and campgrounds) have been mapped using GPS coordinates. The accuracy of the well locations is within 3 to 5 meters, offering decision-makers excellent geospatial information. The work was done as part of a five-year, federally-mandated effort to assess the quality of all public drinking water supplies. The infrastructure investment and development of GIS tools should result in long-term benefits for groundwater protection.

C. Source of Funding: MAES, NPS, USGS, USDA Natural Resources Conservation Service, Army Corps of Engineers, Great Lakes Protection Fund, MDEQ, EPA

D. Scope of Impact: MI, other Great Lakes states

**2) Documenting the links between the lifestyles of human beings and the fates of animals.**
KEY THEME: biodiversity, endangered species, land use, wildlife management

A. Brief Description: Scientists have long studied how size and growth rate of human populations influence biodiversity loss. However, until 2003, household dynamics were usually neglected. The problem with this is that aggregate demographic statistics may mask substantial changes in the size and number of households, and their effects on biodiversity. Household dynamics influence per capita consumption and biodiversity through consumption of wood for fuel, habitat alteration for home building and associated activities, and greenhouse gas emissions, for example.

B. Accomplishment Statement: MAES fisheries and wildlife researcher Jianguo "Jack" Liu has advanced understanding of the link between household dynamics and biodiversity. In research published in 2003 in *Nature*, Liu and other collaborators reported that growth in household numbers globally, and particularly in countries with biodiversity hotspots (areas rich in endemic species and threatened by human activities), was more rapid than aggregate population growth between 1985 and 2000. Even when population size declined, the number of households increased substantially.

Liu found that, had the average household size (that is, the number of occupants) remained static, there would have been 155 million fewer households in hotspot countries

in 2000. Reduction in average household size alone will add a projected 233 million additional households to hotspot countries during from 2000 to 2015. Rapid increase in household numbers, often manifested as urban sprawl, and resultant higher per capita resource consumption in smaller households pose serious challenges to biodiversity conservation.

In related research, Liu has also documented the failings of China's much publicized effort to save pandas by creating wildlife refuges. Liu found that panda habitat is being destroyed quicker inside the world's most high-profile protected nature reserve (the Wolong Nature Reserve in southwest China) than in adjacent areas of China that are not protected. Moreover, the rates of destruction were higher after the reserve was established than before the reserve's creation.

In addition to appearing in *Science*, Liu's panda research was featured in *The New York Times*, *The Washington Post*, *The (London) Daily Telegraph* and other major publications. So his research served to inform public discourse about important biodiversity issues.

C. Source of Funding: MSU, MAES, NSF, NASA, NIH

D. Scope of Impact: MI, China, other international

**3) Cleaning up pesticides and other organic contaminants from soils.**
KEY THEME: agriculture waste management, soil quality, water quality

A. Brief Description: Pesticides and other organic contaminants, even those that have been banned in the United States, are still found in soil and have the potential to contaminate water supplies. New research by an MAES scientist shows that dousing soils with solutions rich in everyday minerals and salts might help soils more effectively soak up pesticides and other organic contaminants.

B. Accomplishment Statement: MAES researcher Stephen Boyd has found that the sponge-like properties of soil clays can be changed, especially by tweaking concentrations of naturally occurring potassium. This provides the basis to reliably and inexpensively control the leaching of important classes of contaminants and to improve the effectiveness of bioremediation technologies such as phytoremediation (using plants to remove contaminants in the soil).

This is how it works: The minerals in the soil initially soak up the pollutants. Over time, however, the minerals slowly release their grip on the pollutants. This slow release makes it easier for the plants used in phytoremediation to remove the contaminants from the soil.

There are several potential applications of these findings, including more environmentally friendly techniques to apply pesticides and more effective ways to clean up contaminated soil. They also may help build models that better explain the role of basic minerals in the spread of pollutants in soils.

Boyd published his results in fall 2004 in the journal *Environmental Science & Technology*. He has applied for a patent for the particular process he used. He says the particular pollutants he studied are common on military bases. So the technology might be especially useful anywhere there's a military base, particularly where a base is being converted from a military to a civilian use.

C. Source of Funding: MSU, MAES, USDA National Research Initiative Competitive Grant

D. Scope of Impact: MI,

**4) Cleaning up pesticides and other organic contaminants from soils.**
KEY THEME: agriculture waste management, soil quality, water quality

A. Brief Description: Most of the pollutants at Dearborn's historic Ford River Rouge Complex coke oven facility are polycyclic aromatic hydrocarbons (PAHs) formed when coal is processed into coke for use in smelting. Looking to clean up the site, Ford and lead architect of the site renovation project William McDonough + Partners design firm turned to MAES crop and soil scientist Clayton Rugh to investigate the feasibility of phytoremediation (using plants to break down and extract soil pollutants).

B. Accomplishment Statement: Because the plant is still operating, the scientists took soil samples from the facility and put them in plots covering approximately one-eighth of an acre for managed treatments to see which techniques are the most sustainable and successful. The most effective plant species and soil treatments were scaled-up in a larger installation of 1.6 acres immediately adjacent to the coke oven facility. Public access and information about the project are posted in a visitor's center for tours of the new assembly plant at the facility and along walkways among the plots.

   During the first testing season, the treatment plot experiments showed that the plants had accelerated the PAH biodegradation rate in the contaminated soils. Rugh is designing a full-scale phytoremediation system for Ford to implement for all or part of the 30 acre coke oven site. In addition to cleaning up the environment, phytoremediation costs less, reduces incidental pollutant discharge, restores the habitat concurrent with the cleanup, and is aesthetically appealing.

   Rugh's research has helped to create an important market for landscape horticulturalists, native plant nursery operators, and remediation engineers for re-development of contaminated industrial properties. Regional native plant suppliers sold more than $150,000 in materials from Rugh's Ford project alone. Landscape and engineering firms also participated in this installation and generated more than $500,000 in services revenue. The developed phytoremediation technology has the potential to save Ford millions of dollars otherwise spent excavating and burying the affected soil in approved landfills.

   These approaches are applicable throughout the United States opening up new agricultural markets and providing stakeholders with less expensive and more environmentally compatible options for industrial property rehabilitation. Research publications and presentations describing this project have been made to international groups attending MSU technology workshops from Asia, Africa, and South America and in seminars given throughout the United States and in several European countries.

C. Sources of Funding: MSU, MAES, Ford Motor Company, US Environmental Protection Agency, The Consortium for Plant Biotechnology Research, USDA National Needs Fellowship program.

D. Scope of Impact: MI, USA, and abroad.

# Goal 5

## *Enhanced economic opportunity and quality of life for Americans.*

*Executive Summary*

Concerns about jobs and quality of life are paramount in Michigan. During the first four years of this new century the state lost more than 170,000 manufacturing jobs, the largest share of the 2 million lost nationwide. Even as economic recovery is underway in much of the rest of the country, Michigan continues to lag, especially when it comes to jobs.

According to January data from the U.S. Department of Labor, only Alaska and Washington, D.C. have higher unemployment rates than Michigan. It's the kind of data that grabs everyone's attention in Michigan, including the governor's. A month later, Gov. Jennifer Granholm titled her state of the state speech "Michigan: Jobs Today, Jobs Tomorrow."

Basic and applied research by MAES scientists is helping to brighten the state's employment prospects, now and in the future. For example, an MAES horticulture researcher is supporting a technical certificate program for workers in the greenhouse industry. Workers who complete the training through the so-called College of Knowledge (CoK) report earning higher wages and making better on-the-job decisions.

The CoK helps to feed an important agriculture-related industry in Michigan. The greenhouse industry generates more than $300 million annually in sales and supports as many as 10,000 employees in the state.

MAES research also is addressing a scourge on the state's massive $9 billion forest products industry – the emerald ash borer. The half-inch long EAB is an exotic, invasive insect from Asia that has infested and killed an estimated 10 million ash trees since it was first discovered in 2002 near Detroit.

MAES scientists determined that infected ash wood could safely be used to make products such as flooring, kitchen cabinetry, paneling and benches. Moving even some of the hundreds of millions infected ash trees to higher-value uses – the trees are currently slated to be cut down and burned for energy – will add to the economies and create jobs in communities where EAB is prevalent.

Other MAES work, particularly in basic research, is building a foundation for future job creation. New understand of the molecular biology of canola may eventually help to wean the United States from its dependence on foreign oil. And work to help plan highway expansion in western Michigan is quite literally laying the groundwork for smart community development and sustainable economic growth over the next several decades.

### *Allocated Resources*

| | FY 2004 |
|---|---|
| Hatch Funds | |
| Hatch Regular | 192,944 |
| Multi-State Funds | 11,519 |
| Other CSREES Funds* | 1,129,280 |
| Other Federal Funds* | 173,338 |
| **Total Federal Funds (est.)** | 1,507,080 |
| State Match for Hatch Funds | 204,462 |
| Remaining State Appropriations | 1,583,507 |
| Self Generated Funds* | 11,168 |
| Industry Generated Funds* | 72,831 |
| Other Non-Federal Funds* | 72,465 |
| **Total State Funds (est.)** | 1,944,434 |
| Total Estimated Funds | 3,451,514 |
| Scientist Years | 8.0 |

* Values extracted from Fiscal Year 2004 Funds and Manpower Report

**1) Transferring technical skills to workers in Michigan's greenhouse industry.**
KEY THEME: jobs/employment

A. Brief Description: In 2003, according to the National Agricultural Statistics Service, the wholesale value of greenhouse crops grown in Michigan was $341,964,000. The greenhouse floriculture industry, according to one MSU estimate, supports approximately 10,000 jobs in the state.

In the late 1990s, too few trained students were entering Michigan's growing greenhouse floriculture industry, and greenhouse employees wanting to become certified growers could not afford the time or expense of enrolling in traditional college and university classes. In response, MAES helped fund the creation of the MSUE Floriculture College of Knowledge (CoK) Greenhouse Grower Career Development Certificate program.

The program began in 1998 to help meet the demand for trained greenhouse growers. A CoK program for Spanish speakers was started in 2000. The CoK is an economical program that targets individuals already working in the industry, primarily assistant growers who have some experience in greenhouse production and want to increase their knowledge and skills in the production of floriculture crops.

MAES funded the research underpinnings of the CoK, which includes modules on disease management, bedding plant production, plant physiological disorders and other topics. MAES-funded research in greenhouse lighting was expanded beyond a course

module into a 95 book, “Lighting Up Profits – Understanding Greenhouse Lighting,” edited by MAES horticulturist Erik Runkle.

B. Accomplishment Statement: Since 1998, more than 400 people from 21 states and four countries have participated in the program. The program has generated more than $300,000 from registration fees, which are used to cover the costs of running the program.

For the past three years, the CoK curriculum has been offered at the Ohio Florists’ Association Short Course conference held every July. This offering has attracted more growers throughout the United States, proving that the program can be a valuable investment for greenhouse companies outside of the Midwest.

The success of the program has led to the need for additional modules, according to MAES horticulture scientist Erik Runkle. Four additional modules are in the works, focusing on the business aspect of floriculture and targeting small growers or middle managers in larger operations. The courses will cover marketing, human resources, strategic planning and understanding balance sheets.

“By completing the College of Knowledge modules, I have a better understanding of production and how plants interact with their environment,” said Jose Loyola, a container grower at Sawyer Nursery, Inc., in Hudsonville, Mich., who recently completed the 12 modules offered through the MAES-supported CoK. “I also earn better wages, I’m a more reliable worker and I can make production decisions.”

C. Source of Funding: MSUE, MAES, GREEEN

D. Scope of Impact: primarily MI and OH, however the 400 graduates of the program have come from 21 states and four countries

**2) Demonstrating how ash wood from trees infected with the emerald ash borer can be used to make wood products instead of being destroyed.**
KEY THEME: impact of change on rural communities, jobs/employment, supplemental income strategies

A. Brief Description: The half-inch long emerald ash borer (EAB) is an exotic, invasive insect from Asia that has infested and killed an estimated 10 million ash trees since it was first discovered in 2002 near Detroit.

Currently, 20 Michigan counties are quarantined, as well as 14 infested areas outside of these counties. Additionally, two counties in northern Indiana and seven counties in northern Ohio have EAB infestations, some resulting in quarantines. No ash trees can be transported outside the quarantine area for fear of spreading the pest.

The state has set up seven disposal sites where the trees can be chipped, with the wood then transported to a burner near Flint to generate electricity. It’s a big job that is

expensive for the federal, state and local governments that are trying to deal with the infestation. For example, by one estimate, Detroit alone has more than 40,000 trees.

B. Accomplishment Statement: MAES scientists determined that infected ash wood could safely be used to make products such as flooring, kitchen cabinetry, paneling and benches. Moving even some of the hundreds of millions infected ash trees to higher-value uses – the trees are currently slated to be cut down and burned for energy – will save money and create jobs in communities where EAB is prevalent.

   One approach being explored is to process infected wood at local mills instead of hauling it to designated sites. According to one estimate, if Detroit milled its infected wood at a metro area facility, the city could save $100,000 annually in costs now spent to transport downed ash trees to chipping sites.

   When the EAB's destruction first became apparent, people were so concerned about spreading the bugs that no one tried to do anything with the wood. However, the EAB doesn't go more than a one-fourth of an inch into the tree. So if the outer layers are stripped away, much of the useful timber remains.

   So there's no reason these local mills couldn't discard the infected part of tree and process what's left into useful timber. By another estimate, it would take only 1,300 trees a year to produce 3,380 street barricades, 43 picnic tables, 24 bleachers and another 200 items such as benches, signs, planters and shelving.

   Another approach is to encourage use of portable mills that small-scale millers can haul from site to site. Today, cities with infected trees often pile up a certain number of downed trees and then call in a grinder who charges $325 per hour for a two- or three-day job. All the cities get, according to one of these small scale millers, is a bill and a big pile of wood chips that the city has to pay to have hauled away.

   Portable mills, by contrast, can be pulled into a driveway. Charges for this on-site milling can be as low as $70 per hour. And the milled wood the property owner doesn't want can be sold to recoup some of the milling costs.

C. Funding Source: MSU, MAES

D. Scope of Impact: MI and neighboring states facing EAB infestations

**3) Discovering new metabolic pathway in canola, an important oilseed crop.**
KEY THEME: impact of change on rural communities, jobs/employment

A. Brief Description: Canola, an annual crop in the mustard family, is widely cultivated throughout the Upper Midwest, Canada, Europe and Asia. The oil extracted from the seeds of this plant is used to make everything from margarine to industrial lubricants.

Canola seeds store large oil reserves to use as energy when the time comes to germinate and grow. In canola, for example, oil can make up half of the seed's weight.

People have long exploited these oil-rich plants. People in India and China have processed canola seeds into oil for cooking and lamps for 4,000 years. In more recent history, the rise of modern biochemistry over the past few decades has increased interest in making quantitative descriptions of plants' and animals' biochemical reactions.

With canola, the biochemical balance sheet just didn't add up. As far as researchers could tell, the seeds were relying on an inefficient pathway to produce their sought-after oil.

All plants use carbon from carbon dioxide, a basic part of Earth's atmosphere, to make compounds such as sugars, oils and proteins in stems, leaves and flowers. To harvest carbon from the air, plants go to a lot of trouble to convert carbon dioxide into simple sugars. When canola then transformed these sugars into oils, the plants appeared to give off large amounts of carbon dioxide.

B. In its research, the MSU/MAES team tagged carbon atoms and tracked how they were processed by developing canola seeds. During the conversion of sugars to oils, researchers expected to see the tagged carbon go through a step-by-step series of chemical reactions known as glycolysis, used by all plants and animals to turn sugar into energy and cellular building blocks. This energy, in turn, is used to link the carbon building blocks into molecules of oil.

Instead, the scientists observed an enzyme called rubisco providing a more efficient pathway to convert sugar to carbon chains for oil. And the pathway involved much less carbon dioxide emission than researchers expected.

Scientists have long known that in the process of photosynthesis, rubisco is the key enzyme that captures atmospheric carbon dioxide for conversion into sugars. However, the MSU team was surprised to see rubisco – the enzyme's shorthand stands for ribulose bisphosphate carboxylase/oxygenase – also acting as a key agent producing oil in the seed.

In fact, in terms of metabolic heavy-lifting, rubisco appeared to be much more efficient than glycolysis. The newly uncovered rubisco bypass pathway produced 20 percent more of the carbon chain building blocks to make oil while losing 40 percent less carbon dioxide than is lost during glycolysis.

The results cast new light on the seemingly well-understood rubisco, which accounts for 50 percent of a plant's total protein content and is likely the mostly abundant protein on Earth.

Through its role in grabbing carbon atoms from atmospheric carbon dioxide, rubisco has been recognized as the main chemical gateway for carbon to enter the biosphere. The

new findings suggest that rubisco also gives plants a way to greatly reduce losses back to the atmosphere while they're synthesizing oil.

"Understanding the pathways plants use to make oil will help us to develop new crop varieties with greater oil content," said John Ohlrogge, an MAES plant biologist and one of the authors of the paper, which appeared in 2004 in the journal *Nature*. These new crops will become especially important as the world depletes its supplies of petroleum.

C. Source of Funding: MSU, MAES, U.S. Department of Energy, the National Science Foundation

D. Scope of Impact: MI, potentially anywhere canola is grown

**4) Assessing the effects of a new highway.**
KEY THEME: community development

A. Brief Description: Plans to build a new freeway through the rural interior of Ottawa County led to heated debate in the western Michigan lakeshore region. The Michigan Department of Transportation (MDOT) proposed constructing anew U.S.-31 bypass through four rural townships to connect I-96 and I-196, just west of Grand Rapids. Opponents of the plan contended the bypass would contribute to sprawl.

B. Accomplishment Statement: MDOT decided that it needed to call in an impartial third party with expertise in new geospatial technology. MAES scientist David Skole was asked to evaluate the impact of the various highway corridor alternatives on land use patterns. Skole used a land use change forecasting computer model called "Forecast Michigan" to assess the impact of each of five alternative options, including a no-build scenario.

The model incorporated a wide array of data to visualize the outcome of each option, including digital geographic layers, remote sensing data from satellites, economic forecast information, demographic projections, household transportation information, network routing information, and the relationship between changes in land values and changes in land use.

Skole and other MAES researchers found that land consumption associated with metro Grand Rapids economic growth is the single most important factor contributing to land use change in Ottawa County. Economic analysis identified this factor as the major influence on land use change over the next 20 years, not the selection of a particular bypass option.

The results showed that the no-build option would still produce more than 80 percent of the land use change associated with any of the other bypass options. Differences among the various options amounted to less than 7 percent. In other words, the differences between the options were far more subtle than expected.

MDOT was extremely pleased with the results and is waiting on the "record of decision" from the Federal Highway Administration on the project.

C. Source of Funding: MSU, MAES, MSU Strategic Partnership Grant, MDOT

D. Scope of Impact: MI

# 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 integrated educational delivery system and were formed as a direct result of stakeholder demands, especially from Michigan's plant and animal industries. 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.

*MSUE and MAES State Council*: The MSUE and MAES State Council link the issues of concern in local communities with the research and teaching at the state's land grant university. A network for organized citizen input at the local and state levels enhances that linkage. County Extension councils identify and prioritize issues, seek collaborations and resources, and communicate to others the importance of Extension's educational programming. Citizen Advisory Councils help establish research priorities at the state's 15 field stations. The MSU Extension and Experiment Station Council serves as a liaison between county councils, field station advisory groups and state agencies and organizations. Members are able to communicate to others (policymakers, organizations and agencies, university administrators, etc.) the importance of the educational programming and the applied research from Michigan's land grant university.

*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.

*Revitalization of Animal Agriculture in Michigan Initiative:* The Animal Industry Initiative (AII) relies on the outreach communication provided through MSUE and the AoE teams to gather input from stakeholders in the animal agriculture industry. When competing for AII funding, the researchers must state which industry priority they are addressing. The industry priorities are identified by AoEs and others closely related to the industry.

*Board of the Southwest Michigan Research and Extension Center (SWMREC):* This board is selected 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.

*Lake City Experiment Station External Advisory Committee:* This committee helps to set priorities for research and Extension activities that are conducted at the station. Its activities are representative of advisory committees at other MAES field stations. The Lake City committee reviews proposals submitted to the John R. Rood Trust and makes recommendations to MAES on their funding. The funds are used to discover better adapted species of cultivated plants and domestic animals, more hardy species, less liable to disease; and better practices in farm management and in raising farm crops and animals, better adapted to the northern part of Michigan.

***Process used by the recipient institution to identify individuals and groups who are stakeholders and to collect input from them***

With its mission to enhance agriculture, natural resources and families and communities in Michigan, the MAES has a broad list of stakeholders. Growers represented by Michigan's commodity groups are on this list, as are many of the state's elected and regulatory officials.

However, several nontraditional groups also benefit from information generated by the MAES. As just one example, Michigan's $300 million-per-year greenhouse industry employs approximately 10,000 workers, many of whom are Spanish-speakers. To meet the needs of this stakeholder group, MSU's successful floriculture training program began offering courses in Spanish in 2000. The program's curriculum is grounded in MAES research and delivered by MSUE educators.

In fact, the MAES relies heavily on MSUE's extensive statewide network not only to deliver information, but also to identify new stakeholders. MSUE employees from county agents to regional directors are tapped to connect the MAES research agenda to the needs of Michigan's residents.

This citizen-scientist connection also is fostered when MAES scientists make public presentations about their research. When just-plain-folks who fall outside the traditional

stakeholder rubric attend these lectures, every effort is made to engage them in dialogue or otherwise enlist their feedback on MAES-backed activities.

Plans by MAES administrators for regional meetings and listening sessions around the state represent another effort to broaden the stakeholder base. These meetings, which last took place around five years ago, will be advertised on the MAES Web site and in local papers, libraries and community centers. Extra efforts will be made to reach historically underserved and underrepresented segments of Michigan's population.

Beyond efforts to find new audiences, well-established Area-of-Expertise (AoE) teams provide strong linkages into traditional agriculture-related constituencies. These teams are staffed by MSUE educators and MAES scientists. They not only publish information to Michigan growers on the success of various on-farm research and demonstration activities, but also communicate grower concerns back to MAES administrators. The result is an iterative and responsive research agenda.

***How collected stakeholder input was considered***

As earlier outlined, stakeholder input provides the foundation to much of the research and extension activities developed by the MAES and MSUE. The success of the 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 the 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, MAES researchers, administrators, and MSUE educators 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. Commodity groups meet and determine research and extension priorities. These priorities are posted on the Web for MAES scientists to consult as they develop their research projects.

*Revitalization of Animal Agriculture in Michigan Initiative:* Proposals submitted for consideration by the AII coalition must meet identified priorities and concerns as listed by the AoE teams and other individuals associated with the AII coalition.

*Lake City Experiment Station External Advisory Committee:* The committee meets annually to determine research priorities and review proposals. The committee is also called upon to give input on biannual field day themes and topics.

# 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***

## Fresh Sliced Apples Offer Profitable Marketing Opportunity for Michigan Apple Industry

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

Brief Description: Fast food outlets have been at the receiving end of mounting pressure from governmental, industry and consumer groups to offer healthier menu options, especially for children. In response to this pressure, McDonald's tested a new product, Apple Dippers – a 2.4-ounce package of peeled, fresh sliced apples served with a low-fat caramel dipping sauce – in three regional markets in 2003. After recording brisk sales in its test markets, McDonald's introduced Apple Dippers across the United States in June 2004.

Work leading up to this success story began in 2002 when Project GREEEN (Generating Research and Extension to Meet Economic and Environmental needs, the Michigan plant industry initiative) invested seed money to explore the viability of a Michigan fresh sliced apple product. Findings from the initial research investigation indicated promising market potential for a fresh sliced apple product and led to expanded involvement in the initiative from other organizations, including the Michigan Apple Committee (MAC) and the Michigan State Horticultural Society.

MAES researchers representing multiple disciplines participated in all phases of the project, from the time the apples grew on the tree until the time they were packaged, including processing, sensory evaluation and consumer sampling. During the project, researchers combined a state of the art processing machine and a commercial preservative and put together a

study based on recommendations received from apple production experts at the MAES Clarksville Horticultural Experiment Station. MAES researchers evaluated six Michigan-grown apple varieties – Empire, Jonagold, Jonathan, Gala, Honey Crisp and Cameo – to determine which varieties would make the most promising candidates for fresh slices.

***Did the planned programs address the needs of under-served and under-represented populations of the State?***
This work is at least indirectly related to fighting obesity, a particular problem in under-served and under-represented populations in Michigan and around the country. In general, obesity costs Michigan an estimated $3 billion per year. Seven percent of all medical expenses in the state are related to obesity, and half of that is paid for by taxpayers through Medicaid and Medicare.

In a survey of 200 Head Start parents in Michigan, MAES-collected data revealed that only 15 percent of mothers and 40 percent of the children were eating more than one serving a day from each of the five food groups. (More than 90 percent of the Head Start population is below the poverty level.) The mothers were low in and dairy and fruit and the kids were low on fruits and vegetables. In one question, MAES researchers asked which vegetables toddlers (2-year-olds) ate during their three meals and three snacks. For nearly half of the 118 children in the survey group, potatoes (usually in the form of high-fat, high-sodium French fries) were the most commonly-consumed vegetable. As alternatives to French fries, apples slices on the menu of the world's largest fast food chain may help address the obesity issue.

The McDonald's product is also good news for the U.S. apple industry. McDonald's has 13,700 locations in the United States alone. So the addition to the menu may drive apple consumption, which has stagnated over the last decade or more according to the industry.

***Did the planned programs describe the expected outcomes and impacts?***
Michigan had 40,000 acres of apple orchards in 2003, and apple production was valued at nearly $100 million. MAES research has helped tap the fresh sliced market, opening the door to a profitable new opportunity for the state's apple growers and processors. Access to this market, facilitated by the work of MAES scientists, is already having a major impact on the Michigan apple industry as a whole.

A western Michigan processor is one of three major suppliers of fresh apple slices to McDonald's in the United States. The company, which opened a new sliced apple processing facility in March 2004 and added several new full-time jobs to help meet demand for the new product, may require up to two-thirds of this year's Michigan crop to supply the fresh slice market and fulfill its McDonald's contract.

***Did the planned programs result in improved program effectiveness and/or efficiency?***
The apple success story is one example of the effectiveness of Project GREEEN, which helps the MAES, MSUE and the Michigan Department of Agriculture 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 between _____** | **__0____** | **78,628** | **157,199** | **155,628** | **155,736** |
| **__the university, Extension service and ___** | _____ | _____ | _____ | _____ | _____ |
| **__the Mich. Ag. Experiment Station. ____** | _____ | _____ | _____ | _____ | _____ |
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**Director** **Date**

**Form CSREES-REPT (2/00)**