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MICHIGAN AGRICULTURAL EXPERIMENT STATION

ANNUAL REPORT

OCTOBER 1, 1999 - SEPTEMBER 30, 2000

EXECUTIVE SUMMARY:

The Annual Report for October 1, 1999 through September 30, 2000 for the Michigan Agricultural Experiment Station (MAES) includes a vast variety of research areas and is organized to mirror the Plan of Work which was submitted for 1999-2000. The following provides an overview of the accomplishments and achievements over the past year.

The MAES embraces the concept of collaboration and partnership with Michigan communities, agricultural and natural resources industries and organizations, and governmental agencies in addressing critical issues. These relationships have resulted in wide-ranging success. Complex challenges ù the loss of the use of some pesticides through the Food Quality Protection Act (FQPA), the effects of global warming on insect pest life cycles, the outbreak of tuberculosis in cattle in northeastern Michigan, the need to improve the health of Michigan's rural families living in poverty _ call for the combined efforts of researchers, Extension agents, producers, agribusinesses, community and nonprofit groups, and state officials.

One example of our efforts to build partnerships and include stakeholders to solve problems experienced in Michigan is the state's plant agriculture initiative--Generating Research and Extension to meet Economic and Environmental Needs (GREEN). This initiative provided funding for many research and educational projects to address issues identified as important to the long-term economic viability and progressiveness of plant agriculture. Among project GREEN success stories is the development of methods to control late blight in potatoes, which saves producers in the state millions of dollars, and the discovery of a nonchemical method to store apples, which allows producers and shippers a wider market in which to sell their product. More information on project GREEN can be obtained through

its Web site at www.green.msu.edu.

Another example of partnerships and stakeholder involvement is the Animal Industry Initiative (AII). This program has funded 96 projects since its inception in 1995, and the completed projects can be viewed on its new Web site, www.animalag.msu.edu. Turkey production and processing in the state have benefitted from AII and its partnerships with the industry, MSU Extension (MSUE), the Michigan Department of Agriculture (MDA) and the MAES in creating the Michigan Turkey Producers Co-op facility in Wyoming, Mich. This turkey processing cooperative has allowed the state's turkey producers to stay in business after their contracts were discontinued by Bil-Mar Foods in 1998 and is providing employment for more than 270

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people.

MDA, Michigan Department of Public Health (MDPH), and Michigan Department of Natural Resources (MDNR) in partnership with MAES, MSUE, and USDA officials have had the onerous task of addressing tuberculosis (TB) in deer and its spread into cattle and other animals. With the research goal of developing efficient and effective control/eradication programs for bovine TB in Michigan, MAES and Michigan State University (MSU) researchers are using risk analysis concepts to provide the best source of information to design these programs, integrating information from epidemiology, pathology, biology, economics and sociology. The risk analysis is based on current, reliable data that take into consideration the epidemiology of the disease, the biology of potential hosts, the economic and social impacts of disease and control/eradication on stakeholders, and communication needs to keep stakeholders informed and educated on the bovine TB problem in Michigan. The university is a partner in maintaining the information on the TB Web site at www.bovinetb.com.

One final example of partnership, of which we are especially proud, is in the area of environmental stewardship. The Golf Course Superintendents Association of America (GCSAA) has

given its 2001 President's Award to the Michigan Turfgrass Environmental Stewardship Program (MTESP) at MSU. This program to environmentally enhance Michigan's golf courses is the only program of its kind in the United States. The MTESP is a partnership between MSU, the Michigan Turfgrass Association, the Golf Association of Michigan, the MDA and the Michigan Department of Environmental Quality (MDEQ).

Our partnerships and coalitions are not only with organizations outside of MSU. Internal to the university we are also building coalitions and partnerships which result in multidisciplinary research. In July, the MAES and the Office of the Vice President for Research and Graduate Studies (VPRGS) committed funds for the next five years to the newly formed Center for Plant Products and Technologies (CPPT). The initial research activity will be in nutritional genomics, biobased industrial products, metabolic engineering and processing, natural products and phytomedicine.

Another example of internal coalition building would be the MAES programs in the areas of children, youth, families and communities. The Families and Communities Together (FACT) coalition is the university's multidisciplinary research, extension and outreach group that invests in research and outreach, links campus and community resources and serves as an information hub for news, research, funding and programs for children, families and communities. FACT supports partnerships involving 11 MSU colleges, MAES researchers, MSUE staff members on campus and throughout the state, and professionals from groups such as the Michigan Children's Trust Fund, the Michigan Association of School Boards and the Mott Children's Health Center; governmental agencies that include the Michigan Department of Education and Head Start; nonprofit organizations and foundations including the Council of Michigan Foundations, the W. K. Kellogg Foundation and the Frye Foundation. In October 2000, the FACT forum, "Building Family and Community Assets: A Dialogue with Foundations," engaged leaders from foundations, nonprofit organizations and universities in a dialogue

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on building partnerships to strengthen Michigan's families and communities.

These accomplishments are the result of our partnerships with MSUE; commodity and processor groups; community, state and national governmental agencies; other universities; and a number of different colleges and departments within MSU. In developing a balanced research agenda of basic and applied research, we always keep in mind that the results of such research must stand the test of public scrutiny.

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Guide To Acronyms In Document

- AII Animal Industry Initiative
- CANR College of Agriculture and Natural Resources
- CAT Crop Advisory Team
- CEVL Computational Ecology and Visualization Laboratory
- CHM College of Human Medicine
- CNS College of Natural Science
- CPPT Center for Plant Products and Technologies
- CVM College of Veterinary Medicine
- FACT Families and Children Together
- FDA Food and Drug Administration
- FNDRC Food and Nutrition Database Research Center
- FQPA Food Quality Protection Act
- GCSAA Golf Course Superintendents Association of America
- GIS Geographic Information Systems

GREEN Generating Research and Extension to meet Economic
and

Environmental Needs

GWP Global Warming Potential

HACCP Hazard Analysis Critical Control Points

IFAS Institute of Food and Agricultural Standards

ILTER Long-Term Ecological Research

MAEAP Michigan Agriculture Environment Assurance Program

MAES Michigan Agricultural Experiment Station

MDCH Michigan Department of Community Health

MDA Michigan Department of Agriculture

MDEQ Michigan Department of Environmental Quality

MDNR Michigan Department of Natural Resources

MDOT Michigan Department of Transportation

MFB Michigan Farm Bureau

MMP Manure Management Planner

MNN Michigan Nutrition Network

MSAC Michigan Sugarbeet Advancement Committee

MSU Michigan State University

MSUE Michigan State University Extension

MTESP Michigan Turfgrass Environmental Stewardship Program

NFSTC National Food Safety and Toxicology Center

NFS National Science Foundation

PAR Pesticides at Risk

PPV Plum Pox Virus

TOPC Thumb Oilseed Producer's Cooperative

USDA United States Department of Agriculture

VPRGS Vice President of Research and Graduate Studies

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GOAL 1: An Agricultural Production System That is Highly Competitive in the Global Economy

Summary:

Agriculture adds nearly \$40 billion to Michigan's economy when all aspects of production, processing and retail operations are considered. Food/agriculture is the state's second most important industry in economic terms, and the state's most stable, employing more than 500,000 people every year.

Agriculture in the state is impressively diverse—Michigan ranks third behind California and Florida in number of crops grown. Surrounded by the Great Lakes, the state has the ideal climate and soil conditions for floriculture, nursery, and fruit crops in the western part of the state. The Thumb provides model conditions for dry beans and sugar beets, while southeastern Michigan boasts large numbers of turf and nursery operations. The MDA reports that Michigan ranks in the top five producing states for 35 crops and is the No. 1 producer of several types of dry beans, blueberries, cucumbers for pickles, tart cherries, Easter lilies, and summer potatoes. These specialty crops contribute to the state's agricultural strength, but they all require specific growing techniques and research.

Every county in Michigan benefits from agriculture, and MAES scientists, with input from the state's commodity groups, are working on a number of projects to ensure the continued competitiveness and robustness of Michigan agriculture in the next five years.

The MAES has three main thrusts that fall under this goal: value-added products, plant production agriculture, and animal production systems. The MAES has long-term commitments to these programs but wants quick results from specific projects that will lead to other innovative work.

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Allocated Resources:

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*Value extracted from the Fiscal Year 2000 Funds and Manpower Report

Value-added Products - Key Program Component

1. Determining the genetic structure of oilseed crops to manipulate them to produce industrially valuable fatty acids.

A. Brief Description: Oilseeds are the lowest cost/highest volume biological production system for reduced organic molecules. Vegetable oils are a major commodity with world production of 108 metric tons generating \$50 billion in oil sale revenues. Well developed commercial infrastructure for production and utilization supplies refined oils at approximately \$0.25/lb. The primary use of vegetable oils is in the food industry, in salad, frying/baking oils and fats, and in margarine. However, genetic engineering offers the opportunity to greatly expand the uses of vegetable oils for chemical manufacture. For example, cyclopropene and cyclopropane fatty acids offer several novel chemistries that can be utilized in a wide range of high-value applications, including the production of methyl-branched fatty acids (for lubricants), direct polymerization for plastics, reactive diluents in coatings, and the production of hydroxy-fatty acids for greases. The development of this material first requires the demonstration of a commercial oilseed containing the desired fatty acid and second, development of processing/extraction technology to recover the fatty acid in high yield at low cost. This multidisciplinary effort is a core program of the newly formed CPPT at MSU. Research is well underway and several distinct acyl-ACP desaturases, which produce unusual mono-enoic acids, have been isolated and characterized. Studies are now in

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progress to produce these fatty acids in heterologous plants by expression of the desaturases.

B. Accomplishment Statement: The major economic and food value of most agricultural products reside in their seeds and centuries of agricultural research have been directed at improving the qualitative and quantitative traits associated with seed products. Different major crop species produce seeds with very different compositions which in large part reflect the proportions of the major storage components accumulated in the seeds. In this reported activity, success in producing unusual mono-enoic fatty acids in oilseeds will enhance the competitiveness of U.S. agriculture by diversifying oilseed production. This research will also create new uses and products from existing oilseed crops, thus further increasing the profitability of U.S.

agriculture. In addition, the new products would serve as replacement for petroleum-based products, therefore opening up new markets for U.S. farmers as well as creating an environmentally friendly source of industrial lubricants, polymers, and other feedstocks.

C. Source of Funding: See table for Goal 1.

D. Scope of Impact: State specific, but study will be an integral part of the newly established Midwest Consortium for Biobased Products and Bioenergy (MI, IA, IN, IL, plus DOE Laboratories in Ames, IA and the Argonne National Laboratory, IL)

2. Purifying, characterizing the chemical composition and synthesizing natural products from plants and microbes.

A. Brief Description: Chemicals derived from plants and microbes provide a rich source of biological activity with many useful applications for society. These natural chemicals include important pharmaceuticals (such as anticancer agents vinblastine and taxol), agrochemicals and animal growth promoters. Recently, intense interest has been generated in research suggesting that phytochemicals in the

diet can combat chronic diseases such as cancer, diabetes, arthritis and cardiovascular disease. The resulting fields of "functional foods" and "nutraceuticals" in which such compounds are enriched in foods or provided in purer forms as dietary supplements are under intensive development in the industry. Michigan is the largest producer of tart cherries in the nation with an annual production of 300 million pounds of cherries. There is anecdotal evidence that cherry consumption has potential health benefits, but there has been no systematic analysis of cherry components and their potential biological activity.

B. Accomplishment Statement: Preliminary studies indicate that cherry tissue, when added to ground beef patties will not only prevent lipid oxidation, but will also reduce the formation of heterocyclic aromatic

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amines. These compounds are very potent carcinogens. Approximately 20 compounds have been isolated and characterized from Montmorency and Balaton™ tart cherries. The anthocyanins and cyanidin isolated from tart cherries exhibited in vitro antioxidant and anti-inflammatory activities comparable to commercial products. The antioxidant activities of these compounds were comparable to those of commercial antioxidants (butylated hydroxytoluene and tert-butylhydroquinone) and superior to vitamin E at 21 M concentrations. Some of the anthocyanins have shown excellent anti-inflammatory activity in cyclooxygenase enzymes, COX-1 and COX-2, inhibitory of lipid oxidation. A novel process has been developed to capture the anti-inflammatory and antioxidant compounds in tart cherries in a "cherry pill" which can be marketed as a dietary supplement. MSU has negotiated a license agreement with a major corporation to develop and commercialize this product. At least five patents have been issued on this technology which has the potential to generate millions of dollars in net sales.

The ability of cherry anthocyanins and cyanidin to inhibit cyclooxygenases suggest that dietary intervention with anthocyanin-containing foods may have potential for

prevention of colon cancer and other chronic diseases. Preliminary research data indicate that tart cherry anthocyanins reduced cecal adenoma numbers and sizes in Min mice. Further studies are in progress to provide a scientific basis for the notion that consumption of tart cherries has the potential to reduce the incidence of colon and other forms of cancers in humans.

C. Source of Funding: See table for Goal 1.

D. Scope of Impact: State specific

3. Developing new uses for agricultural crops including creating a process to make brandy from Michigan fruits (cherries, pears, peaches, apples, and plums) and greater utilization of corn biomass.

A. Brief Description: Michigan's plant agriculture is one of the most productive and diverse industries in the U.S. Project GREEN was established (and funded), in part, to allow MSU to create and support programs to benefit food processing industries and, in turn, the whole state. Food processors want research on new processing techniques that will add value to Michigan raw commodities, as well as studies that will help them gain access to new markets for current and subsequent products.

B. Accomplishment Statement: This area of study is a major thrust at MSU which has been greatly assisted by the formation of the CPPT (initially funded at a level of \$1.5 million/five years by the VPRGS and the MAES). Initial efforts of this center include research on nutritional genomics, nutraceuticals and phytomedicine, metabolic engineering, and utilization

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of corn biomass. Two specific projects on utilization of surplus Michigan fruit production are related to the development of a Michigan fruit brandy and cherry cider. In the first year of the fruit brandy project, attention focused on fruit selection and fermentation conditions. Fresh fruit yielded brandy of a superior flavor and aroma

and should be used whenever possible. Fermentation conditions were critical to product quality and temperatures needed to be maintained below 550 F to ensure high quality flavor and aroma. Technology transfer to the wine industry was emphasized throughout the project and two short courses were held in the first year of the project. Current studies are targeted to minimize and control methanol and urethane production, and to develop new products based on distilled spirits. Ports and infusions will be the targets of opportunity. The work completed and in progress is quickly building the base for distillers in Michigan to enter the industry. A technological base has been built that can be transferred to individuals wishing to enter production. Six distillers have already started in Michigan.

The objective of the cider project was to develop a hard cherry cider suitable for commercialization modeled on that of hard apple cider in the United Kingdom. The latter utilizes apple varieties with high tannin and organic acid levels in a dual fermentation in which introduced yeast convert sugars to alcohol, followed by a spontaneous malolactic fermentation by bacteria to reduce organic acids to the level desired to impart a suitable flavor without tartness. The lack of suitable hard cider apples in the United States and the availability of tart cherry juice with suitable flavor, tannin, and organic acid attributes have stimulated an effort to develop a process for hard cherry cider modeled on that of hard apple cider. Following selection of a suitable yeast, a strain of *Oenococcus oenus* was isolated from Montmorency cherry juice which demonstrated highly effective malolactic conversion of malic acid without interference with cider flavor or alcohol content. Timed addition of the malolactic bacterium in defined quantity rather than the later spontaneous fermentation utilized for apples was found to be critical in establishing a controlled and effective cherry cider process. Further scaling and optimization of the process using this new malolactic bacterium is now in progress. Perceived benefits of these studies will be the utilization of surplus fruit and the positive effect on tourism.

C. Source of Funding: See table for Goal 1.

D. Scope of Impact: State specific

4. Initiating new wave cooperatives based on the needs of

Michigan commodity groups and producers.

A. Brief Description: "Getting the price you want instead of the price they

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want to pay." To many farmers in Michigan, this sums up the concept of value-added, the use of alternative methods to market crops as products that can bring in more profit for the producer. Project GREEN and the AII have funded several efforts that have led to the creation of producer-owned cooperatives and to a possible Michigan agri-food partnership.

B. Accomplishment Statement: The Thumb Oilseed Producers' Cooperative (TOPC) was the first cooperative in Michigan developed under the contract cooperative method. TOPC is the first value-added cooperative in the state where only those members who buy delivery rights have the opportunity to market their products there. It deals strictly with soybean products meal, oil, and new high-value products developed beyond these traditional products. The co-op has 198 producer members/shareholders in 10 counties and a 900,000 bushel capacity and it produces 21,000 tons of extruded high-energy soybean meal annually. The TOPC initial business plan projects a 15% return on investments based on meal and oil alone. The TOPC has partnered with MSU scientists and local industry in developing a fruit-flavored soy shake from Michigan soybeans that tastes good and is economically profitable. Discussions are now underway to obtain a license to manufacture, distribute and market the drink with a multi-national company.

The alfalfa dehydration facility in Western Tuscola County was not as successful and went bankrupt after one year of operation.

In another development, processed turkey meat came off the line the week of March 6, 2001 at the new Michigan Turkey Producers Co-op facility in Wyoming, Michigan. In the 18 months since western Michigan turkey producers lost their market, they have banded together to restructure the

industry. They formed a cooperative, raised and borrowed money, bought and furnished a processing plant, grown the birds and are back in the market with Michigan grown turkey. The plant will hire about 215 line employees and another 55 in sales and management.

The structural changes that are dramatically reshaping agriculture has had a number of adverse impacts on agricultural and food processing firms/industries within Michigan. Producers, processors, input suppliers, elevators, and commodity groups have all been affected. We recognize the need for a systematic response that can reposition Michigan's agricultural and food firms and industries for the emerging product-oriented system that lies ahead. To do this, we have proposed a Michigan Partnership for Product Agriculture. The partnership would support the search for and development of innovative and exclusive business opportunities for products and services based on Michigan agricultural commodities and specialty production. The partnership would provide for the real-time discovery and screening of innovative, reasonably exclusive business/product concepts, provide for coordinated technical and financial expertise to

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firms, entrepreneurs, producers, and other relevant participants for the development, expansion and commercialization of business and product concepts that will enhance the future of Michigan's agricultural and food system, and provide for executive education and leadership programs. MSU is working closely with the MDA, Michigan Farm Bureau (MFB), Michigan Agribusiness Association, and the Michigan Rural Development Council to develop the "partnership."

C. Source of Funding: See table for Goal 1.

D. Scope of Impact: Integrated Research and Extension, NE-127, S-292

Plant Production Agriculture - Key Program Component

1. Enhancing the economic viability of producers and processors of

Michigan's more than 65 specialty/minor crops.

A. Brief Description: Crop integrators for the specialty crop industries of potato, Christmas tree, landscape/nursery, sugarbeets and fruit have been hired through a financial partnership with the appropriate industry. These academic specialists, through interactions with program advisory committees, commodity groups, and individual producers assist the industry in the assimilation of research information, maintain linkages between MAES researchers and MSUE personnel, and conduct farmer-friendly field research that demonstrates the adaptability of new technologies developed by MAES researchers.

B. Accomplishment Statement: The close interaction fostered by the crop integrators and Michigan's numerous specialty/minor crops has provided research focus on industry priorities. Each commodity group posts their research priorities on the project GREEN web site for the benefit of MAES researchers making short- and long-term research plans. A newly released red kidney dry bean variety dominated the Michigan certified seed market last year because of its enhanced disease resistance, increased yield, and cooking quality. Similar advances are being made in the areas of blueberry, strawberry, tart cherry, peach, wheat, and soybean variety development. The Michigan Sugarbeet Advancement Committee (MSAC) has been formed between sugarbeet producers, sugar refining companies, sugarbeet seed and input suppliers, MSUE, and MAES to increase profitability of sugarbeet producers. Cooperative field trials addressing industry challenges have been conducted across Michigan's sugarbeet growing areas plus northern Ohio and southwestern Ontario. Sugarbeet yields across the region have increased and over 95% of the

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surveyed sugarbeet growers have indicated that they have benefited from the MSAC program and they use the information in developing their management plans.

C. Source of Funding: See Table for Goal 1.

D. Scope of Impact: W-150, S-222, NE-183, NC-218, W-186, NE-185, NC-213, NC-502, W-130, S-294, and NE-501. Additionally, MI cooperates with MA on plant chemical

defenses to Lepidoptera and with MN on forage management for northern climates.

2. Helping Michigan growers comply with the new pesticide use and residue regulations mandated by the FQPA by developing new methods of pest and disease control, maintaining the Pesticides-At-Risk (PAR) database and registering pesticides for use on minor/specialty crops.

A. Brief Description: Twenty-seven research projects addressing reduced pesticide or pesticide free production approaches for field crops, fruit, and vegetables are being conducted as part of GREEN. Risk assessments have been developed for 450 pesticide-crop combinations as part of the PAR database. Resource allocations are determined by the at-risk rating of important pesticide options. Pest management strategic plans have been developed with the carrot, asparagus, and apple industries. A pesticide residue laboratory has been developed to monitor pesticide residue levels in minor crops from the field through the food processing plant.

B. Accomplishment Statement: The use of pheromones to minimize insecticide use in fruit orchards is being field tested in 600 acres of apples, 300 acres of peaches, and 150 acres of juice grapes. MSU scientists have demonstrated that the use of pheromones in orchards and vineyards can provide a nontoxic method of pest management by keeping some pests below economic thresholds. The IR-4 program for registration of pest management compounds for minor-use crops has conducted approximately 70 field trials and 100 analytical projects for food crops and 30 projects for ornamentals. Crop profiles used to assess pest vulnerability and potential residue risks have been developed for 18 crops grown in Michigan. Natural predators of Japanese beetle have been identified and are being explored as biocontrol alternatives for the turf, vegetable, grape, blueberry, and nursery crop industries. Nonchemical approaches to controlling the European chafer in turf, wheat, and nursery crops have proven to be as effective as chemical control approaches. Plum Pox Virus (PPV) is an invasive disease of stone fruits that has the potential to devastate the fruit and fruit tree nursery industries. In a joint effort with the MDA, nearly 35,000 trees were tested in 22 counties for PPV. The aggressive and thorough testing program developed has allowed the industry to be confident that plum pox has

not invaded Michigan. Shifts in weed population and ecology are being studied under new weed management ap

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proaches such as nonselective herbicide resistant crops, to ensure effective weed control while minimizing the volume of persistent compounds or herbicides that are susceptible to leaching. A coordinated Plant Diagnostic Services has been developed with the Center for Integrated Plant Systems to provide comprehensive plant pest and nutrient diagnoses. Five diagnosticians have been hired in the areas of plant pathology, weed science, entomology, and nematodes. During 2000 nearly 6,000 diagnostic cases were completed by Diagnostic Services in service of the field crop, vegetable, fruit, and nursery industries.

C. Source of Funding: See table for Goal 1.

D. Scope of Impact: NC-125, NE-171, NC-202, NC-205, NC-215, and NC-226. Additionally, MI cooperates with MD and NY on research to develop cultural and biological alternatives to methyl bromide fumigation in strawberries.

3. Understanding the structure and function of plant genomics, including molecular mapping; specially designed plants that produce desirable compounds such as biodegradable plastic, phytoremediation; natural ecosystems; principles of plant growth and development; and plant pest control.

A. Brief Description of Activities: Research programs in fundamental plant genomics and molecular biology are being coordinated and integrated for greater cross species impact. An effort among the MAES, College of Agriculture and Natural Resources (CANR), and the College of Natural Sciences (CNS) to build upon MSU's traditional strength in the plant sciences has resulted in the hiring of additional fundamental scientists in key thrust areas. The Department of Energy Plant Research Laboratory has provided leadership in the mapping of the Arabidopsis genome. Graduate student numbers and quality have been increased through joint graduate student recruitment efforts across the plant science departments. Students with outstanding

qualifications are actively recruited to MSU in a manner normally only reserved for star athletes.

B. Accomplishment Statement: Programs in nutritional genomics, phytoremediation, soybean genomics, and landscape ecology have been enhanced through recently hired faculty. Cold-tolerance genes have been isolated from Arabidopsis. These gene constructs are now being transferred into strawberry to protect fragile plants from late spring frosts. Adoption of genomic discoveries from forestry affecting timber growth is being explored for application in fruit tree breeding. Campus-wide seminars are conducted for graduate students and faculty on contemporary genomic issues. Topics have explored the full range of issues from social implications of genetically engineered crops, to ethics of transgenic research, issues from the College of Human Medicine (CHM), to discussions of new advances in genomic research. The extraction and concentration

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of health-enhancing compounds from tart cherries has been licensed to a major drug company and is currently undergoing clinical trials. New research in identifying the genes responsible for the desired compounds, plus management approaches to increase compound yield in comparison to fruit yield, have been stimulated by this discovery. Recent advances in wheat genetics through the National Wheat and Barley Scab Initiative have resulted in the isolation of genes within soft white winter wheat that naturally provide resistance to fusarium head blight. These genes are being transferred to agronomically important varieties. Other researchers have used genomic techniques to track genetic variability in fusarium. A centralized genomic support facility has been developed at MSU with MAES support to more effectively facilitate genomic research across the campus and to foster greater interaction among scientists using genomic techniques.

C. Source of Funding: See table for Goal 1.

D. Scope of Impact: NC-7, NC-142.

4. Meeting the needs of Michigan's floriculture and turf

industries.

A. Brief Description: Michigan's floriculture and nursery industry is the fourth largest in the nation with a wholesale value of \$300 million. Michigan is the nation's largest producer of bedding impatiens, flowering hanging baskets, potted and seeded geraniums, Easter Lilies, and New Guinea Impatiens. Golf course, recreational turf, and residential lawn management, combined with the sod production industry, is a rapidly expanding component of Michigan agriculture with an annual value of over one billion dollars. An additional \$500 million dollar per year landscape horticulture industry challenges the MAES with research problems related to diverse microclimates and high consumer standards. The floriculture Area of Expertise (AoE) team, consisting of research and extension faculty, conducted a strategic plan to focus integrated research/extension programming.

B. Accomplishment Statement: Water quality concerns from golf course runoff and leaching are being addressed through the construction of experimental sloping golf greens with groundwater and runoff collection instruments. Two new scientists have been hired in the areas of turfgrass breeding and turfgrass soil management. The GCSAA recognized the MTESP as the best program of its kind in the nation. Over 130 golf facilities are participating in the program with 20 courses achieving full certification. From these 20 golf courses 56 wellheads were protected, 14 new pesticide storage facilities were constructed, 32,558 feet of buffer strips were installed along waterways, 10 new wetlands were constructed, and 132 acres were designated sensitive areas and off limits to future development. Research on potted flower crops has resulted in a

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reduction of fertilizer usage by the industry. Models using water, temperature and light conditions have been developed to assist growers in forced flowering in perennials and bulb plants. Fungicide trials have been conducted on numerous flower crops and diseases to determine product efficacy and cost effectiveness.

C. Source of Funding: See table for Goal 1.

D. Scope of Impact: NE-164, NCR-192, S-290.

Animal Production Systems - Key Program Component

1. Better understanding of animal diseases, animal nutrition and animal health.

A. Brief Description: The history of our time will be marked by recurrent eruptions of newly discovered diseases; epidemics of diseases migrating to new areas; diseases which become important through human technologies; and diseases which spring from insects and animals to humans through man-made disruptions in local habitats and the continuous adaption of pathogens. Infectious diseases are a leading cause of death, accounting for approximately one third of an estimated 54 million deaths worldwide. In the U.S., infectious disease-related deaths have doubled since 1980. In addition, infectious diseases have added a huge economic burden on our health care system and worker productivity. The State of Michigan has not, and will not, escape the threats of emerging zoonotic disease problems with *Escherichia coli* 0157:H7, *Salmonella typhimurium* DT-104, Lyme Disease, cryptosporidiosis, giardiasis, campylobacteriosis, equine encephalitis, and listeriosis. The re-emergence of *Mycobacterium bovis* or bovine TB in Michigan is a significant disease threat not only to our cattle and deer population, but also to other mammalian hosts, including humans. The MAES, in cooperation with the College of Veterinary Medicine (CVM) and relevant state agencies (MDA, MDNR, and MDCH) have dedicated much time and effort addressing zoonotic diseases.

B. Accomplishment Statement: Recognizing the enormity of the bovine TB problem in Michigan, personnel from MSU, MDA, MDNR, MDCH and the USDA Animal and Plant Health Inspection Service agreed to coordinate current and future projects into a unified body of research aimed at providing the information necessary to develop TB eradication programs. It was determined that interdisciplinary research is needed to generate data to be used in conducting risk analyses to assist in developing effective eradication programs. A committee consisting of an epidemiologist, a pathologist, a sociologist, a wildlife biologist and an

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economist, was formed to identify areas of research and communication needed to reach the overall goal of developing effective eradication programs. The following areas of research were identified: epidemiology (including disease surveillance, mechanisms of transmission, and survival of the organism in the environment), diagnostic methods and pathogenesis, deer ecology, economic and social impact, communication and risk analysis. Many projects in these areas have been initiated and funded in part by grants from the MAES, MDA, CVM, and a USDA Special Grant. Accomplishments and impacts of some of these studies include:

(i) Creation of a TB Interagency Communications Committee, the main functions of which are to foster open communication between state agencies and MSU units working on bovine TB, to identify public information needs, and to foster coordinated efforts among state agencies and MSU. The committee meets at least once a month. The committee organized a MSU Bovine TB Researchers/ Stakeholders Meeting in late Fall 2000 to share research findings. A web page (bovinetb.com) has been established to provide better access to the general public.

(ii) MSU hired two basic molecular pathologists (Dr. Carol and Steven Bolin) from the USDA Ames Laboratory to aggressively expand our basic research programs in infectious diseases. These researchers are part of a MSU team, which together with researchers from the Department of Agriculture and Rural Development in Northern Ireland, and Teagasc in the Republic of Ireland, will work on the development and evaluation of novel diagnostic assays for diagnosis of *M. bovis* infection in cattle. Elements of this study are now in progress.

(iii) Pathology and pathogenesis of *M. bovis* infection in white-tailed deer indicate that decreasing deer density, preventing prolonged contact between deer or between deer and cattle, and decreasing the prevalence of infection are all methods to limit spread of the disease. The load of organisms present in the environment and the length of time

bacilli persist in the environment also contribute to risk of transmission.

Other accomplishments over the past 12 months include a concept paper on the development of a Center of Emerging Zoonotic Diseases at MSU, the commitment from the Provost of a Hannah Professorship in Emerging Zoonotic Diseases, and development of programs linking animal nutrition, animal genomics, and animal disease. Studies on other diseases such as Johne's, mastitis, and bovine respiratory disease continue.

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C. Source of Funding: See table for Goal 1.

D. Scope of Impact: State Specific, Integrated Research and Extension,

NC-62, NC-107, NE-112, NC-228, NCT-175

2. Manure Management

A. Brief Description: Significant progress has been made over the last decade in implementing more environmentally-friendly strategies and technologies for animal manure management on farms, feedlots, and ranches. Unfortunately, expectations of society have rapidly advanced and litigation and new environmental laws or rules have outpaced the adoption or development of new technologies. The problems were once primarily seen as questions of nutrient movement, control and recovery; pathogen and toxicity reduction or elimination; and/or energy recovery. Now, public emphasis has shifted toward nuisance concerns. To address such issues, a number of land grant universities and/or state agencies have joined forces to address them collectively.

B. Accomplishment Statement: The Multistate Animal Waste Management Consortium, formed in 1997, continues to promote multi-institutional integrated research. Funding from each of the six participating states (MI, MO, NC, IN, OK, IA), coupled to an Environmental Protection Agency Grant awarded

through the University of Missouri, has enabled research projects to be developed in three broad categories, (1) manipulating diets to reduce odors and unwanted minerals and toxins in animal waste, (2), measuring odors, and (3) application of waste to land. Nine projects were funded in 2000 and all report progress.

Specific accomplishments/impacts for MSU efforts include:

(i) The Michigan Agricultural Environmental Assurance Program (MAEAP) in early 2000 established a set of goals for the program. Two hundred producers were interviewed in the fall of 1999 and winter of 2000. Issues and needs brought forward by the producers during these focus groups were used to develop the program. The MAEAP also worked closely with environmental groups to identify their concerns and add credibility to the program. The livestock system is the current emphasis of MAEAP and consists of 3 phases. Phase I consisted of educational seminars, which started in January 2001. Phase II is an on-farm assessment which consists principally of developing a Comprehensive Nutrient Management Plan. Phase III is a third-party verification by the MDA. MAEAP also identified environmentally and socially sensitive areas in Michigan that includes large numbers of livestock producers in areas where there are rural residential social pressures and the presence of environmental monitoring activities. It is

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expected that over 85% of Michigan producers will have implemented the MAEAP by 2005.

(ii) Odors associated with swine production facilities is the most frequently cited complaint against the operations. MSU researchers separated the urine fraction from feces and subjected it to ozonolysis. Ozone is a well-established biocide and its utility in odor reduction has been proven in our own laboratories. Studies in the laboratory have been encouraging and a full-scale system will be installed at the new university swine facility.

(iii) MSU researchers, in conjunction with colleagues from Illinois and Purdue, have developed Internet-based computer

programs for comprehensive nutrient management planning and record keeping. Progress in upgrading the Manure Management Planner (MMP) software is ahead of schedule. Test versions were released in October 1999 and work is in progress to develop swine, poultry, and dairy examples for each consortium state.

C. Source of Funding: See table for Goal 1.

D. Scope of Impact: S-275, W-195, Multistate Animal Waste Management Consortium (IA, IN, MI, NC, OK, MO)

3. Animal Genomics

A. Brief Description: Life science research has clearly entered an era of genomics, the study of whole genomes of humans and important plant, microbial and animal species. No other area of science has developed as rapidly or has demonstrated as much promise for unraveling the basic and fundamental mysteries of life. The ultimate goal of genomics is to identify and functionally characterize all of the genes that determine how and why species evolve, survive, and do or do not thrive. The commitment by MSU to develop a strong animal genomics program will enhance research programs in human genomics and biomedicine by faculty researchers already actively engaged in research on disease, fertility, nutrition, immune function and growth in swine and dairy cows. Animal genomics research will also have direct impacts on how we produce food for human consumption that is safe, nutritious, and of high quality.

B. Accomplishment Statement: A Center of Animal Genomics was created in July 2000 with funding from the VPGRS and the MAES. Researchers associated with this Center are working to discover new mechanisms related to growth and development in swine, immune competence and disease susceptibility in dairy cattle, and reproduction and fertility in dairy cattle. This diverse group has come together through common threads

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that are defined by functional genomics. Strong institutional support in the form of other functional genomics programs, a central core facility, bioinformatics

support, and an outstanding structural biology group, has been key to the early success of this group.

Some key efforts/accomplishments of the animal genomics group include:

(i) Genetic mapping and meat quality/muscle development in the pig, including the creation of markers that will guide future generations of genomics researchers. Using a technique called differential display reverse transcriptase polymerase chain reaction, at least 15 genes that are expressed differently in fetal and post-natal pig muscle have been identified. Many of these have been mapped to the swine genome.

(ii) Susceptibility of dairy cows to mastitis and other infectious diseases during periods of stress such as calving and transport. Research has focused on measures and causes of immune suppression during these periods.

(iii) Integrating differences in susceptibility of cattle to Mycobacteria (including Johne's disease and bovine TB) from a genetic viewpoint. The NRAMP gene has been shown to have a dramatic effect on survival of Mycobacteria in mice. The goal is to provide at least one genetic marker system that may be useful in predicting Mycobacterial susceptibility in cattle populations. This work has direct consequences for many other species including humans.

(iv) Developing and using cDNA microarray technology to examine changes in an unparalleled number of gene expression events in a single experiment. The application of cDNA microarrays and EST libraries to programs within the Animal Functional Genomics group will deeply impact the experiments and science of the group. Such approaches are necessary to understand complex traits such as immune competence and muscle growth or meat quality. These are timely investments and will greatly benefit the basic research programs in animal science.

A fully integrated, campus-wide genomics program will contribute significantly to the generation, preservation, dissemination, and application of biomedical, agricultural, and natural resources knowledge that could solve some of society's most pressing problems.

C. Source of Funding: See table for Goal 1.

D. Scope of Impact: State Specific, NC-131, NC-168, NC-209, NRSP-8, NC-210, NC-220, NC-229

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GOAL 2: A Safe And Secure Food And Fiber System

Summary:

Food safety has always been an issue of significance, but in the last decade it has taken on new importance. On top of existing concerns about chemicals in the diet, the public has now recognized that microbial contaminants in foods are dangerous to their health. This concern was triggered, in part, by the human fatalities associated with *Escherichia coli* 0157:H7 acquired from contaminated meat. This initial focus on meats was more recently extended to include fruits, vegetables, and juices due to a continuing series of health incidents related to *E. coli* 0157:H7 in lettuce, bean sprouts and cider, hepatitis A on strawberries, and *Cyclospora* on raspberries. There is every reason to believe that in future years new health threatening organisms will enter the food chain. New human disease threats appear in the United States with regularity. Many of these pathogens are food-borne. In some cases, there are existing organisms that have simply expanded their range through changes in human ecology, food preferences, and transportation. In other cases, the threat arises because the organism itself evolves into new and more dangerous forms. A classic example of an evolving pathogen is *E. coli* 0157:H7 which has acquired the ability to produce very potent Shiga-like toxins and thus has changed from a relatively benign organism to one that is highly dangerous to health. Another serious aspect of microbial evolution is the development of antibiotic resistance.

Salmonella DT104, for example, is a great concern because it is resistant to most types of antibiotics and causes about 15% of *Salmonella* outbreaks in the United Kingdom. It has started to appear in the United States. Accordingly, evolutionary changes in the pathogenicity, ecological capabilities, and antibiotic resistance of food-borne human pathogens can radically change risk levels and patterns.

Another great concern is the recognition of subsequent and chronic disease problems associated with food-borne pathogens. An example is the occurrence of Guillain-Barre Syndrome as a delayed aftermath of enteric disease caused by Campylobacter sp. Disease in humans caused by Campylobacter sp. bacteria is a serious emerging problem in the United States and the world. In fact, Campylobacter has been targeted as one of the four most important food-borne pathogens in the United States. Currently C. jejuni is one of the major causes of diarrhea in humans worldwide. Guillain-Barre is a debilitating infectious polyneuritis that is characterized by fever, pain, and weakness that progresses to paralysis.

The major goal of the microbial food safety program of the National Food Safety and Toxicology Center (NFSTC) is to have an enhanced capability to understand which organisms may become health hazards and the pathogenicity factors and evolutionary adaptations that make emerging pathogens a health hazard in the food chain. One element of the program is to enhance our capability to understand the role of microbial

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toxins as pathogenicity factors. A further objective of the "Emerging and Evolving Pathogens Program" is to develop better methods for the analysis of health risks from these emerging and evolving microbial pathogens. To facilitate the execution of these initiatives, several key faculty (including a Hannah Professorship) have been hired through joint funding by the Provost and the MAES.

The concept of risk plays an important role in understanding food safety. Several MAES researchers are using risk assessment as a framework to study risks associated with food. Closely related to risk assessment is the concept of risk management, evaluating and implementing ways to minimize risk at specific points in the food chain. This is most effective when several links of the food system, from producer to consumer, are targeted simultaneously. MSU is actively engaged in promoting the "Hazard Analysis and Critical Control Point (HACCP) System" to ensure the safety of meat and poultry products, as well as many plant

products. Assistance to processing plants is vital as they face unique challenges in training appropriate plant personnel in HACCP principles, and development and implementation of HACCP with their respective plants. Assistance to these plants has been provided in the form of applied and adaptive research for the production of safe food products.

These efforts in microbial food safety represent only a small part of the MAES research portfolio on food safety. Chemical food safety such as the effect of endocrine disruptors on human health, pesticide residues and the impact of the FQPA on the economic viability and survival of Michigan's plant industries, and the social science implications of plant biotechnology (including genetically modified organisms) are actively and aggressively researched. The linking of social, microbiological, and chemical dimensions of food safety is critical as we strive to ensure the safety of our food and fiber system.

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Allocated Resources:
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*Value extracted from the Fiscal Year 2000 Funds and Manpower Report
Food Safety _ Key Program Component

1. Enhancing the economic viability of animal production in Michigan by continuing to register beneficial treatments through the Minor Use Animal Drug Program for the North Central Region

A. Brief Description: As part of a national project, work was conducted on goats, sheep, fish, bison, veal calves, honeybees, and game birds. However, the lead university status for this project is being moved to another university. MSU's role as the North Central regional leader is being negotiated. It is unknown at this time if the minor-use animal drug program will continue.

B. Accomplishment Statement: The North Central Region continues to contribute to research on minor-use animal drugs.

C. Source of Funding: See table for Goal 2.

D. Scope of Impact: NRSP-4

2. Better understanding of the epidemiology of E. coli in cattle

A. Brief Description: To address the ever-growing issues of food safety, scientists at the NFSTC continue their research on food-borne illness. During the past year, a research project funded, in part, by MSUE has

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included surveillance of E. coli in Michigan dairy cattle. Additionally, MAES jointly provided start-up funding to establish an evolutionary microbiology program housed at the NFSTC. Evolutionary microbiologist, Thomas S. Whittam, was hired to conduct internationally recognized research on the emergence and evolution of bacteria. Whittam and a team of researchers will investigate the evolution of key pathogens, including E. coli 0157:H7, relevant to food safety. Team participants will look at various campus-based technologies including chip array and proteomics to further their efforts. An international conference on pre-harvest food safety, planned for May 8-10, 2001, will highlight the latest management and technical approaches for controlling E.coli 0157:H7.

B. Accomplishment Statement: The evolution of pathogens is being studied in E. coli strains. Several funded projects have been initiated that include surveillance of E. coli in Michigan dairy cattle.

C. Source of Funding: See table for Goal 2.

D. Scope of Impact: MAES, USDA, CDC, FDA, NC-107.

3. Characterizing new organisms and strains of pathogens that cause food-borne disease.

A. Brief Description: Antibiotic resistance is an area of research drawing a great deal of attention. Dr. Mahdi Saeed joined the NFSTC in 2000 to study the epidemiology of food-borne illnesses and is involved in a three-year study

investigating current cattle farming practices that may contribute to antibiotic resistant diseases in humans

B. Accomplishment Statement: The development and occurrence of new strains of antibiotic resistance are being studied in several species, including E. coli, Salmonella, and Campylobacter.

C. Source of Funding: See table for Goal 2.

D. Scope of Impact: MAES, USDA, CDC, FDA, NC-107.

4. Identifying genetic and molecular traits that have resulted in changes in microbial pathogenicity

A. Brief Description: Campylobacter jejuni is another pathogen undergoing extensive study at the NFSTC. MAES researchers have worked with faculty from the CVM to study this organism, and the collaboration has resulted in improved speed for testing food products and animal tissues for C. jejuni. Research has been targeted toward the rapid diagnosis of C. jejuni through development of a TAC system, resulting in a less-than-three-hour assay test, which has been patented. Further, work on an

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enhanced enrichment process for growing C. jejuni is being reviewed.

B. Genetic and molecular traits, which affect pathogenicity, have been studied in C. jejuni.

C. Source of Funding: See Table For Goal 2.

D. Scope of Impact: NC-107, S-295

5. Better understanding the nature and mechanism of the action of bacterial toxins.

A. Brief Description: Recruitment continues in the effort to hire a microbial toxicologist to study the nature and mechanism of the action of bacterial toxins as pathogenicity factors

B. Accomplishment Statement: The effect of bacterial toxins on hepatic tissue and the blood vascular system is being studied.

C. Source of Funding: See table for Goal 2.

D. Scope of Impact: S-263, S-294, S-295, National and International, FDA, USDA

6. Better understanding of the nature and mechanism of endocrine disrupters.

A. Brief Description: Joint faculty positions with the CANR have been created to study the various and multiple actions of bacterial toxins and endocrine disruption. Dr. Timothy Zacharewski has developed in-vitro and in-vivo bioassays and has demonstrated differences in species (human, mouse, chicken, lizard, and trout) relative to endocrine receptor binding of estrogenic substances and PCBs.

B. Accomplishment Statement: The fusion proteins responsible for variations have been identified. Species-specific endocrine disruptions by PCBs and PAH are being studied.

C. Source of Funding: See table for Goal 2.

D. Scope of Impact: National and International, NIH

RISK ASSESSMENT AND RISK MANAGEMENT: Key Program Component

1. Enhancing food safety in Michigan by assisting growers, processors and retailers in implementing HACCP (Hazard Analysis Critical Control Points) programs.

A. Brief Description: HACCP programs are required by law in many industries

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tries because of issues related to food safety. New challenges to the U.S. food supply prompted FDA to consider adopting a HACCP-based food safety system on a wider basis. The NFSTC continues to provide HACCP training through

workshops, seminars and educational outreach.

B. Accomplishment Statement: A W.K. Kellogg grant was obtained that has enabled the delivery of HACCP training programs in many aspects of the food chain.

C. Source of Funding: See table for Goal 2

D. Scope of Impact: Food handling industry, Integrated Research and Extension

2. Better understanding of the social aspects of risk analysis

A. Brief Description: Risk analysis should be viewed as a way to organize and use scientific information to support decisions. Three components work hand-in-hand to form the structure of risk analysis. They include risk assessment, risk management, and risk communication. The NFSTC cosponsored an international conference in June 1998 to address risk analysis in food safety. A publication was produced and a subsequent conference was held in July 2000. The May 8-10, 2001, conference on preharvest food safety will include a considerable number of reports on risk assessment. The MAES, as well as MSUE, and the Provost's Office have provided speaker support and funding for the food safety risk assessment conferences. Recruitment of two scientists to address microbial and sociological aspects of risk analysis is in progress. Additionally, a faculty person in the area of risk communication has been hired on a temporary basis as efforts continue to make this a permanent position.

B. Accomplishment Statement: Recruitment of two scientists to address microbial and sociological aspects of risk analysis is in progress. Additionally, a faculty person in the area of risk communication has been hired on a temporary basis as efforts continue to make this a permanent position. A "human dimension" group, which includes the social aspects of risk analysis, has been developed.

C. Source of Funding: See table for Goal 2

D. Scope of Impact: NCT-183

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GOAL 3: A Healthy, Well Nourished Population

Summary:

To achieve a healthy and well nourished population, it is essential to provide integrated research approaches that range from behavior modification of dietary patterns to fundamental elucidation of mechanisms associated with chronic diseases and other health anomalies. The research conducted under this goal encompass the breadth and depth required to achieve a significant impact on the health status for the people of Michigan with implications on a national and global scale. Research has encompassed the assessment of discreet population groups with particular susceptibility to malnutrient status and its subsequent impact on individuals, families, and communities. Suboptimal nutritional status, based on food choice and eating patterns, can be addressed through behavior modification intervention and educational programming. It is noteworthy that these programs must be targeted to meet the needs of specific population groups based on ethnicity, age, and gender. The research conducted by scientists associated with projects to discern dietary profiles and food consumption patterns both directly and through nutrient database systems enable the collection of meaningful information useful for sound policy direction and program implementation.

It is readily evident that highly specified segments of our population require assessment because of the broad diversity existent within their food consumption patterns. The vast diversity of food products and their varied use by consumers results in a substantial differential in nutrient delivery within the population. It is essential to develop tools to adequately assess consumption patterns and nutrient distributions among selected groups and individuals. Dietary recommendations for specific nutrient requirements and desirable dietary food choices and meal patterns have been established from a substantial research effort. The research conducted under this objective clearly demonstrates broad divergences in nutrient intake and food consumption in populations at particular risk. It is noted that limited income women with

infants and adolescents practicing weight control methodologies may be at substantial risk due to inadequate or inappropriate food choices. Direct surveys of limited income mothers and adolescents have been conducted to discern the dimension of these suboptimal diets and to establish strategies for intervention and behavior change.

The MSU Food and Nutrition Database Research Center (FNDRC) provides a central infrastructure for the use of nationally recognized and respected databases to conduct original research addressing specific needs for specified sectors of our population. Researchers have posed numerous questions directed toward specific ethnic, age, and gender differentiated groups, and the nutrients derived from their food choices. Specific research questions are posed, data sets are constructed, and statistical analyses performed to enable a rapid assessment of the dietary condition of a defined group. Similarly, researchers are able to discern the nutrient contribution of a defined commodity or food product within a specific segment of the consuming public.

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These research tools enable improved assessment of the areas of need and of the specified foods contributing nutrients. Judicious analysis and data interpretation linked with application provides opportunity for improved educational programs and marketing strategies to insure enhanced food selection and nutrient delivery. The MSU FNDRC has supported faculty and graduate student directed research addressing the nutrient needs of specified diverse populations. Results have demonstrated specific nutrient deficiencies and inappropriate food choices and meal patterns within high risk groups.

Basic biochemical/molecular and metabolic nutritional research is required to establish the fundamental mechanisms associated with digestion of specific food groups or classes and assimilation of essential nutrients and bioactive compounds. Controlled studies, utilizing laboratory animal models, provide basic understandings of genetic, molecular, cellular, and physiological processes involved in food and nutrient metabolism. With these designed research protocols

the influence of specific compounds and the qualitative and quantitative affects of these on chronic diseases (cardiovascular, cancer, and diabetes/obesity) may be discerned. With the rapidly advancing research methodology available in the biological sciences, there are increasing opportunities to continue the assessment of specific compounds and their association to chronic diseases. Researchers within these projects have designed and conducted specific studies relating the influence of specific dietary phytochemicals (anthocyanins and phytoestrogens) and bioactive lipids (sphingolipids) to cancer prevention. Other studies address the chemical and physical properties associated with bioavailability of minerals and selected nutrients. The influence of specific nutrients and constituents within the diet on embryonic development and on hormonal controls of body fat regulation have encompassed studies of retinol (vitamin A), and leptin (a hormone secreted from adipose tissue in response to food intake), respectively, each demonstrating specific metabolic influences.

This overall research program designed to enhance a healthy, well nourished population benefits significantly from the interaction of the social based and biochemical-based disciplines. This approach has provided for positive interaction and awareness of the importance of identifying specific metabolic processes and nutrients/bioactive compounds with a knowledge of the food use and choices made by consumers. The breadth and diversity of these focused studies provide a basis for improving the nutritional well-being of the people of Michigan with implications to global populations.

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Allocated Resources:

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*Value extracted from the Fiscal Year 2000 Funds and Manpower Report
Food and Nutrition - Key Program Components

1. Developing dietary profiles and food consumption patterns of populations.

A. Brief Description: The "stages of change" model has been applied to promote improved dietary patterns affecting the consumption of increased levels of grains, fruits, and vegetables. Research findings demonstrate that young adults have seven behavior processes associated with eating fruits and vegetables. Educational materials including newsletters targeted to young adults in the early stage of readiness were prepared and evaluated for effectiveness. Peer developed educational tools were viewed to be highly successful. An assessment of the consumption of fruits and vegetables with weight control practices among adolescents demonstrated that youth of average weight were most likely to be practicing vomiting and laxative abuse, and that adolescents who used a variety of general weight control methodologies possessed nutrient-deficient food consumption patterns when compared with standardized recommendations.

Continued assessment of dietary patterns for mothers with infants was undertaken to establish a longitudinal study on family health issues among early "Head Start" eligible families and families eligible for WIC and food stamp programs. The quality of the overall diet pattern was

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assessed using surveys of "one-day dietary recalls" and classified according to consumption patterns. Results indicate significant deficiencies among the participants, with only 10% reporting daily consumption of at least one serving from each of the five food groups designated in the USDA food guide pyramid. Further, 43% of those surveyed consumed foods from only four of the food groups on a daily basis. It was noted that 41% of these mothers did not normally consume breakfast. Further analysis of infant feeding patterns was evaluated and

demonstrated additional levels of concern within this class of limited income mother-infant pairs. Results demonstrate that limited income mother-infant pairs are not achieving sound nutritional adequacy according to established guidelines.

B. Accomplishment Statement: The eating habits and risk behavior of youth practicing weight control and limited income mother-infant pairs demonstrate continued need for behavior modification to achieve dietary patterns in alignment with standard recommendations.

C. Source of Funding: See table for Goal 3.

D. Scope of Impact: NC-219

2. Enhancing the MSU Food and Nutrition Database Research Center (FNDRC).

A. Brief Description: The MSU FNDRC has been established as a focal point for conducting research to assess food and nutrient consumption and its impact on diverse populations. This center utilizes a variety of nationally established databases and sophisticated statistical analyses to discern relevant food and nutrition consumption information. This database center has been enhanced through the participation of faculty and graduate students addressing specific nutritional assessment needs in population-based epidemiological studies. A broad array of specific nutrients derived from foods selected by defined population groups have been analyzed to assess diet adequacy. For example, analyses have been conducted

on beverage consumption of children and beta carotene intake among diverse populations (African American, Hispanic, and Caucasian) with differentials among varying age groups of men and women.

B. Accomplishment Statement: Knowledge of the specific nutrients consumed by specific population groups enable development of targeted educational programs and intervention to assure a healthy population. The ability to discern specific ethnic-based differentials is essential for targeted program intervention.

C. Source of Funding: See table for Goal 3.

D. Scope of Impact: State specific

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3. Examining the link between diet and chronic diseases such as cancer and allergies

A. Brief Description: A wide variety of projects focused on assessing the causative links and associations among diet (foods and frequency consumption patterns), chronic diseases, and overall health status have been undertaken. Controlled experiments were conducted to assess the influence of plant-derived phytochemicals and fermentable dietary fiber on intestinal tumor development using animal studies. Challenge studies incorporating a variety of foodstuffs contributing a broad array of bioactive compounds (anthocyanins, flavonols, and estrogenic compounds) were initiated. Further, work was conducted to elucidate the mechanism by which disruption of sphingolipid metabolism by fumonisins, a prevalent micro toxin, caused subsequent kidney toxicity. Sphingolipids are also being studied for apparent modulating effects on breast and colon cancer development. Further, the prevalence of sphingolipids in

common food products is being assessed. Studies on the bioavailability of selected nutrients and their interactions with minerals and dietary fiber components provide data that are valuable in identifying thermal extrusion processing conditions to maximize the bioavailability and stability of various essential nutrients. The role of vitamin A in embryonic development including cardiac symmetry and neurotron and somite development has been identified. Controlled feeding studies were conducted to determine how dietary factors regulate insulin secretion and its impact on overall metabolic activity and nutrient status. Leptin, a protein released from adipose tissue in response to food intake, was shown to have a profound influence on release of neuropeptide that control food intake and metabolic activity. These studies are designed to improve the understanding of the relationship between the central nervous system controls associated with food intake and metabolism.

B. Accomplishment Statement: These studies provide data that focuses the impact of specific compounds on a broad spectrum of chronic diseases. Results provide guidance in dietary recommendations to decrease chronic disease prevalence and to form hypotheses for further research for improved dietary patterns which contribute to prolonged health.

C. Source of Funding: See table for Goal 3

D. Scope of Impact: NC-167, W-143

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GOAL 4: Greater Harmony Between Agriculture and the

Environment

Summary:

Producing crops is all about management. By adding supplementary fertilizer, tilling the soil, irrigating fields, and controlling pests, farmers subtly compel the ecosystem to conform to their desires and produce more wheat, corn, or beans than would have

been grown without additions. In the recent past, growers have been criticized for exerting too much pressure on the soil, forcing it to give larger and larger yields until, exhausted, it simply could not achieve any higher level of production.

In the mid-1980s, the phrase "sustainable agriculture" became commonplace in discussions between growers and researchers. Though it can mean many things to many people, most would agree that it refers to an agricultural system that provides growers with a good income, provides consumers with a dependable, safe food supply, and has minimal negative impact on the environment. It means understanding the various systems well enough to manage and integrate them.

The MAES believes that it is important for people to know that there is not just one sustainable agriculture "program" at MSU that includes some projects and excludes others. Biological integration is a theme that runs through many MAES programs and is important to everyone.

The MAES has two main areas of focus under goal 4: land use and cover, and environmental stewardship.

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Allocated Resources:

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*Value extracted from the Fiscal Year 2000 Funds and Manpower Report

Land Use and Cover - Key Program Component

1. Land use and cover, global changes.

A. Brief Description: Michigan citizens believe that agricultural practices, development, and land-use planning should strive for ecologically safe, socially responsible, and economically positive approaches. Ecosystem management that provides consumers with a dependable, safe food supply with minimal negative impact on the environment is the focus of research at MSU. Monitoring of land-use change and understanding the factors associated with change and

different types of landscapes provide policy-relevant information for sustainable agriculture and our air, water, and land environments. We report progress in several multidisciplinary research efforts.

B. Accomplishment Statement:

(i) Researchers from geography, sociology, resource development, agricultural economics, and entomology are collaborating in the development of university-wide land-use research and outreach initiatives. Projects focused on developing a better understanding of various dimensions of land use and land cover change through analyses of ecological, social, and economic causes and their

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impacts on environmental resources. This work spans locally-specific to globally-relevant sites. The MSU Basic Science and Remote Sensing Initiative laboratory maintains the largest nongovernment Landsat archive. Satellite data provide information on land cover type and spatial patterns of change. With the MDNR, web-based spatial analyses information systems are being developed. The system will use digital air photos with other sources of spatial information to create a system to inform planning and policy decisions. For example, this land-use/land-cover database is being used to examine urban sprawl related highway development by the Michigan Department of Transportation (MDOT) and to understand coastal dune ecology. In addition a remote sensing and GIS laboratory at the W. K. Kellogg Biological Station in Michigan is instrumented with radiometry and other spectral devices for field experimental work in association with plant and crop ecosystem analyses.

(ii) The Center for Remote Sensing and Geographic Information Science is updating Michigan's land-use/land-cover high resolution maps in order to provide data for analyzing land-use change over a 20-year period. Issues such as urban sprawl, disappearing farmland, environmental change and deforestation are being examined. A digital atlas of Michigan, a multimedia CD product has been created for use in university classes, public schools, and by the general public.

(iii) At the MSU Basic Science and Remote Sensing

Initiative, land-use monitoring includes observations of change in the landscape using earth observations satellites for both large-area analyses and field-level work. As part of a multi-university team, MSU researchers are furthering our understanding of greenhouse gases released and absorbed in tropical rainforests. The delicate balance of the world's carbon cycle hinges on fluctuations that are accounted for by deforestation, natural decay as well as rainforests growth. These researchers caution that highway development and deforestation in the Amazon rainforests could destroy a significant portion of the forest vegetation patterns and dynamics, thus affecting carbon sources.

(iv) Researchers, under the auspices of the MSU Long-Term Ecological Research (LTER) Project, are studying the ecological interactions underlying annual and perennial field crop productivity in corn, soybean, and wheat rotations, along with alfalfa and agro-forestry crops like poplars. Contrasts with natural forest and old-field sites provide important comparison points for gauging the effects of intensive management on the ecology of organisms in modern field crop ecosystems. Recent studies at the LTER of microbial activity

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(measured by short-term microbial respiration) varies among and within plant communities and that microbial activity may be attributable to the distance to the nearest plant.

(v) Researchers have developed a decision support system that local government planners can use in determining the best areas for agriculture. Designed for planning for large livestock facilities, the system uses GIS data to look at a range of factors to determine the relative suitability of land areas within townships for large livestock operations.

C. Source of Funding: See table for Goal 4.

D. Source of Impact: State specific, with national and international implications. Integrated Research and Extension. The LTER is a national project which is linked to other LTER sites in the US. NC-94, W-133, NRSP-3. Environmental Stewardship - Key Program Component

1. Continuing the Long-term Ecological Research (LTER) Project and the Living Field Laboratory at the Kellogg Biological Station with the aim of enhancing the understanding of biological interactions in the environment.

A. Brief Description: The Kellogg Biological Station LTER site is part of the NSF-sponsored biological station network. The site is the only LTER location that represents an agriculturally-managed ecosystem. Research is directed towards understanding ecological interactions underlying the productivity of both annual and perennial field crops. Agricultural biodiversity and the microbial ecology of landscapes of varied levels of management are central themes throughout all research conducted within LTER. Ecosystems range from intensively managed annual row-crops, perennial forage crops, agro-forestry crops, agricultural successional fields, and natural hardwood forests.

B. Accomplishment Statement: Soil organic carbon levels reach equilibrium within any ecosystem that reflects the balance between influxes and decomposition. Over a 10-year period, conventionally tilled systems showed no detectable change in soil carbon, while no-till systems accumulated 30 grams of carbon per meter square annually. Carbon accumulation was greatest in early successional (abandoned agricultural fields) sites but demonstrated little accumulation after the initial 40 years. Conventional cropping systems had the largest global warming potential (GWP) among the studied ecosystems. Nitrous oxide production was the largest single source of GWP in nearly all ecosystems. Carbon storage offset most sources of GWP in no-till systems, poplar stands, and early

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successional fields. Lime and nitrogen fertilizer were significant sources of GWP in all intensively managed systems. Organic production systems of field crops had a GWP midway between conventional and no-till systems. Researchers have documented that there is spatially structured dependence in microbial processes at both a macro- and micro-scale. Within-community studies demonstrate a doubling

of microbial activity due to distance to a plant. Differences in microbial communities have been found in key functional groups such as denitrifiers. A biogeochemistry program is developing among MSU scientists researching the interface between the atmosphere, hydrosphere, biosphere, and lithosphere. The program will link fundamental research with strategic research, and socioeconomic analysis for enhanced public and private resource management policies through a well informed population. The program will bring together ongoing programs in greenhouse gas mitigation, ecosystem response to invasive species, and nutrient cycling.

C. Source of Funding: See table for Goal 4.

D. Scope of Impact: NC-174, NRSP-3, NC-218. Additionally, MI cooperates with all members of the national LTER network.

2. Better understanding of what it takes to make agriculture and natural resources sustainable.

A. Brief Description: The ecology of field crop and fruit production systems across a range of management protocols are being evaluated for short- and long-term effects. The sustainability of any agricultural system is dependent upon profitability, environmental degradation, and structural impacts on the community. Agronomists, soil scientists, microbiologists, entomologists, nematodelogists, plant pathologists, sociologists, and economists work together as a team evaluating sustainable agriculture systems. The Mott Chair for Sustainable Agriculture has provided statewide leadership to researchers, extension educators, producers, and crop consultants dedicated to sustainable agriculture systems. A student network sponsors a seminar series on sustainable agriculture issues and facilitates thesis research.

B. Accomplishment Statement: Organic and sustainable agriculture field crop production systems are treatments in many agronomic and horticultural research programs. Studies on weed ecology, pest management, and nutrient cycling have been combined with economic and social science research. Organic apple and pear orchards have been established on MAES facilities with the guidance of organic fruit producers to conduct long-term systems research. Nonchemical pest management treatments are commonly included in pest control

product efficacy research. Publications focusing on field crop and fruit ecology have effectively communicated new advances in sustainable agriculture to producers and increased

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their awareness of the need to holistically evaluate production systems. Nearly 500 people attended an organic agriculture conference with the MDA. Researchers and extension specialists conducted a successful organic fruit school.

C. Source of Funding: See table for Goal 4.

D. Scope of Impact: W-133, NE-165, NC-202, NE-177, NC-226. Additionally, MI cooperates with MN on sustainable forage production systems for northern climates.

3. Using geographic information system information, remote sensing and computer modeling to manage ecosystems, including fish populations, forests and insects.

A. Brief Description: Geographic information systems (GIS) have become a data management tool used by many resource managers. Spatial and temporal data can be cross-referenced and used in making policy or management decisions. Precision agriculture will advance only as fast as the public accepts user-friendly information management systems. Local and region land-use planners rely on GIS to manage land use, land cover, infrastructure, and resource information collected from various sources and at different scales. Many projects at MSU utilize extensively GIS approaches; only two will be reported here.

B. Accomplishment Statement:

(i) The US Forest Service designated the Computational Ecology and Visualization Laboratory (CEVL) at MSU as a database and communication node for the National Slow the Spread Gypsy Moth program. As part of this program, the CEVL, in collaboration with Virginia Polytechnic Institute coordinates the proportion of the 85,000 trap-catch observations made in Wisconsin, Indiana, Illinois and

Michigan. The CEVL makes contributions to geographic projections of the advancing front of the gypsy moth population. New applications of Arc Internet Map Server and Oracle database provide an on-line service to gypsy moth observations across the multistate network. Research on ladybird beetles continues as a key component of the NSF LTER Program. This year, a major effort was placed on mapping the abundance and distribution of ladybird beetles, extracted from a database which archives the observation made weekly from 210 agronomic sites over the past 12 years. To date, over a million observations have been recorded on ladybird beetle species-location-time. In particular, a focus was placed on exotic ladybird beetles. A new synthesis of the importance of the flow of life in the atmosphere with a focus on

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North America has been documented in a book entitled Flow of Life in the Atmosphere where Isard and Gage argue that for ecosystem management it is just as necessary to understand how atmospheric systems can transport organisms over long distances as it is to understand field level dynamics.

(ii) The second project focuses on developing system models which integrate ecological and socioeconomic factors, and providing information for decision makers and wildlife managers to design long-term management plans. A deer management options model has been developed and validated using data from the Upper Peninsula of Michigan and is being applied to deer population in southern Michigan. The impacts of land-use and land-cover change on wildlife habitat in two watersheds have been studied with the outcome that the project has been extended to include explicit evaluation of human attitudes and activities on land-use change and aquatic ecosystems.

The impacts of the studies are: (1) aerobiology is an emerging field of science which is critical to managing ecosystems and to the security of the world, and (2) the integration of social, economic and ecological factors to provide essential information for biodiversity conservation, wildlife management, and decision-making at multiple spatial

and temporal scales.

C. Source of Funding: See table for Goal 4.

D. Scope of Impact: NC-94

4. Managing the white-tailed deer population in Michigan.

A. Brief Description: This theme is an integral part of the bovine TB efforts at MSU discussed earlier in Goal 1. White-tail deer populations have dramatically increased to excessive levels during the past three decades. Average deer populations per square mile range in Michigan from approximately 29 in southern Michigan to nearly 90 head per section in portions of the northern Lower Peninsula. The MDNR has limited deer baiting and banned deer feeding across the state in an attempt to minimize deer concentrations that have been proven to facilitate the spread of disease among the herd. Changes in the deer population have resulted in shifts in forest ecology. High populations of white-tail deer continue to be a source of conflict between agricultural producers, hunters, and wildlife enthusiasts. Farmers report economic losses from crop damage and motorists frequently involved in car-deer accidents.

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B. Accomplishment Statement: Studies have been initiated to document deer behavior at fall baiting and winter feeding sites, deer behavior at sites using alternative feeding methods, deer movement (seasonal migration and dispersal) patterns and home range size/use, and sources of deer mortality. The hypothesized mode of deer-to-deer transmission of bovine TB is from close face-to-face contact at feeding stations. Close face-to-face contacts at fall bait pits and winter feeding stations were documented, verifying that baiting and winter feeding provide an avenue for the transmission of bovine TB among deer. Deer did not restrict their activities to only one feeding station throughout the winter or to only one bait station throughout the fall. This behavior provides for the possible increased spread of bovine TB throughout the herd by bringing infected animals into contact with a larger number of individual

deer. There is no evidence of a change in movement and migratory patterns prior to and following the 1998 ban on winter feeding.

C. Source of funding: See table for Goal 4.

D. Scope of Impact: NCT-175

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Goal 5: Enhanced Economic Opportunity and Quality of Life for Americans

Summary:

Rural families and communities and economic development have always been part of the MAES mission. Critical issues such as quality child care, safe housing, good schools, and nutritious food challenge all Michigan citizens. Community organizations and policymakers need information on best practices for making and evaluating program decisions, as well as training to allow them to be the most effective leaders possible.

Development is linked to economic growth and prosperity, something to which everyone in Michigan aspires. At the same time, everyone also wants a clean, healthy environment, with plentiful food and water for all creatures and natural areas for wildlife and vegetation, room to get away, green areas for children to play in and enough room for everyone to live comfortably.

To enhance their economic opportunities, some agricultural producers have become business entrepreneurs, which offers a new set of challenges, in addition to those of growing food.

The MAES is committed to these areas and has four main areas of emphasis under this goal: children, youth, families and communities; farm management; and natural resources initiatives.

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Allocated Resources:

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*Value extracted from the Fiscal Year 2000 Funds and Manpower Report

Children, Youth, Families and Communities - Key Program Component

1. Children, Youth, Families and Communities

A. Brief Description: The MAES and MSUE planned and established the Family and Communities Together (FACT) Coalition. Working with university and community partners, FACT is supporting new directions in research, problem-solving and multidisciplinary outreach scholarship on critical social issues and challenges facing Michigan families and communities. While many critical issues face our communities, FACT is focused on youth development: communities and schools, and children: nutrition and health. A web site www.fact.msu.edu has been developed with an interactive, searchable directory of faculty, staff and community partners, science-based articles on family and community, and links with programs around the state.

B. Accomplishment Statement: FACT programs continue to flourish. Specific accomplishments/impacts include the following:

(i) A statewide forum "A Dialogue With Foundations" was held to promote better university-foundation cooperation and understanding. Over 120 foundation representatives, community leaders, and faculty attended and rated the forum 4 on a scale of 5

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for its relevance and usefulness.

(ii) Competitive grants (19) have been awarded to multidisciplinary teams representing researchers, extension agents, and community partners.

(iii) Projects initiated through FACT have significantly

impacted families and communities around the state. One such project on kin care, i.e., grandparents raising grandchildren, has resulted in legislative changes involving funding through foster care for kin care, a statewide resource center for grandparents, and greater awareness of the incidence and issues of grandparents raising their grandchildren.

(iv) A FACT-supported study integrating research with extension to improve the nutrition and health of children and families was undertaken. Research shows that skipping breakfast diminishes school performance and teenagers need extra nutrients to support adolescent growth. Kids who eat breakfast have improved memory, increased problem-solving skills, verbal fluency, and creative abilities. In a community-wide partnership with schools, agencies and others, a Michigan Nutrition Network (MNN) campaign is promoting breakfast eating among teens. MNN fosters public/private partnerships that bring together community organizations and faculty and staff from MSU to improve the nutrition and health of Michigan consumers.

(v) Another FACT multidisciplinary study with pediatrics and psychology examined breast-feeding rates and duration, and the support and information available to breast-feeding mothers in pediatric practices. Mothers chose breast-feeding for the health benefits for their infants, yet most mothers report problems with breast-feeding. The team is developing a breast-feeding promotion program through pediatric clinics to encourage and support mothers.

(vi) A program of research and outreach scholarship is developing analytical frameworks and research on the developmental assets among children and youth, family and child resiliency, and community support. The "GiveEm40" project involves research, extension, and community partners such as United Way to develop, assess, and evaluate action plans to create healthy, supportive environments for young people that promotes positive youth assets. Over 4,500 youth in a 5-county area have been surveyed. The project is being replicated in urban schools. The urban project is being combined with a community program for after-school activities. Another study is assessing the developmental assets

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among elementary children. To this end, an instrument to measure developmental assets among elementary school children, based upon America's Promise Model, was pilot tested and, with revisions, administered to over 2000 K-5th graders. These projects are too recent to have measurable impacts. The scale of community involvement in these projects is indicated by the initial report to a community rally by the GiveEm40 project that drew over 900 in attendance.

C. Source of Funding: See table for Goal 5.

D. Scope of Impact: Integrated Research and Extension, NC-219, NCT-184

Farm Management - Key Program Component

1. Encouraging the competitiveness of agri-food system participants in a globalized value-added marketplace.

A. Brief Description: A need exists for a systematic response that will reposition Michigan's agri-food firms and industries for the emerging product-oriented system in our future. Research linked to extension is designed to encourage the competitiveness of Michigan's agri-food system participants in a globalized, value-added marketplace. Many of these activities will be indicated under the auspices of a Michigan Agri-Food Partnership.

B. Accomplishment Statement: The Michigan Agri-Food Partnership is having planning sessions. The Partnership is made up of representatives from all sectors of the agri-food system and works to provide for the establishment and maintenance of strategic information resources; provide for coordinated technical assistance to firms, entrepreneurs, producers, and other participants for the development, expansion and commercialization of business and product ideas; and for executive education programs and experiences that build the human-capital base necessary to support a product-oriented competitive agri-food system in Michigan.

Continuing research is being conducted on value-added agricultural product development and agribusiness

strategies. This work includes inquiries into scenario planning methods, innovations in inventorying agricultural and processing resources for the support of value-added industries, the attitudinal and strategic differences between value-added and commodity-based commercial farmers. Research on agri-food firm globalization strategies suggest methods for improving global strategy formation in agri-food firms, e.g., the usefulness of decision frameworks focused on market entry and product marketing strategy within the global context and utilization of social capital in globalization strategy.

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A workshop, "The Food System of the 21st Century: Strategic Opportunities and Challenges" for understanding the changes in the global food system and forces driving these changes was held. Workshop activity involved panels on consumer issues, globalization, world trade and biotechnology, and concluded with strategic planning by participants as to the implications for alternative paths for the Michigan Food System. Over 400 people attended including food retailers, wholesalers, agribusinesses, producers, and producer association representatives, as well as academics.

C. Source of Funding: See table for Goal 5.

D. Scope of Impact: State specific

2. Studying and interpreting decisions made by the World Trade Organization on nontariff trade barriers.

A. Brief Description: Producers and processors of many Michigan commodities now operate in global markets. This poses new opportunities and new concerns. International trade is governed by grades and standards. To promote agricultural and food trade it is important to understand the social, economic, political, and ethical aspects of grades and standards creation, enforcement, and review.

IFAS, a network of scholars and practitioners concerned with issues such as the relationships which connect science and technology to the creation, maintenance and modification of

agricultural grades and standards, has been established for the purpose of identifying the sociopolitical dynamics surrounding the development, maintenance, and change of agricultural grades and standards. Multidisciplinary, collaborative research projects funded by MAES and the NSF are exploring issues surrounding standards and international trade for selected Michigan commodities: dry beans, grapes, cherries, and potatoes. These projects will lead to better understanding of how science and technology are used in the creation, maintenance, and modification of agricultural grades and standards, and to identify and understand how grades and standards influence domestic and international agricultural trade.

B. Accomplishment Statement: In late Fall 1999, IFAS hosted an international workshop at MSU that brought together 70 participants from 22 nations. The workshop consisted of several plenary sessions, where perspectives on standards were presented; and working group sessions, at which key issues were identified and policy recommendations were developed. The charge to the working groups was to develop policy recommendations designed to produce effective, equitable and transpar

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ent standards for the 21st century food and agricultural system. The major recommendations that emerged fall under the broad heading of International Standards Setting Process; Revisions to the Agreement on the Application of Sanitary and Phytosanitary Measures (SPS) and the Agreement on Technical Barriers to Trade (TBT); Complementary Private Sector Involvement; and Knowledge about Standards.

Specific research by the IFAS group focused on soybeans and soybean standards. Of particular importance is the growing role of domestic and international buyers in structuring the industry, as well as increasing concentration in elevator ownership and consequent decline in the number of and farmer choice among elevators. This parallels the global mode toward downstream coordination of commodity subsectors due to growing economic concentration in the supermarket and processing industries. Work on the grape juice industry

reveals the reliance on sugar content as the sole standard of importance. Research results indicate that while there is considerable frustration with the use of that measure, it has the advantage of being easy to measure and "objective" in the sense that farmers may measure it nearly with the same accuracy as those doing the grading. The impact of these studies is the considerable benefit for producers concerned with changing standards and strategies they should take toward those standards. As the food industry becomes global in scale, understanding the "politics" of standards will become increasingly important.

C. Source of Funding: See table for Goal 5.

D. Scope of Impact: State specific, NE-185, NC-213

3. Better understanding the role of farm, rural development and environmental groups in agricultural research and development policy.

A. Brief Description: The original concept was to, through IFAS, develop a comprehensive database of Michigan agricultural, rural development, and environmental groups that would identify and clarify the policy, technology, and organizational issues of those groups. The development of this database would serve several colleges at MSU, Michigan commodity groups, the MDA, and MFB.

B. Accomplishment Statement: We are still planning the integrated project. Isolated initiatives have begun with individual researchers and specific commodity groups. For example, the cherry industry has been working closely with MAES researchers to identify challenges facing the Michigan cherry industry and have detailed these in the "Tart Cherry Industry Strategic Directions for Future Success." Several of the plant industries have developed environmental stewardship programs, not only to address food

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safety issues, but also to promote sound environmental practices that would be protective of the environment. Again, the cherry industry has been a key leader. As

reported elsewhere in this document, several dialogues, including those with agricultural industry leaders have taken place to develop a Michigan Agri-Food Partnership with three key components, a business incubator initiative, a "futuring think tank" component designed to help industry look at its future with respect to product development, and the academy, the training/education of business and company executives with respect to business management, international grades and standards, and food laws and regulations. Discussions have also included the Michigan Rural Development Council. Land-use issues continue to be a major focus of both research and extension activities and a senior person in land-use policy will be hired. This position will be jointly funded between the Office of the Provost and the MAES. We expect this position to complement the extension activities of the Victor Institute (brown field remediation) and link much of the land-use research at MSU.

C. Source of Funding: See table for Goal 5.

D. Scope of Impact: State wide, Integrated Research and Extension

Natural Resources Initiative - Key Program Component

1. Natural Resources Coalition

A. Brief Description: Natural resources and the environment are critically important to Michigan's future. The increasing complexity and interrelatedness of natural resources issues demands comprehensive, multidisciplinary, science-based management approaches. To facilitate these activities at MSU, a Natural Resources Coalition was formed.

B. Accomplishment Statement: The Natural Resources Coalition brings together representatives from MSU units, key partner agencies, public/private organizations, and businesses that share a commitment to advancing knowledge and its application on critical natural resources and environmental issues. The Coalition has developed multidisciplinary and multi-organizational action programs to enhance natural resources and the environment in Michigan through research, outreach, and extension. Through the Natural Resources Coalition partnership, with key state agencies and organizations, a strategic plan for addressing natural

resources-based industry needs has been established. Five areas for coordinated research and extension development include: watershed management, ecosystem management, natural resources and environmental leadership academy, land resources management, and sustainable natural resources industries.

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Recent research has focused on developing information that is needed for integrated, systems-based, and sustainable approaches to natural resource management in Michigan and throughout the Great Lakes region.

Agricultural and farm-based recreation, that is, the linking of tourism with agriculture, is becoming an important source of revenue for farmers, as well as important new outlets/attractions for recreation. Studies have found that farmers and growers have created diverse enterprises to offer a wider array of recreation use resources and family expertise. Agri-tourism operations allow more family members to earn income on the farm and may make it financially feasible for persons to enter farming. Agri-tourism stimulates rural community development and increases public knowledge and awareness about agriculture, stewardship, and rural life styles. A general lack of knowledge about management, marketing, and development of agri-tourism is a barrier to new venture.

Forest sustainability and economic returns are improved through studies of wood preservation and recycling. Researchers are developing new recycling methods that extend product life, conducting fundamental research on new environmentally benign wood preservative compounds that can be subsequently extracted from wood and reused, and developing genetically engineered trees that incorporate natural decay resistance to extend product life. Forestry researchers are conducting long-term ecology research on forest succession patterns, nutrient and carbon cycling, and fire ecology that are redefining traditional forest management models and use technologies, such as GIS, to better define ecologically sustainable forest management practices.

C. Source of Funding: See table for Goal 5.

D. Scope of Impact: State Specific, Integrated Research and Extension

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Stakeholder Input Process

As indicated in the POW for 1999-2004, the MAES has established and implemented a process to obtain input on the use of formula funds from people who benefit from agricultural research. We have a long history of working with a variety of clientele.

The MAES Administrators meet regularly with commodity groups to assess their research needs and to discuss the research agenda they would like followed as we attempt to address short-, medium-, and long-term issues within their area of interest. An example of this effort would be GREEN. At least annually, groups which are concerned with plant-related issues meet to discuss and determine their highest priority issues for research and extension. These are shared with us and placed on the web at www.green.msu.edu/ind.priorities.htm for reference by our faculty and others who might be interested. In the fall, we send out a RFP for GREEN-related topics. Researchers consult the priorities listed on the web and submit competitive proposals to address these issues. The review committees for this program have industry representation. Thus, commodity stakeholders interested in issues addressed through this program are involved at every stage and throughout the year.

Area of expertise teams have been established in a variety of areas ranging from dairy to community development. MAES faculty serve on these teams along with extension staff and growers. The purpose of these teams is to discuss current and future issues of concern to the area of expertise being addressed by the team.

Stakeholders are also involved in the following ways:

ò serve on faculty search committees

ò serve on CSREES departmental review committees

ò serve on numerous departmental advisory boards

The MAES and MSUE developed the Michigan State University Extension and Experiment Station Council which meets biannually. The council members learn about ongoing programs, participate in leadership development activities, and advise the directors on issues of concern to them. The members are primarily selected based upon their prior involvement and interaction with either MAES or MSUE. In addition, we have sought out representation from nontraditional arenas. These individuals typically represent a segment of the citizenry which we feel we serve, but for which there is no common representative organization.

Also, we have actively involved CARET members and National Leadership Participants in program (research and extension) development.

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We strive to have a seamless system between the MAES, MSUE, and our stakeholders in order to provide the best service possible.

Involvement of stakeholders is useful in reaffirming or refocusing priorities and in identifying emerging issues. Frequently, stakeholders focus on the short-term problems they face daily, but with thoughtful dialogue and encouragement they can, and will, think about the future to assist us in planning our research agenda and focus. Currently, we have an ESCOP/ACOP intern working closely with the vegetable industry to review current issues and look to the future to ensure profitability and continuity of the industry. The review team includes industry representatives (both processors and growers), extension field staff, MAES

faculty, and MDA representation. A comprehensive report of their findings will be published before midsummer.

We will continue to have actively involved stakeholders, as this is embedded in our operational philosophy.

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Program Review Process

There has been no change in this process since we submitted the 1999-2004 POW.

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Evaluation of the Success of Multi and Joint Activities:

The following is one of many successful multi and joint activities

1. The FACT Coalition is a unique collaborative initiative at MSU that puts cutting-edge, multidisciplinary research to work for Michigan communities. Growing out of MSU's leadership as an engaged institution, FACT is committed to partnering with diverse sectors such as philanthropy, education, business, and government to generate children, youth and family research that is applied to community problems and shaped by community needs.

In the midst of rapidly changing economic and political contexts, Michigan citizens are facing exceptional social pressures such as: pervasive poverty, concerns about environmental quality, shifting definitions of family, health risks, new demands on the educational system, and concerns about youth violence and at-risk youth. Viable solutions that address these issues cannot be neatly found within a single discipline. Rather, these complex matters require applied research and scholarship that is multidisciplinary and collaborative.

FACT is helping to lead the way by investing in innovative, multidisciplinary research and outreach, fostering collaborative work across campus and with communities, and serving as an information hub for news, research, funding, and programs for children and families.

We are building bridges that link campus and community in mutually beneficial partnerships to produce valuable research and best practice.

2. FACT drives research in the areas of youth development, kinship care, schools and education, violence prevention, health and nutrition, bridging the digital divide, and early childhood. Our two focus areas for 2000-01 are Youth Development: Communities and Schools; and Children, Youth and Nutrition.

Since 1999, FACT has awarded over \$1,000,000 to 40 projects based in 20 counties throughout Michigan via its annual grant program and targeted funding. FACT supports partnerships involving 11 MSU colleges, MAES researchers, MSUE staff on campus and throughout the state, and professionals from community groups, government agencies, nonprofit organizations and foundations.

To foster collaboration, FACT hosts a listserv with over 700 participants, and maintains a searchable directory of expertise on the FACT web site. In October 2000, the FACT forum, "Building Family and Community Assets: A Dialogue with Foundations," engaged leaders from foundations, nonprofits and universities in a dialogue on building partnerships to strengthen Michigan's families and

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communities.

3. A few examples of FACT initiatives include:

A. Grandparents Raising Grandchildren: A pilot research study on grandparents raising grandchildren has provided valuable data on these caregivers' financial, legal, and health concerns. It has also developed unprecedented

networks and relationships between agencies, community groups, and the university around kinship care, and has led to the establishment of a kinship care resource center.

B. Nutrition Education Aimed at Toddlers (NEAT)üKnowing that poor nutrition in young children jeopardizes school readiness, and poor feeding practices can lead to unhealthy development and obesity, the NEAT project has worked with parents of toddlers to improve feeding practices, ensure good nutrition, and increase their confidence to offer new healthy foods. MSU faculty and extension staff partner with Early Head Start and have developed a nutrition education curriculum for rural low-income families.

C. GiveEm40 Coalition: Positive Youth Development: This five county, multi-organization partnership involving United Way of Northwest Michigan, MSUE, MSU faculty, schools, and community groups work to promote positive youth development in the region. They have developed a partnership with 19 school districts; established pilot school projects to increase parent and community involvement in schools; launched a mentoring program to connect caring adults with kids; and sponsored a public awareness campaign. In addition, through teen theatre troupes, youth advisory councils (youth-run philanthropic efforts), and space made in the local newspapers for kids issues, the region is giving kids a voice and showing them they are valued members of the community.

D. Michigan Nutrition Network: The Michigan Nutrition Network recently launched the "Eat Healthy, Eat Breakfast Campaign," a research-based campaign to improve breakfast eating, and ultimately school performance and overall health among teens. The campaign has over 200 community partners, will reach over 20,000 kids and will help us understand effective strategies to improve nutrition and health among kids and families.

E. Kid Curator: This project uses MSU's nationally recognized 4H Children's Garden to give young children a hands-on exploration of nature and plant science and to develop a model for linking children, parents, educators, and community park areas. The goal is to create a generation of kid curators-kids, who respect and take care of each other and the environment. The research is helping communities use existing outdoor park areas as a rich

learning environment for preschoolers.

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Through efforts like these, FACT is building ties between the university and communities to meet the needs of children, youth and families.

As a land grant university, MSU has always been committed to serving society, improving people's lives, and working alongside community partners. We pride ourselves on being an institution that is responsive to social needs and that has the capacity to work in collaboration with communities to improve the lives of individuals and families.

For more information about the FACT Coalition, visit www.fact.msu.edu

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Integrated Research and Extension Activities

The following is one of many successful integrated research and extension activities

Michigan's sugarbeet industry is a multi-million dollar business. In recent years, its productivity and profitability has been affected by production problems associated with sugarbeet emergence and declines in yield.

Ongoing integrated research between grower producers, MSU researchers and extension agents, the MSAC, USDA, and agribusiness is essential to solving production problems and increasing the profitability of the Great Lakes sugarbeet industry.

The MSAC is a partnership between the state's sugarbeet growers, Michigan Sugar Company, Monitor Sugar Company, agribusiness,

MAES, MSUE, and state agriculture departments. Each year this committee evaluates research efforts and reprioritizes them to target significant industry problems. MSUE District Sugarbeet Agent, Steven Poindexter, and the MSAC have been key in facilitating this industry-leading research and education effort carried out by faculty researchers from MSU and the USDA. Over \$200,000 worth of grants has been secured over the past two years from project GREEN and the USDA. Multiple agribusinesses have also been instrumental in the research efforts through donation of seed, laboratory analysis, equipment, and labor.

Researchers from MAES and the USDA have established 20 research trials at a leased 40-acre farm and at various farm assessment plots offered by grower producers. Research has focused on improving beet emergence, stand persistence and increasing harvest yield, industry problems targeted as high priorities by the MSAC. Trials have been established relating to herbicide, soil health, tillage, disease, insects, seed, and genetic vigor. Efforts are directed towards continuing this project for a three-year duration.

Research has already realized several high impact findings for the industry:

ò For the first time, beet seedling vigor has been selected and confirmed as a seedling emergence gene. This finding could result in a \$7,000,000 return to growers.

ò Timing of fungicide application for Cercospora Leaf Spot is important, but so is administering control throughout the growing season. Significant loss in harvest yield and sugar content can result from as little as a 3% infection rate. Growers could reap a \$50-60 return per acre after deducting the cost of fungicide application, or a total of \$9,000,000 to the industry annually.

ò Spacing uniformity improves beet quality through more uniform size and better topping. Pelleted seed tended to improve spacing uniformity as

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compared to Fasonated seed. Improving beet stand would

increase producer returns by several million dollars.

ò Pelleted seed treated with Tachigaren may improve stands and reduce replanting.

ò A root aphid nursery was established to study variety evaluation, and cultural and chemical control. Root aphids cost the industry millions of dollars annually for lost yield. A tarnished plant bug trial will continue in 2001.

ò Sugarbeet cyst nematode infected over 50% of the 2000 crop. Crop rotation and nematicides have been inadequate control options in the past. Studies in 2000 discovered that using oilseed radish as a cover crop improved yield, but not as much as by using a fumigant.

ò Soil quality was found to increase yield in good years and help offset the effects during poor years. Length of rotation was found to have the most influence on soil quality, followed by reduced tillage and the use of cover crops and/or manure.

Communicating and using the results of these research efforts is vital to improving the profitability of Michigan's sugarbeet industry. Over 300 producers took part in a full-day educational tour at the 40-acre research farm. Across the state, programs related to this work have been offered: 7 programs on variety selection and related topics; 2 soil health programs; 6 sugarbeet weed disease control programs; 6 educational on-farm research tours; and several winter meetings highlighting research progress. MSUE and the MSAC have printed the fourth "On-Farm Research and Demonstration" bulletin released in January 2001. This comprehensive guide offers practical information ranging from variety selection to the effects of tillage on sugarbeet production. During the beet planting and growing season, a Field Crop Advisory Team, made up of MSUE agents and MAES researchers, produce a series of 19 newsletters reporting crop development and pest outbreaks by region and respond to current outbreaks and recommend preventative measures. A grant from MDA helps minimize mailing costs and offsets the cost for placing this information on the Internet.

Research efforts have been paying off through improved production management practices. A preliminary study showed

that growers' traditional farming methods have been affected by results of these trials: 69% changed Cercospora Leaf Spot control practices; 52% modified herbicide use; 45% shifted to pelleted seed; and 34% altered tillage practices.

What will continuing these research efforts mean for the sugarbeet industry? The 2000 growing season went on record as the best overall for harvest yield in the last 10 years and a 20-plus ton per acre goal challenged by the MSAC was achieved. Continuing this integrated research between sugarbeet growers, MSU, MSAC, agribusinesses, and the USDA means setting and meeting even higher goals to increase the profitability of Michigan's sugarbeet industry.

Reference:

"On-Farm Research and Demonstration," January 2001.

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[Image] [Image] [Image] [Image] [Image][Image]

Final Summary

Are there any significant changes between our 1999-2004 Plan of Work and what we intend to do in the future?

No. We do, however, intend to be more focused in the development of our research thrusts. We see ourselves as fully immersed in the development and execution of research programs such as:

ò plant products and technologies to create a biobased economy

ò nutritional genomics, natural products and phytomedicine and metabolic engineering to enhance MSU's competitiveness for Life Science Corridor funds

ò plant science programs such as plant growth and development to enhance crop production systems with concomitant protection of our natural resources

ò emerging zoonotic diseases that threaten the health of our livestock industry and public health

ò environmental sciences with several key foci including:
environment genomics, biogeochemical dynamics, evolution and
population responses, pollutant transport and transformations,
and environmental economics

ò food safety, both microbial and chemical, and its impact on
society

ò land-use issues and their relationship to the urbanization of
Michigan

ò families and communities

The MAES is in a unique position to make a major contribution to
these overall research programs in the next decade.

We have been, and will continue to, aggressively recruit faculty
of the highest quality. We are strongly committed to the
recruitment of outstanding basic researchers and to the proper
balance between basic and applied research. It is equally as
important to retain our best faculty in those fields consistent
with our vision for the future.