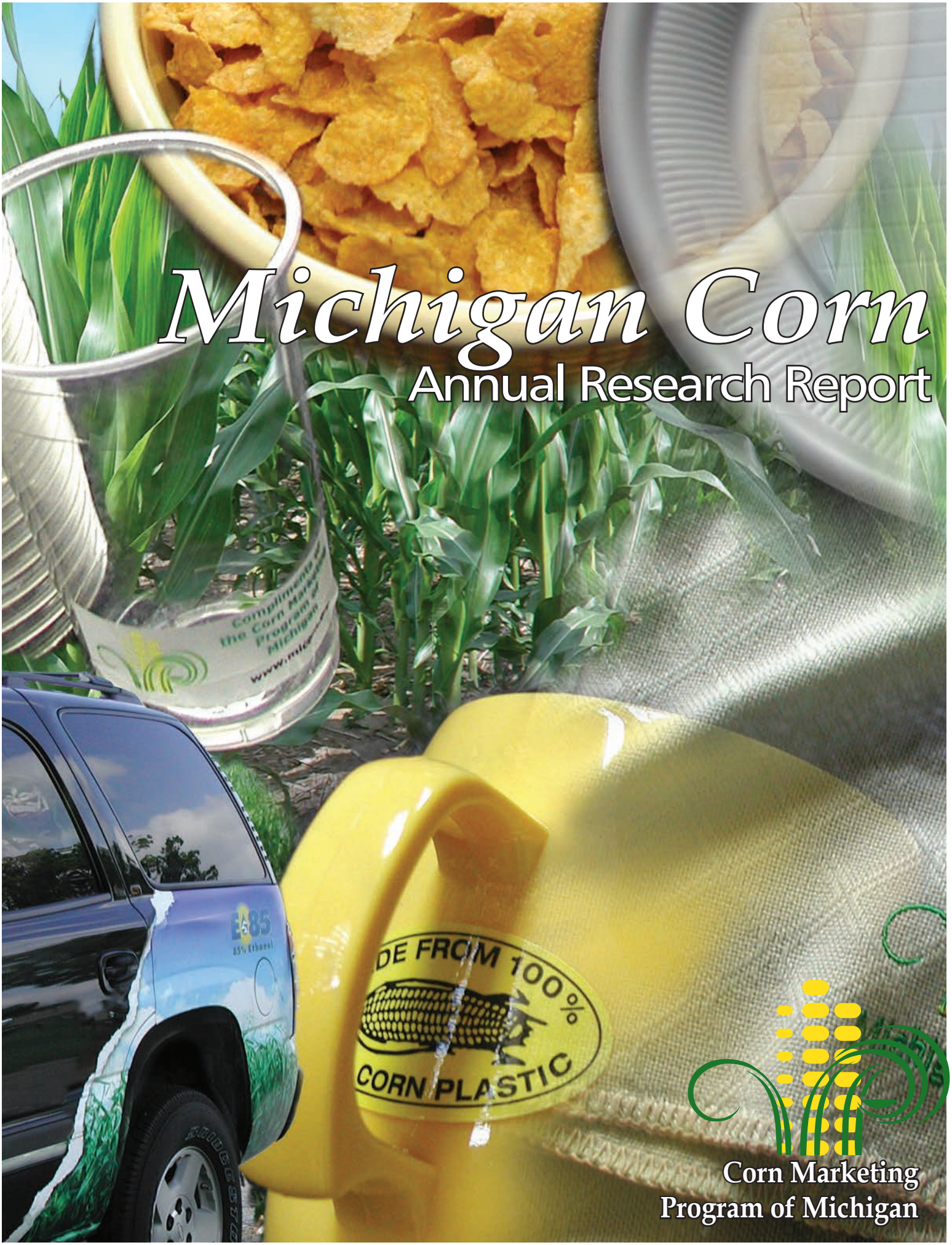

Michigan Corn

Annual Research Report

Corn Marketing
Program of Michigan

Michigan Corn
ANNUAL RESEARCH REPORT

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January 2008

Dear Michigan Corn Farmers:

In 1992, corn farmers in Michigan established the Corn Marketing Program of Michigan (CMPM), the state's check-off program, in order to enhance the economic viability of corn production in our state. Every five years, the check-off program goes back to a vote of the state's corn farmers. Since the program's establishment 15 years ago, the farmers have overwhelmingly supported the check-off program in each continuation vote.

Through the CMPM, corn farmers in Michigan have invested in check-off funded research projects that focus on improving on-farm production and conservation practices, strengthening traditional markets, and also developing new uses for corn. The CMPM strives to expand and enhance current markets while at the same time develop new markets for our state's corn.

Corn Marketing Program of Michigan Board of Directors. Pictured left to right: Scott Lonier, Mark Kies, Lyn Uphaus, Bruce Noel, Frank Lipinski, and Carl Barth. Not pictured: Jay Drozd, Clark Gerstacker, Ken Wadsworth and ex-officio members Dr. Doug Buhler, MSU; Robert Craig, MDA; Scott Miller, MCGA; and Ken Lake, MABA.

Research is an integral part of the CMPM and has led to the funding of more than 150 research projects that have led to improved production and conservation practices, a booming ethanol industry within the state, an expanding corn heat industry, and the development of corn-based products for new markets such as carpeting, fabrics, packaging materials, salt substitutes, pharmaceuticals, and plastics that replace petroleum-based products.

The results of farmer investments in the industry can be seen through the development of new markets and products, increased educational events for farmers, consumers and media, and significant advances in corn-related research.

The following pages in our Annual Research Report showcase how the CMPM has invested check-off funds over the past couple of years. Some of the research projects cited in this report are completed projects while others are ongoing. All of the research is designed to help keep the Michigan corn industry on the cutting edge of production, technology, and new uses.

If you have any questions or suggestions about the research funded through the farmer check-off funds, please contact the CMPM office at 1-888-323-6601.

Sincerely,

Wm. Lyndon Uphaus, President
Corn Marketing Program of Michigan
Manchester Corn Farmer

Corn Marketing Program of Michigan

Established under 1965 P.A. 232, and voted in by the state's corn farmers in 1992, the Corn Marketing Program of Michigan (CMPM) receives one penny per bushel for all Michigan corn sold. The "check-off" funding is invested in research, education, market development, and new uses. The continuation of the program is voted on by Michigan farmers every five years. For the program to continue, the referendum vote must be approved by both the majority of voting farmers and corn production. The nine-member Board of Directors, appointed by the Governor, sets the yearly direction of the program. As a way to dispense research results to the state's corn farmers, the CMPM annually holds the Corn & Soybean Winter Research Meetings and publishes an Annual Research Report, highlighting current and past check-off funded research projects.

PRODUCTION AND CONSERVATION INVESTMENTS

The Corn Marketing Program of Michigan (CMPM) understands the importance of agronomic research and the role it plays within the agricultural industry. It is with this research that advancements in production and conservation practices are made. The CMPM works on behalf of corn farmers in Michigan to fund research looking at tillage practices, pest control, conservation and fertilizer recommendations. The CMPM strives to keep corn production economically viable in the state.

Corn farmers take a gamble every year when they plant their crops in the spring; but when they try a new production or conservation technique as well, that risk escalates. Through check-off funded research, farmers can benefit from ground-breaking practices which are analyzed in test plots across the state without jeopardizing their bottom line.

Center for Excellence Showcases New Production Practices

The CMPM, once again, partnered with the Lenawee Conservation District and the Michigan Soybean Promotion Committee to conduct extensive research and demonstration projects, collectively known as the Center for Excellence. Through the Center for Excellence, new agronomic practices are conducted in test plots where farmers can learn and gather data without having to alter their own on-farm production practices.

The Center for Excellence, which began in 1998, is a research and testing program consisting of plots on two farms in Lenawee County, Bakerlads Farm and Raymond & Stutzman Farms. The plots test various production practices including conservation tillage, soil fertility levels, sub-irrigation, and testing new seed genetics to determine how farmers can increase productivity while conserving Michigan's natural resources. The Center for Excellence focuses on researching, developing, and refining viable conservation tillage systems that can be adopted on farms.

This year's test plot at Bakerlads Farm included continuous corn silage and had one of five different practices: No-Till with Gypsum, No-Till without Gypsum, Strip-Till, Deep Till, or Chisel Plow. The control plot was no-till and had a 24.4 ton yield. Figure 1 illustrates the yield results.

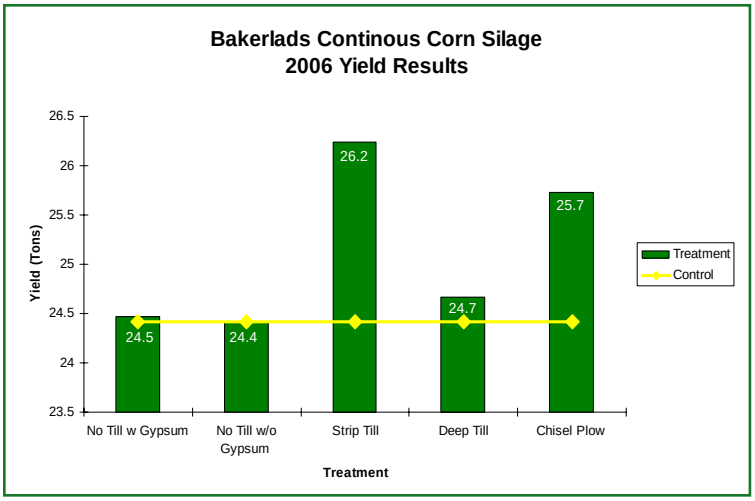


Figure 1. Yield Results from Bakerlads Corn Silage Plot

This year three corn test plots were conducted: traditional, precision, and a what-if plot. Figure 2 provides more detail on the three systems.

Figure 2. 2006 Corn Systems

System	Seeding Rate	Fertilizer	Insecticide (Capture)
Traditional	30,000	0-0-60 200# 16-3-8 18.5 gal. 28% 120#	5.15 ozs.
Precision	28,000	0-0-60 0# 16-3-8 18.5 gal. 28% (8 rows) 120# 28% (8 rows) 0#	5.14 ozs.
What-If	34,000	0-0-60 250# 16-3-8 18.5 gal. 28% 200#	5.14 ozs.

All systems utilized the same herbicides: 3 quarts of Full-time and 3 ounces of Hornet

The yields and returns on the plots are shown in Figure 3 and are based on a corn price of $2.645 (taken from the Chicago Board of Trade at close on July 5, 2006).

Figure 3. 2006 Corn Plot Results

System	Yield (bu)	Returns ($)
Traditional	215.45	296.54
Precision	217.53	310.38
What-If	210.39	242.68

The research projects and plots at the Center for Excellence are done over a long period of time to ensure the most accurate data is obtained.

"Farmers have benefited greatly from check-off and privately funded research at the Center for Excellence for nine years," said Lyn Uphaus, CMPM president and a corn farmer from Manchester. "The Center for Excellence allows corn farmers to see the results of implementing new tillage and conservation practices in the field."

Every August, the Center for Excellence holds a Field Day, where farmers can learn more about the research being done at both locations and see the plots first-hand before harvest. After harvest, the Center for Excellence Yield Results meeting is held and the results of the research and the yields of all the test plots are reported.

Sustainability of Irrigation Production

Water is a vital component for all farming operations, especially those in Michigan. Even though there is an abundant water supply in Michigan, it is vital to understand the importance of protecting and managing our valuable resource in the most efficient manner.

"Water use, particularly in lieu of the legislation passed in 2006 that provided a framework for water monitoring and management, has become an even more important issue," said Jay Drozd, a corn farmer from Allegan and Corn Marketing Program of Michigan (CMPM) secretary. "The legislation could cause huge implications for Michigan's irrigated agriculture."

The CMPM partnered with Dr. William Northcott of Michigan State University (MSU) to conduct research looking at how geology, the climate, and various management practices affect groundwater recharge, specifically for irrigation of corn production within Michigan.

Groundwater availability is highly dependent on the amount of recharge that occurs on an annual basis. The recharge period is between October and May when the precipitation that falls replenishes groundwater. Groundwater stress during growing seasons typically occurs when the previous fall and winter were dryer than normal.

For this project, long term (103 years) climate data from two locations in the state, representing the driest (Bay City – 29.9") and wettest (Coldwater – 34.0") locations where corn is grown, were analyzed to determine the frequency that a climate-related drought condition would occur. "An analysis of the data over this time period revealed that a droughty fall resulting in significant recharge reduction occurs roughly every 15 years," said Northcott.

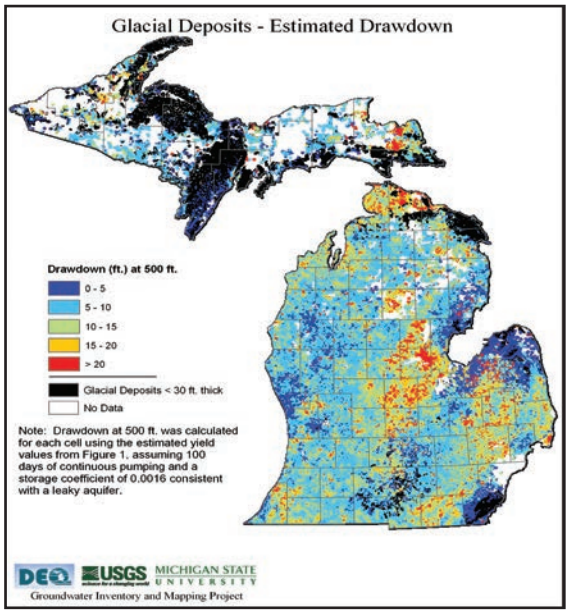
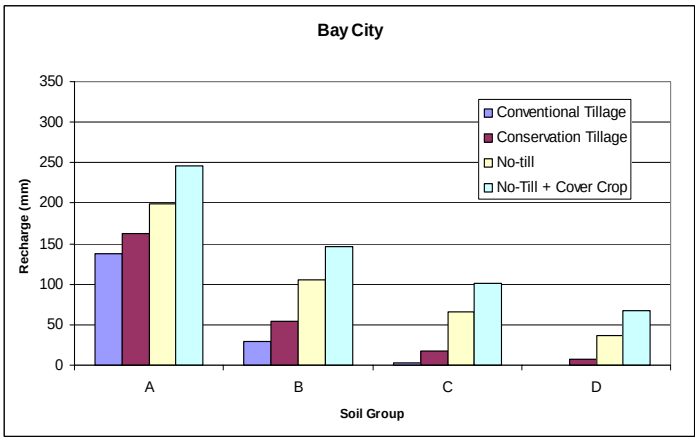


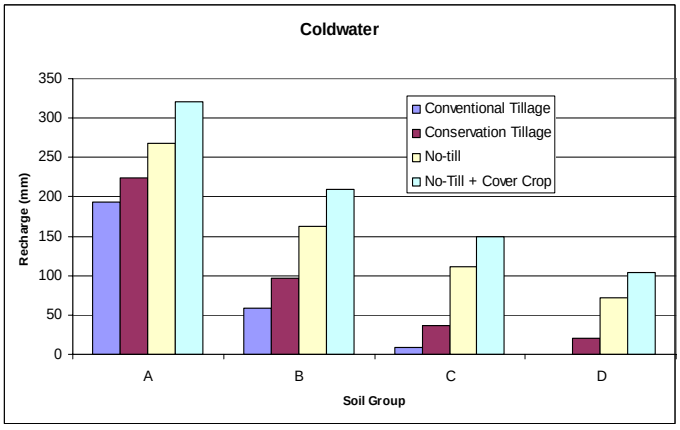
Figure 4. Groundwater Modeling Results

Dr. Northcott also looked at the impact a high capacity well would have on groundwater availability. Using an Interactive Groundwater model, Dr. Northcott compared three common aquifer types in the state, based on a high capacity well pumping for 100 straight days. The results from this modeling are shown in figure 4. "Under the new state legislation, the impact of high capacity pumping will be determined by its affect on nearby stream levels. Our research has shown that by placing irrigation wells a reasonable distance from streams, there is little or no impact on stream levels," said Northcott.

Field management practices also have an impact on the water balance of a field. Farmers should try to convert as much of the season's rainfall into infiltration instead of surface runoff, Northcott noted. "Simulating three levels of tillage (no-till, conservation, and conventional), we found significant differences in the amount of groundwater recharge," said Northcott. "Not only did no-till provide the most groundwater recharge, but the addition of a fall cover crop further increased the effects. The recharge difference between conservation tillage and no-till with a fall cover crop was approximately six inches annually." The impacts of the various tillage methods are shown in Figure 5.

Figure 5. Tillage Impacts on Recharge





Stacking Insect and Herbicide Resitance Traits

One Corn Marketing Program of Michigan (CMPM) funded project, initiated during the 2004 growing season, focused on corn with stacked transgenic herbicide and insect resistant traits. Stacking both insecticide and herbicide resistant traits into a single corn hybrid offers new strategies for pest management in Michigan's corn production. These technologies will be aggressively marketed strategies in the near future.

"As more of these products come to the market, it is important that we look at the results and efficacy of the stacked trait corn and also the economics of these systems," said principle investigator, Dr. James Kells, a leading weed expert at Michigan State University (MSU). Kells thinks transgenic traits will offer corn farmers new options for weed and insect management. "Stacking both insect and herbicide resistant traits into a single corn hybrid gives farmers new and innovative strategies for insect and weed management. We wanted to really explore the economic impact these new strategies could have versus the more conventional types of weed and insect control," he added.

The three-year study examined the economics of managing weeds and corn rootworm through stacked transgenic corn hybrids as compared to conventional insect and weed management strategies. Field trials were conducted at four locations during the 2004-2006 growing seasons. Research sites varied in weed and insect pressures and were chosen based on past history of infestation levels.

Near-isogenic corn hybrid lines were used throughout the trials to minimize agronomic differences between the hybrids. Transgenic and conventional weed management strategies involved preemergence and postemergence herbicide applications and herbicide selection based on scouting. Corn rootworm strategies included a resistant hybrid, a conventional soil-applied insecticide, and a seed treatment. Data collected included weed control efficacy, visual assessment of corn rootworm damage, and corn grain yield.

Figure 7. Corn Yields Across Insect Control Treatments at MSU2 and St. Johns in 2004, 2005, and 2006.

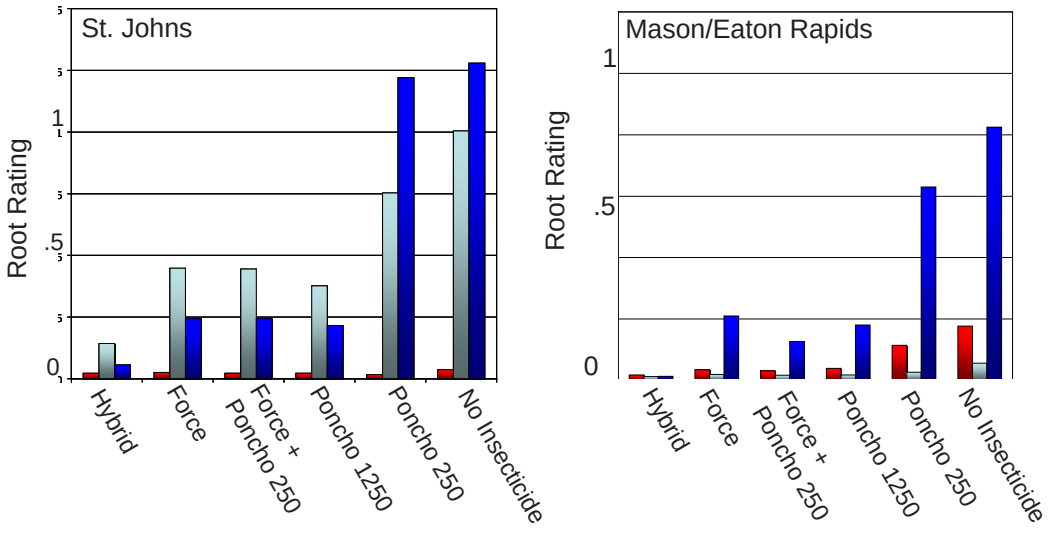
MSU2	Yield (bu/A)		
Treatments	2004	2005	2006
Hybrid	227.1 (± 2.1)	231.1 (± 2.5)	214.2 (± 4.7)
Force	230.6 (± 2.6)	226.6 (± 3.3)	170.7 (± 6.2)
Force + Poncho 250	233.8 (± 2.6)	219.1 (± 3.3)	207.8 (± 6.2)
Poncho 1250	227.4 (± 2.6)	189.3 (± 3.3)	206.4 (± 6.2)
Poncho 250 + Weed Free	223.6 (± 4.6)	223.1 (± 6.7)	211.1 (± 12.4)
No insecticide + Weed Free	225.9 (± 4.6)	223.6 (± 6.7)	187.1 (± 12.4)
Yield Reduction by CRW	3 %	3 %	13 %

St.Johns	Yield (bu/A)		
Treatments	2004	2005	2006
Hybrid	162.2 (± 4.0)	153.1 (± 5.1)	185.7 (± 7.8)
Force	164.8 (± 5.3)	132.7 (± 7.2)	165.6 (± 8.8)
Force + Poncho 250	165.4 (± 5.2)	138.8 (± 7.2)	175.3 (± 8.8)
Poncho 1250	166.7 (± 5.2)	119.7 (± 7.2)	148.4 (± 8.8)
Poncho 250 + Weed Free	151.1 (± 7.3)	73.6 (± 10.2)	135.9 (± 10.6)
No insecticide + Weed Free	164.5 (± 6.9)	75.9 (± 10.2)	110.8 (± 10.6)
Yield Reduction by CRW	1 %	50 %	40 %

Figure 6 illustrates the root damage rating across the corn rootworm control treatments across the four locations. Figure 7 illustrates the corn yields across insect control treatments at the MSU2 and St. Johns locations.

"The data generated through this research will be the basis of recommendations on the adoption and utilization of these technologies, which should lead to greater production efficiency and profitability," explained Kells. "This study will provide the information needed to determine those situations in Michigan where stacked resistant traits are economically justified."

Figure 6. Root damage across rootworm treatments



Corn Yield Response to Nitrogen Rate and Timing

This past year, the Corn Marketing Program of Michigan (CMPM) partnered with the Michigan State University (MSU) Department of Crop and Soil Science to conduct research looking at corn yield response to nitrogen rate and timing. "Efficient use of nitrogen for corn production is essential to maximizing economic returns for corn farmers, since the cost of nitrogen fertilizer continues to increase," said Jody Pollok-Newsom, CMPM executive director. "Improving our understanding of factors affecting corn yield and yield response to nitrogen in Michigan is important for providing efficient and profitable nitrogen recommendations, so farmers have a good understanding of what will provide them with the greatest return on their investment."

In order to study the effects nitrogen rate and timing have on corn yield, several trials were conducted for the 2006 growing season. Ten sites were chosen across Michigan to provide a representation of the state's major soil types. Treatments consisted of urea preplant/incorporated, ammonium nitrate, and 28 percent UAN sidedress injected and varied depending on the location.

Figure 8 shows the response of corn to nitrogen rates at individual sites and provides a comparison of different approaches for determining the optimum nitrogen rate to apply (nitrogen rate based on maximum yield versus economic optimium yield), as well as a performance evaluation for the presidedress soil nitrate test (PSNT) at several of the study sites. Figure 9 (on page 8) provides a comparison among the various nitrogen treatments at each site. "With the exception of Hillsdale and St. Clair, 120 lbs per acre or less, regardless of application time, was sufficient to obtain the maximum corn yield. At Hillsdale and St. Clair, 160 lbs per acre was required to achieve maximum yield," said Dr. Ron Gehl, associate professor at MSU.

The PSNT was an effective tool for adjusting nitrogen rates at the locations in 2006. With the exception of the Tuscola site, which had a clover cover crop, the PSNT-adjusted nitrogen rate was 6 to 42 lbs of nitrogen per acre greater than the

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Figure 8. Corn Yield Response to N Fertilizer Rate

Location	Max Yield	MSU N Rec.	PSNT Credit	PSNT Adj. N Rec.	Yield Opt. N Rate	PSNT Adj. N Rec - Opt. N Rate	Max Econ. Yield	Econ. Opt. N Rate (EONR)	PSNT Adj. N Rec.- EONR
	bu/ac	----------lbs N/acre----------					bu/ac	----------lsb N/ac----------	
Branch	190	201	-	-	148	-	189	132	-
Hillsdale	188	199	-	-	165	-	187	145	-
Huron	218	240	54	186	144	42	217	136	50
Ingham C-C	199	244	39	205	178	27	198	163	42
Ingham Sb-C	199	214	50	164	156	8	198	141	23
Saginaw	201	216	54	162	156	6	200	144	18
Sanilac	192	204	44	160	142	18	191	130	30
St. Clair	162	193	-	-	151	-	160	143	1
Tuscola	187	184	120	64	157	-93	185	123	-59
Van Buren	161	192	-	-	151	-	160	143	-

PSNT Credit = Nitrogen credit (lb N/ac) based on a one foot sample taken just prior to sidedressing.

PSNT Adj. N Rec. = The MSU N recommendation minus the PSNT credit.

PSNT Adj. N Rec. = Opt. N Rate = The PSNT adjusted N recommednation minus the optiumum N rate. Negative values indicate that using the PSNT to adjust N rates would result in an under-application of N for max. yields.

Max. Econ. Yield = The maximum economic yield as determined by a 1:10 corn N required maximum yield.

Econ. Opt. N Rate (EONR) = Economic optimum N rate is the amount of N required for maximum economic yield.

PSNT adj. N Rec. - EONR = Provides a comparison of the PSNT adjusted N recommendation and the EONR. Negative values indicate that using the PSNT to adjust N rates would result in an under-application of N for max. economic yields.

Effects of Starter Fertilizer on Corn Production

As input costs for corn production continue to escalate and farmers push for increased yields, it is vital that today's corn farmers have an accurate assessment of the effectiveness both nitrogen and sulfur have on corn production when incorporated in starter fertilizer. In order to provide this information to farmers, the Corn Marketing Program of Michigan (CMPM) has partnered with Michigan State University (MSU) to study the impact of different variations of starter fertilizer.

"The recent decrease in atmospheric sulfate deposition, increases in corn yields, and relatively early corn planting dates have prompted farmer and industry interest in evaluating the use of starter fertilizer containing Sulfur for corn," said Dr. Kurt Thelen, an associate professor in the Crop and Soil Sciences Department at MSU. To address this issue, a series of sulfur trials were initiated in 2005 and were continued during the 2006 growing season. Six study locations were evaluated in 2005 and 2006, including two sites on MSU research farms and four sites on farmer fields. Trial locations and soil texture are shown in Figure 10. All sites had coarse-textured soils with minimum- or no-till cropping systems and were managed as a corn/soybean rotation except Ingham (continuous corn) and Tuscola (2006, wheat/clover cover). The starter fertilizer treatments for each location are shown in Figure 11.

Figure 10. Trial Locations and Soil Textures in 2005 & 2006

Location	Texture	
	2005	2006
Berrien	Sandy Loam	Loam
Clinton	Loam	Loam
Ingham	Loamy Sand	Loamy Sand
Lapeer	Sandy Loam	
Monroe	Loamy Sand	Loamy Sand
Montcalm		Loamy Sand
Saginaw	Silty Clay	
Tuscola		Loam

Figure 11. Starter fertilizer treatments at study locations in 2005 and 2006.

Ingham, Montcalm, Saginaw, Clinton	Clinton	Berrien	Monroe	Lapeer**	Tuscola
Study Year					
2005, 2006	2005	2005, 2006	2005, 2006	2005	2006
----------lbs/ac----------					
Control	-	-	-	-	-
25N	-	-	-	60N	25N
25N+25P	25N+25P	13N+46P	15N+52P	-	-
25N+5S	25N+5S	136N+46+5S	15N+52P+5S	64N+5S	25N+5S
25N+10S	25N+10S	138N+46P+10S	15N+52P+9S	69N+10S	25N+10S
25N+20S	25N+20S	143N+46P+20S	15N+52P+16S	67N+20S	25N+20S
25N+25P+10S	-	-	-	-	-
10S	-	-	-	-	-

**Treatments were applied at sidedress rather than as starter

"As a corn farmer and an environmental steward of the land, I want to know exactly how the nutrients I apply to the soil will affect production on my fields," said Lyn Uphaus, CMPM president and a corn farmer from Manchester. "I want to be able to optimize my corn production by applying the most cost-effective amount of nutrients. Research projects such as Dr. Thelen's, provides me with the data I need to make those decisions for my farming operation."

Corn yield response to nitrogen and sulfur fertilizer applied as a starter at planting in 2005 and 2006 are shown in Figure 12 and 13 respectively on page 8. "The yield responses observed in this study can primarily be attributed to the use of nitrogen, phosphorous, or a combination of both containing starter fertilizer in general, rather than

Continued on Page 8

Corn Yield Response to Nitrogen Rate and Timing

Continued from Page 6

agronomic yield-optimum nitrogen rate, and was 18 to 50 lbs of nitrogen per acre greater than the economic optimum nitrogen rate. While the PSNT did over recommend nitrogen, use of the PSNT resulted in reduced nitrogen rates compared with the current MSU recommendation. "The economic optimum rate was less than the yield optimum rate at all sites and resulted in only slight reductions in crop yield," noted Gehl. Based on these results, the economic optimum nitrogen rate provided the maximum return on the fertilizer nitrogen investment at these sites in 2006.

"The research Dr. Gehl is conducting will provide farmers with valuable information to aid in nitrogen management decisions," said Pollok-Newsom. "Farmers can use this information to evaluate the most economical nitrogen rates based on returns, and make well-educated decisions based on their specific locations."

Figure 9. Corn yield response to N fertilizer rate and time of application.

Treatment	Saginaw	Ingham Sb-c	Ingham C-C	Branch	Hillsdale	Huron	St. Clair	Sanilac	Tuscola	Van Buren
lb/ac	----------bu/ac----------									
0	98	114	94	119	118	74	48	97	150	22
40	143	164	134	158	159	161	97	168	169	75
80	185	184	167	178	160	198	125	176	178	145
120	193	184	188	187	181	208	148/	180	182	146
160	196	199	198	182	199	201	163	185	170	159
200	195	194	196	186	181	207	160	184	183	148
160 sd	193	193	195	184	167	-	-	-	-	-
80 sp	162	177	169	-	-	-	-	-	-	-
120 sp	187	198	198	-	-	-	-	-	-	-
160 sp	195	185	201	-	-	-	-	-	-	-

Effects of Starter Fertilizer on Corn Production

Continued from Page 7

from the addition of sulfur to the starter fertilizer blend," added Thelen. "As atmospheric sulfate deposition continues to decrease, a corn yield response to Sulfur is more likely to occur. The likelihood of response should increase in cool, wet springs where mineralization is minimized and early crop growth is slowed."

"This research provides Michigan's corn farmers with valuable information regarding the potential benefits of starter fertilizer and the effect of starter fertilizers containing sulfur," said Jody Pollok-Newsom, CMPM executive director. "As a result, farmers will have a better basis for deciding which nutrients to include in their starter fertilizer when planting corn, and which nutrients are most likely to result in a profitable crop response."

Figure 12. Corn yield response to nitrogen and sulfur fertilizer applied as a starter at planting in 2005.

	Location					
Treatment	**Ingham**	**Saginaw**	**Berrien**	**Clinton**	**Monroe**	**Lapeer**
lb/ac	**----------bu/ac----------**					
25N	178.2	190.7	150.6	149.4	174.4	156.8
25N+5S	174.7	193.1	151.5	154.7	175.3	162.9
25N+10S	167.7	192.2	149.5	157.5	174.6	160.6
25N+20S	182.5	189.0	144.3	157.2	188.8	162.9

Figure 13. Corn yield response to nitrogen and sulfur fertilizer applied as a starter at planting in 2006.

	Location				
Treatment	**Ingham**	**Montcalm**	**Berrien**	**Monroe**	**Tuscola**
lb/ac	**----------bu/ac----------**				
25N	160.4	206.9	165.3	213.6	184.2
25N+5S	158.2	208.3	172.2	213.3	187.3
25N+10S	157.5	210.5	164.5	213.9	192.4
25N+20S	157.8	207.7	157.3	215.9	191.5

NEW USE DEVELOPMENT

The Corn Marketing Program of Michigan (CMPM) works to stretch check-off investments by not only focusing on production research and enhancing traditional markets, but also by creating new and innovative markets for corn. The CMPM works with a diverse group of partners across the state to look five, ten, and even twenty years into the future to identify new markets and possible uses for Michigan corn. Through state check-off funded research, the CMPM has played an integral role in the development of corn-based polymers, which can be used to make plastics, fabrics, and packaging materials. Check-off funded research has also led to other new corn use developments including pharmaceuticals, ethanol, and engine oil. This is just the tip of the iceberg when it comes to the development of new uses and markets for Michigan's corn.

Corn Can be Used as Not Only a Fuel, But as an Engine Lubricant

For years, farmers have grown corn specifically for the purpose of converting the full-grown crop into a renewable, alternative fuel - ethanol. The CMPM is taking that concept one step further. As a result, farmers may be able to grow a crop specifically for a corn-based engine oil market.

The CMPM has partnered with Michigan Molecular Institute (MMI) to develop an auto engine lubricant that contains corn oil. "Corn farmers have long known the value of their crop as an energy source and may utilize the crop in a new way," said Jody Pollok-Newsom, CMPM executive director. "It's important for corn farmers to have options when it comes time to market their crop. The addition of a new corn oil market will only strengthen their position. We have seen the changes in the corn market due to the ethanol industry. We want to make sure we diversify those opportunities even more in the future."

Through research done at the MMI laboratories, David Dalman, principal investigator on the project, has looked at the blending of various levels of corn oil and additives with different commercial automobile engine lubricants. "The addition of corn oil to commercial automobile engine oils acts like a performance-enhancing additive by reducing all additive levels, including the reduction of undesirable phosphorus, lowering pour points, reducing wear levels, and increasing the load-bearing capability of the engine oil," said Dalman.

Photo Courtesy of the Corn Refiners Association

Dave Dalman (left) and Mike Rozniak with some of the equipment used at MMI to develop corn oil containing automotive engine oil lubricant.

The engine oil market offers a large opportunity to corn producers, not only to those in the Great Lakes State, but also in other corn growing states. "Even with the modest goal of adding 10% corn oil to engine oil and achieving a 10% share of the U.S. market, the potential for automotive engine oils alone is so large that all the corn grown in Michigan would have to be converted to oil just to supply this market," said Clark Gerstacker, NCGA Corn Board member and a corn farmer from Midland. "This represents a large opportunity to capitalize on a new market for our corn."

Work is still being done to further enhance the corn-based engine oil to get it ready for commercialization. A patent has been submitted that would allow for the licensing of the technology and the further study of commercialization opportunities.

The Endless Uses for Corn

For most people, when they hear the word corn, food, livestock feed, and ethanol come to mind. Corn-based products such as plastics, packaging materials, household cleaning agents, fibers and fabrics have been making their debut on the shelves of stores all across the country.

Corn-based products are produced from biodegradable corn polymers which are made from a 100 percent annually-renewable resource, corn. There are currently three companies producing corn polymers in the United States.

Corn-based plastic tableware

With environmental issues drawing great media attention these days, corn-based products are gaining momentum. These products are biodegradable or compostable, depending on the individual product.

Corn-Based Plastic

"More than 80 billion pounds of plastics are produced in the United States every year, and these plastics have traditionally relied on petroleum-based feedstocks. Corn-based products offer a 100 percent renewable, plastic alternative," said Clark Gerstacker, Corn Marketing Program of Michigan (CMPM) vice president and National Corn Growers Association (NCGA) Corn Board member.

The production of corn-based products opens up a new market for corn. The opportunities are endless to replace petroleum-based plastics and move toward the environmentally-friendly, corn-based plastics. "Essentially, anything that can be made from petroleum-based products can be made with corn or corn-based products," said Gerstacker, who is also a corn farmer from Midland. "However this transition will not happen overnight. It takes time to build infrastructure, develop markets and educate consumers."

Corn-based products in the past tended to be slightly more expensive than traditional petroleum-based products. Although, as the price of petroleum rises and more research is conducted, that gap continues to narrow. According to the NCGA,

Corn-based plastic coffee mug

Wal-Mart, the country's largest retailer and grocery seller, began substituting 114 million clear-plastic clamshell containers made from corn-based plastic for the traditional petroleum-based plastic in November of 2006 in its 3,779 Wal-Mart, Sam's Club and Neighborhood Market stores. Wal-Mart will also use corn-based plastic to make its gift cards and calling cards.

Corn-based plastic clamshell container

"With this change to packaging made from corn, we will save the equivalent of 800,000 gallons of gasoline and reduce more than 11 million pounds of greenhouse gas emissions," said Matt Kistler, Wal-Mart vice president for product development and private brands for the company's Sam's Club division.

Corn polymers can be used in a wide range of applications. Listed below are just a few:

- Fabrics used to make clothing and blankets
- Coffee cups and travel mugs
- Corn-based plastic bags
- Cups, utensils, plates and bowls
- Fiberfill used in pillows and comforters
- Golf tees
- Packaging for fresh food storage
- Surface yarns and fibers in carpet

Corn-Based Apparel

One of the most exciting applications of corn polymers is corn-based apparel. Corn-based apparel lasts just as long as traditional fabrics and is the first man-made synthetic fiber created from a 100 percent annually-renewable resource. There are many other benefits that go along with this environmentally-friendly fabric. It is wrinkle free, will not shrink and is hypo-allergenic. The fabric exhibits excellent stain resistance and is also compostable.

New Z Lander, a retail company out of Troy, Mich., just began carrying the following corn-based clothing:

- Men's and women's long sleeve twill shirts
- Men's and women's short sleeve tees
- Coaches jackets
- Ball caps

Other Corn-Based Products

In addition to plastics and fabrics, corn can also be made into cleaning products, packing materials,

pharmaceuticals, and a corn-based salt substitute, such as AlsoSalt, a sodium-free salt substitute.

Scientists are also devising ways to ferment, separate, and purify various chemical streams from corn processing. One such chemical stream forc succinic acid. Succinic Acid serves as a starting point for chemicals that can lower the freezing point of water and thus be used to make safer engine coolants and jet runway de-icers; becomes biodegradable industrial solvents that pose little threat of air pollution or ozone damage; or makes biodegradable polymers for car parts such as dashboards. Thanks to research funded by the CMPM, scientists continue to develop new products or chemical streams from corn.

Corn-based twill dress shirt

The opportunities are endless to replace petroleum-based products and move toward the environmentally-friendly, corn-based products. "We have only just begun to unlock the great potential that exists within the corn plant. As we continue to further develop and understand the corn plant, we begin to realize its full potential," added Gerstacker. "Michigan corn farmers, through the check-off program, invest in research that focuses on new uses and new markets for corn. The future for corn is very promising."

For a listing of additional corn-based products and where they can be purchased in Michigan, visit www.micorn.org

The Heat Potential of Corn

As the corn heating industry continues to expand, the Corn Marketing Program of Michigan (CMPM) has made investments in several projects looking into corn-based heating systems.

The CMPM partnered with Dr. Chris Schilling of Saginaw Valley State University (SVSU) to examine the viability of expanding the market for industrial and residential heating fuels made from corn-based raw materials. Because of their abundance and low-cost, Dr. Schilling combined corncob powder and dried distillers grain (DDGs) and created a pelletized form of heating fuel. These raw materials are readily available and have a high heat content per unit weight. Dr. Schilling also created a public demonstration site showcasing corn heat at *The Good Neighbors' Mission* in Saginaw, Mich. A 200,000 BTU corn-burning furnace was installed in order to educate the public about the science and economics of energy crops, while also helping reduce the Mission's heating bill. In addition to the fuel and the demonstration site, Dr. Schilling conducted a market opportunity analysis of corn-based solid fuel. The analysis showed that not all market segments have the same potential for corn use. According to the analysis, the largest growth opportunity for corn-based fuel is industrial and commercial applications, such as educational institutions, churches, hotels and motels, warehouses, correctional facilities, and greenhouses.

The CMPM has been working closely with Michigan State University Extension (MSUE) to hold educational meetings across the state to educate consumers regarding heating with corn. Through CMPM funding, MSUE is also conducting an emissions and efficiency testing program for corn-heating systems. Once completed, this information will provide increased consumer confidence and buy-in regarding corn as a primary heat source.

Sparty stopped by the MSU Alumni Association tent to experience Michigan corn heat first-hand.

The Exciting World of Ethanol

Ethanol has been one of the most valuable new uses for corn and one of the hottest topics for the past few years. The Corn Marketing Program of Michigan (CMPM) is continuing its research looking at new uses for ethanol including our continual work with Kettering University and its entry in the Society of Automotive Engineers (SAE) snowmobile challenge. The CMPM continues to fund the engineering students at Kettering University who have developed an ethanol-powered snowmobile. They have shown that with modifications, a snowmobile specifically built to run on E85 can achieve optimum performance and reduced emissions as compared to gasoline. Figure 14 below shows a comparison of the snowmobile running on gasoline compared to E85.

"It is a great opportunity for us, as farmers, to be able to support the next generation of engineers and give them exposure to ethanol as a fuel," said Lyn Uphaus, CMPM president and corn farmer from Manchester. "We hope to get them excited about ethanol and biofuels while they are still getting their education, so when they begin their professional careers, they will have familiarity and

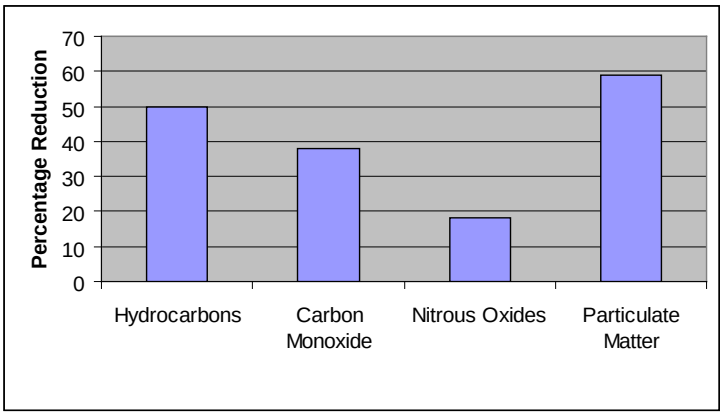


Figure 14. Reduction in snowmobile emissions when using E85, as demonstrated by the research at Kettering University.

hopefully an advantage in the workplace as a result of their experience working with ethanol."

In addition to working with Kettering University, work continues with the engineering students at Saginaw Valley State University. Under the direction of Dr. Chris Schilling, the students were awarded a grant to modify a garden tractor to run on ethanol instead of gasoline. The tractor was restored and modified to be an E85 capable vehicle. You can see from figure 15 how impressive the tractor is when on display.

Ethanol production has been ongoing for several years, but it has not been until recently that there has been a bigger push on exploring the efficiencies of the plants including making them self sufficient and fully utilizing the co-products and inputs. The CMPM has been doing research the past few years looking at technologies related to its co-products and it seems that the options are limitless.

One of the technologies being explored is what has been referred to as degerm or fractionization of the corn kernel. Research to take out the germ, the oil containing portion of the kernel, prior to processing seems to have merit. The ability to pull the oil out of the kernel prior to processing would lend another product, corn oil, to the ethanol plant's production. The germ could then be sent to be processed into either corn oil for consumption or for the processing of biodiesel.

The CMPM partnered with several states through the National Corn Growers Association several years ago to further look at this technology. Now that there are several plants across the United States producing ethanol, this technology is beginning to be embraced and implemented to see what the yield would be and how it would work on a larger scale.

In addition to the degerm technology, research is ongoing for additional uses for the current co-products of the ethanol process, carbon dioxide (CO_2) and dried distillers grains (DDGs). There are several more easily identifiable uses for the DDGs at this point than the CO_2.

The grain can be further processed for several industrial uses. In addition to these uses, there is still ongoing research looking at other markets and other industries. More information on those projects will be shared after patents have been filed and further market research has been completed.

Figure 15.Garden Tractor Modified to Run on Ethanol by Students at Saginaw Valley State University

Converting Dried Distillers Grains (DDGs) Into Plastics

As the ethanol market in Michigan continues to expand, the Corn Marketing Program of Michigan (CMPM) is working hard to fund research looking for new and innovative ways to utilize dried distillers grain (DDG), a co-product of the ethanol process.

Michigan will soon have five ethanol plants in production and will have an onslaught of DDGs to the marketplace. For every bushel of corn processed through an ethanol plant, it yields 2.8 gallons of ethanol and 16 pounds of DDG. "As ethanol production continues to increase in Michigan, it is important that we find new uses for the co-product, DDG," said Clark Gerstacker, CMPM vice president and National Corn Growers Association Corn Board member. Figure 16 shows the amount of DDG that is produced from the four operational ethanol plants in Michigan and that which will be produced from the ethanol plant under construction. "We are very excited that investments made by the state's corn check-off have lead to the development of DDG-based plastic materials."

Figure 16. DDG Production in Michigan

Michigan Ethanol Plants	Annual DDG Production (metric tons)
Poet Biorefining, Inc.	145,000
The Andersons Albion Ethanol, LLC	177,000
US Bio Woodbury	145,000
Global Ethanol	183,000
Marysville Ethanol, LLC	160,000
Total	**750,000**

In 2002, two hundred billion pounds of plastics were manufactured globally, 40 percent of which came from the United States. The production of plastic has increased by approximately 49 percent since 1986. This traditional plastic is derived from petroleum and the majority of plastics are used as disposable packaging. Since these plastics are derived from petroleum, they biodegrade slowly and exist for many years in our country's landfills.

Through his research, Dr. Mohanty was able to take DDG material and transform it into DDG-based plastic materials such as this tray.

In order to address this problem, the CMPM has been working on two research projects. Dr. Chris Schilling, an engineering professor at Saginaw Valley State University, and Dr. Amar Mohanty, a packaging professor at Michigan State University have both developed ways to create plastics from DDGs. "By producing plastics from DDGs, we are helping to reduce the amount of petroleum used in the United States," added Gerstacker, who is also a corn farmer from Midland.

Dr. Schilling with a sample of his DDG-based plastic.

Schilling uses a pelletized form of DDG to create environmentally-friendly and biodegradable plastics which can then be used in furniture, architectural panels, and temporary landscape structures, to replace wood and polystyrene foam in composite molding applications. "Our intent was to produce biodegradable solids from simple, economical, and environmentally-safe methods that rely on abundant, low cost biomass feedstocks usually considered by-products from industrial sources," said Schilling. "This plastic has the look and feel of hard plastic or wood and has promise as strong, lightweight, biodegradable structural materials."

Dr. Schilling took his research one step further and also assessed the economics and performed a marketing analysis for creating construction, automotive, aerospace and other products from these plastic materials. He also continued his experiments with the goal to reduce processing times and mitigate drying shrinkage cracks and has shown significant progress in these areas.

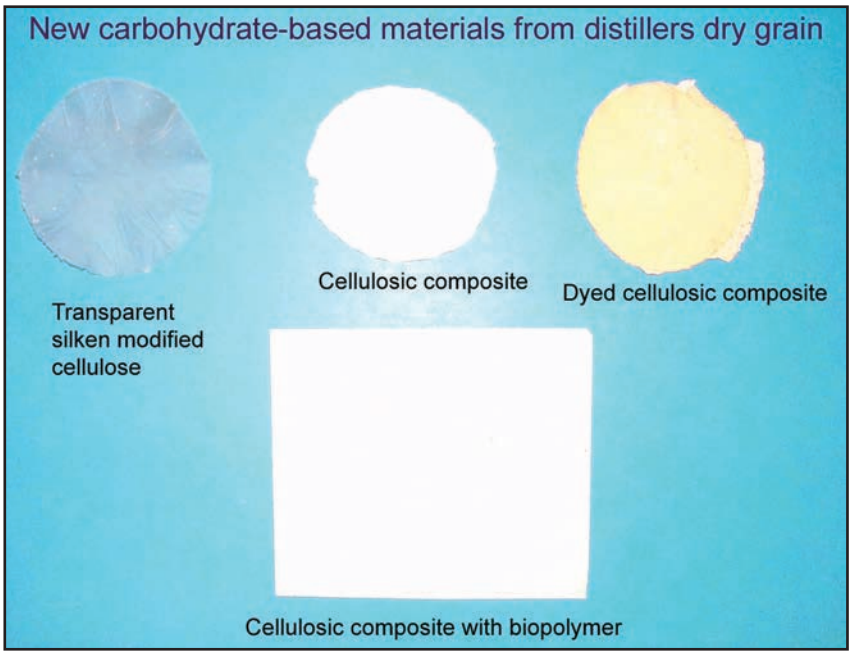
Dr. Mohanty utilizes an extrusion process to create DDG-based plastics from a raw form of DDGs and a biobased polyurethane. Through his ongoing research, Dr. Mohanty has successfully improved the resulting materials brittleness, ease of production and tensile strength of the material. The DDG-based plastics created by Dr. Mohanty are also water resistant. "Through our research funded by the CMPM, we were able to produce a low-cost DDG-based plastic material, which shows great potential for commercial applications," said Dr. Mohanty. "The biobased product we developed would be very suitable for furniture applications or for food containers, all leading to a more bio-based and sustainable future."

Corn as Medicinal Building Blocks

The Corn Marketing Program of Michigan (CMPM) board of directors understands the vast importance of the traditional markets for Michigan's corn crop. However, they also look toward the future by funding research projects looking at new and innovative uses for corn.

The CMPM has been working to enhance the market value for corn by working with Dr. Rawle Hollingsworth, president of AFID Therapeutics, Inc. on the development of a carbohydrate-based drug chemistry program.

Dr. Hollingsworth's research explores the molecular structure of carbohydrates, including that of corn and works to develop new uses for them. One of the most promising new uses for these corn-based carbohydrates includes manufacturing the base compounds used as building blocks for pharmaceutical production. "The primary aim of this research program was to develop a commercial product stream for a class of chiral molecules called pyrrolidines," said Dr. Hollingsworth. "These are used in the preparation of drugs that are used for treating a host of diseases including cancer and viral infections."



Not only is this technology exciting for researchers, but farmers as well. "As a farmer, I always feel a sense of pride driving past corn fields. I can see the value of the corn crop as we help to fuel the nation with ethanol and also help feed livestock. Knowing that those same fields could be used to provide medicines which could ultimately save lives, gives me an extra sense of pride," said Clark Gerstacker, CMPM vice president and NCGA Corn Board member. "Michigan corn farmers have a long history of feeding and fueling our nation and our world. Now, with innovative research such as this, we are ready and willing to step up to the challenge of providing medicines to fight disease as well."

The technology utilizes the transformation of refined corn products such as starch and pentose sugars into small general chemical intermediates that can then be converted into nitrogen containing compounds. "The use of corn-derived carbohydrates offers several advantages over petrochemical based approaches," added Dr. Hollingsworth. "Chief among these is simplicity, purity and cost. There are no competing routes for many of the products we are developing routes to." The research program at AFID Therapeutics, Inc. had four key elements, with pyrrolidines being only one of several chemical families they are developing commercial routes to.

Not only does Hollingsworth serve as president of AFID Therapeutics, Inc., he is also a professor at Michigan State University in Biochemistry and Molecular Biology which he takes very seriously. "The land grant institution is predicated on a covenant between itself and the community that it serves and I take that very seriously in my role as a university professor," said Hollingsworth.

"Corn farmers in Michigan are very proud of the accomplishments that Dr. Hollingsworth has achieved in terms of new molecular compounds and are very proud of the partnership that CMPM has developed with AFID Therapeutics, Inc.," added Jody Pollok-Newsom, CMPM executive director. "In order to remain on the cutting edge, we must continually look beyond traditional partnerships in order to work outside the conventional realm of agriculture. By working with Dr. Hollingsworth through research projects, we will maintain corn's position on the cutting edge not only in corn production, but also in pharmaceuticals."

Leveraging State Resources to Conduct National Research

The CMPM worked cooperatively on research projects with 27 other corn-growing states across the nation through its affiliation with the NCGA. The various research projects looked to increase demand and add value to the corn crop. These projects focus on using underutilized portions of the corn kernel, converting ethanol into chemicals, mapping the corn genome and sequencing maize traits.

Corn Fiber

Corn fiber is the least valued and least utilized portion of the corn kernel. It is currently sold as a low-value protein carrier in corn gluten feed (CGF) and dried distillers grains with solubles (DDGS) for the livestock industry. Corn fiber represents a significant amount of the total mass processed by ethanol plants, and the continued expansion of the ethanol industry is increasing the amount of corn fiber co-products on the market.

"Converting the fiber from ethanol co-products into higher value products will have two benefits," said Clark Gerstacker, CMPM vice president and NCGA Corn Board member. "It will decrease the amount of high-fiber feed products entering the market and create a larger, more diversified market for corn."

The fiber project will develop new technology to separate corn fiber recovered during the wet milling process into the component substances. Valuable chemicals will be separated from the fiber stream and the sugars will be converted into ethanol or other chemicals, which are used in solvents, inks, anti-freeze and deicing products. Fiber separation and process technology can be developed to improve the profitability of many corn-based bioproducts.

Developing Chemical Streams

The CMPM, in conjunction with the NCGA has been working with Dr. Dennis Miller at Michigan State University (MSU) to study a separation process known as reactive distillation.

Reactive distillation is a technique in which a mixed chemical stream is treated with a reactive chemical in the presence of a catalyst. This results in a combination of chemicals that can easily be separated, saving energy and plant design costs. This technology will allow the application of traditional catalysts to non-traditional corn-derived feed streams.

Reactive distillation involves simultaneous chemical reactions and product purification in a single unit of process equipment. The research illustrated the application of reactive distillation to the efficient production of renewable-based organic acid esters, a class of products that have low toxicity, excellent solvent properties and a wide range of industrial applications.

"The emerging development of the biorefinery concept for renewable fuels and chemicals has opened opportunities for novel reaction pathways and processes," said Miller. "New reaction pathways for biorenewables have received considerable attention during the past decade, but separation processes, which are critical to achieve marketable products, have lagged somewhat in their development."

Mapping the Corn Genome

One of the most exciting research projects being done is mapping the corn genome. The NCGA is working cooperatively with the National Science Foundation. "Once the corn genome is mapped, it will provide us with the baseline information as to how the corn plant really works and what properties it possesses," said Gerstacker, who is also a corn farmer from Midland. "Mapping the corn genome will provide additional understanding of the traits contained in the genome and will enhance corn's position as the ideal crop for food, feed, fuel and industrial uses by unlocking key attributes and additional yield potential."

The next phase of the project will be to place larger pieces of the genetic map together. Over the next several years, it will be of key importance to continue efforts such as functional genomics and studying the full set of proteins encoded on a genome. It is equally important to develop genetic and physical maps of the genome. Once these tools are in place, researchers and plant breeders will be able to quickly and efficiently introduce new traits into corn. Advancements in traditional breeding programs, as well as, programs to introduce new traits using molecular biology, offer exciting new opportunities for corn farmers.

Sequencing Maize Traits

Researchers use a number of procedures to build an artificial chromosome that can contain more than one desired trait. Once successful, this technology will enable researchers to speed the creation of seed corn with multiple desired characteristics. As a result, crops with multiple favorable genes can be quickly developed.

As part of the maize trait program, Divergence, Inc., a biotech company, is developing a technology to deliver nematode resistance. "This is just one innovative example of what can be done as a result of sequencing maize traits," said Gerstacker. "This represents a huge milestone in efforts by farmers to find solutions to their own production challenges and reap the rewards themselves."

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2007 Annual Research Report

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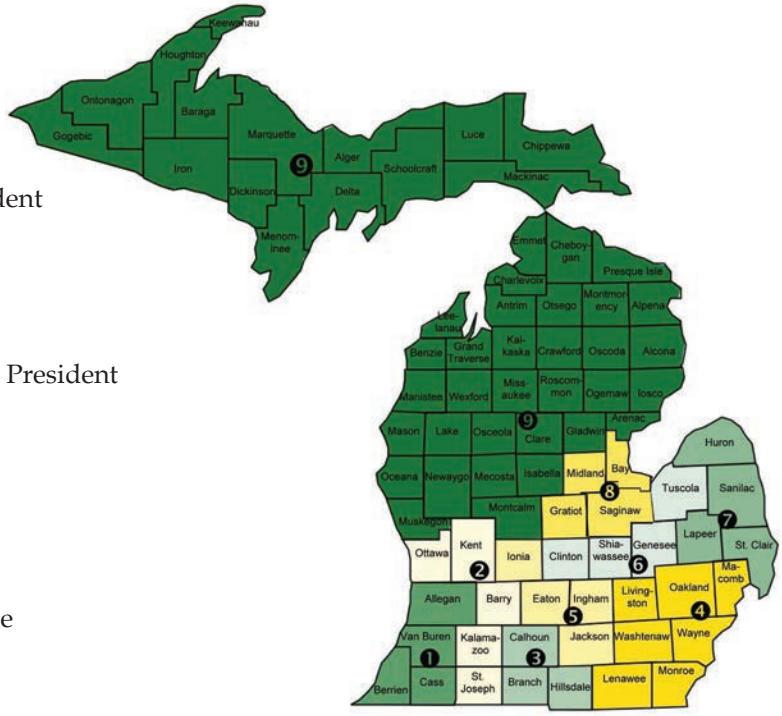

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Headquartered in DeWitt, Michigan, the Corn Marketing Program of Michigan (CMPM) is a legislatively-established statewide program that utilizes one-cent per bushel of corn grown in Michigan and sold. Investments are made in the areas of research, education, market development, and new uses in an effort to enhance the economic position of Michigan's corn farmers.

For more information on the CMPM, call the office toll-free at 1-888-323-6601 or visit us online at www.micorn.org.