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**BRIEFING PAPER ON CORN ETHANOL USE IN  
MICHIGAN: SHORT-RUN AND LONG-RUN ISSUES**

Corn Ethanol Working Group  
H. Christopher Peterson  
Roy Black  
Jim Hilker  
William Knudson  
John Ferris

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*80 AGRICULTURE HALL, MICHIGAN STATE UNIVERSITY, EAST LANSING, MI 48824*

## **BRIEFING PAPER ON CORN ETHANOL USE IN MICHIGAN: LONG-RUN AND SHORT-RUN ISSUES**

### **Introduction**

The rapid emergence of corn ethanol production capacity in Michigan has stimulated considerable discussion of the state's ability to produce corn for energy, livestock and export to other states and provinces. Effective utilization of the distillers grains with solubles (DGS) byproduct of ethanol production is also in question. This briefing paper is designed to provide a rapid assessment of what is known and projected for ethanol production in the state. It draws upon readily available public and private analyses of the production and use of corn, ethanol, and DGS. The estimates of specific uses of corn for feed in Michigan and for export, as well as the potential use of DGS, are less precise than the estimates of corn acreage and yield and are not from public sources.

Two timeframes are examined—a short-run view through 2007/08 (Exhibit 1) and a longer-run view through 2016 (Exhibit 2). The short term view is based on statistics for the past three crop years and projections for the coming crop year, with 5 ethanol plants, under three corn supply scenarios. The longer-run view begins with a baseline of one ethanol plant, and then explores an intermediate term with 7 plants, and a longer term with 10 plants, based on existing and proposed plant capacities.

The key findings from the analysis are as follows:

- ***In the short-term, Michigan is facing in-state corn supply limitations for ethanol production, and further expansion of corn ethanol production would be a substantial challenge.*** Michigan corn acreage will likely increase with a switch from other crops to meet ethanol production requirements. A reduction in corn exports to other states and provinces is anticipated. DGS production, beyond the equivalent to about 10% of in-state livestock and poultry corn use, will require export or non-feed uses. The five plants soon to be operating can be supported with a 15% increase in corn acreage and a 24% reduction in exports. Seven plants would reduce the state's baseline corn surplus by 64% and would require further switches from other crops to corn and further reductions in corn exports. Ten plants would nearly eliminate the baseline surplus, and this situation would require a substantial switch from other crops to corn, finding a market for a substantial amount of DGS, and challenges to meet the needs of current importers of Michigan corn. The ability to export DGS will require viable end users who are currently feeding Michigan corn.
- ***In the long-term, Michigan's capacity to support increased corn utilization for ethanol and competing uses rises again as yield improvements meet or exceed historic improvement trends.*** Under a ten plant scenario, Michigan would be in a position to realize a significant corn surplus again by 2016 without a major shift in acreage. This surplus (74 million bushels) would be 44% of the baseline surplus (169 million bushels). To accomplish this surplus would require (1) improving trend yields from the current 135 bu/acre to 170 bu/acre, and (2) a shift of 200,000 acres to corn production.
- ***Crop year variability will exacerbate any pressures on the system, as will sustained demand by current buyers of the state's exported corn.*** In the final analysis, Michigan's corn balance can not be examined in isolation from uncertainties about annual crop yield and out-of-state demand. Both of these forces will reduce the state's ethanol carrying capacity in the short and long terms.
- ***Under any reasonable assumption about the number of ethanol plants in the state, byproduct production of DGS will be substantial and its profitable use highly uncertain.*** The challenge will be disposing of DGS—26 million bushels for 5 plants, 49 million for 7 plants, and 68 million for 10 plants. At a 10% substitution rate for corn, it is not clear what the market for these uncommitted DGS will be. This challenge would be eased by an expansion of the livestock industry and/or a dramatic improvement of the percent of DGS that can be included in livestock and poultry rations.

## **Short-term Perspective (Exhibit 1)**

### ***Overview***

In the short-run, corn availability for all uses—livestock, fuel, and export—must be examined as well as the impact of production variability. Exhibit 1 provides a short-run analysis of the immediate past three crop years and a contingency analysis of the coming crop year. Beginning and ending stocks are presented to fully estimate supply, while corn use is broken down into multiple categories. Columns 2, 3, and 4 present actual crop year data on the supply side, actual use data for the first two years and a use estimate for the third year. The remaining three columns examine the impact of variability in 2007/08 crop size based on corn yield per acre.

### ***Key Assumptions***

- Ethanol production includes the operation of 3 plants and the start-up of 2 more for 2006/07 and full operation of 5 plants for the various 2007/08 scenarios. These five plants are the 3 currently operating in the state plus the 2 under construction. Maximum ethanol corn use is thus capped at 104.3 million bushels. (See Exhibit 3 for assumed plant capacities.)
- Corn exports to Canada are presented in two parts—(1) non-ethanol uses (other exports to Canada) which are estimated at 10 million bushels, except for the low yield year (column 5), and (2) ethanol exports which rise from 0 in 2004/05 to 15 million bushels in 2007/08.
- Exports of corn out of state is used as the residual figure in this analysis to allow production and use to balance without causing ending stocks to drop unacceptably low.
- Yield per acre is allowed to vary within its historic range—trend yield of 135 bu/acre with a range of -20% (108 bu/acre) to +10% (148.5 bu/acre). (See Exhibit 4 for historic yield information.) Total corn acres are assumed to go up 15% over 2006/2007, representing a shift out of other crops. (See acres of competing crops at the bottom of Exhibit 1.)

### ***Key Implications***

- As long as the state remains at high yields (149 bu/acre in 2006/07, and 148.5 in 2007/08) versus historic trend, the ethanol expansion represented by 5 plants can be absorbed with limited decline in the state's ability to export—a modest 6% decline from 138 million bushels in 2006/07 to 130 in 2007/08. Michigan has been a substantial exporter of corn especially to the southeastern and northeastern U.S (see Exhibit 5). Out-of-state buyers will need to find a portion of their corn needs from alternative sources, or there will be additional upward pressure on eastern corn-belt corn prices.
- At trend yields of 135 bu/acre (column 6) or poor yields of 108 bu/acre (column 5), export ability declines significantly—24% and 63% respectively. At these levels of decline, out-of-state buyers will likely attempt to bid up corn prices. If they enter the market during harvest, they may be able to take supply that would not be available later in the crop year for the ethanol plants in state. Therefore, the plants must be able to secure supply (with adequate contracts and/or storage capacity) at time of harvest to avert problems later. Livestock producers would have to be in a similar position to compete for supply. In any event, corn prices will likely rise with resulting negative impacts on plant profitability.
- The scenarios for 2007/08 show low ending stocks for corn even in the best scenario (column 7). The worst scenario (column 5) takes ending stocks just below their prior all time low. Such low stock levels provide very little cushion to absorb production shocks in future periods. Feedstock price volatility would likely be a significant problem for the industry as a whole.
- The net result of these forces is a probable shift of additional acres from other crops to corn to bring corn production and use into balance.

## Longer-Term Perspective (Exhibit 2)

### Overview

The concerns of the short-run can be mitigated or exacerbated by improvements in longer-run yields and/or the presence of more plants. Exhibit 2 (column 2) begins with baseline numbers representing approximate 2003/05 actual averages and the existence of one ethanol plant (Caro). An intermediate scenario based on 7 plants is then presented (column 3) while the long-term is represented by 10 plants used throughout the remainder of the exhibit (starting with column 4). Column 5 examines acreage conversion to corn. Two scenarios for 2016 are modeled--Column 6 increases yield/acre by historic improvement rates and column 7 increases yields/acre and ethanol gallons/bushel based on seed company estimates.

### Key Assumptions:

- The balancing number is surplus (deficit) at the bottom of the exhibit. As the baseline surplus (2003/05) declines, the various scenario surpluses will be resolved by market forces. Even though the exhibit makes it appear that livestock and ethanol will be supplied with corn, market forces will determine the ultimate distribution of corn to livestock, ethanol, and export.
- Based on Michigan Department of Agriculture information, the range of potential ethanol plants is limited to those actually operating (3) plus those under construction (2) plus those seeking permits (2) plus those formally proposed (3). In addition, one of the plants under construction has the option to double its capacity in the short-term and thus replace one of the other proposed plants if that plant is not pursued. Thus, the intermediate term estimate (2008/09) of plants is 7 (3 operating + 2 under construction + 2 of 3 from those seeking permits or the possible expansion). The long-term estimate is 10 plants (3 operating + 2 under construction + 5 of 6 from those seeking permits or proposed or the possible expansion). *At least six additional ethanol plants (bringing the total to 16) are being explored by others for the state. It is assumed none of these plants goes forward.* (See Exhibit 3 for assumed plant capacities.)
- Corn acres harvested and yield per acre are significant uncertainties that are modeled as separate long-term outcomes as is the gallons per bushel yield in the ethanol plants. The exhibit does assume a permanent increase of 200,000 corn acres across all scenarios after the baseline 2003/05. This is consistent with maintaining the acreage increase assumed in the short-term case (Exhibit 1). (See Exhibit 4 for historic yield information.)
- Livestock production remains constant. Thus, livestock use of corn is only affected by any replacement of corn by DGS. This replacement is assumed to be at 10% of livestock and poultry use of corn. This assumption is potentially controversial. There may be other substitution effects in the use of DGS that may increase this number, perhaps substantially. However, there are counter concerns about how much use of DGS can be made without negative impacts on livestock and poultry health and meat quality. The assumption adopted is thus a conservative one.

### Key Implications:

- Even after the 200,000 acre shift, the 7 plants envisioned for 2008/09 would reduce the state's corn surplus by 108 million bushels, or 64%. Given this decline in surplus, the ability of current export users of Michigan's corn to find alternative sources is a major issue that affects whether this scenario, let alone the next several, could ever really occur. One would presume that a significant number of additional acres might shift to corn and/or pressure on corn prices would be substantial.
- The 10 plant scenario would essentially eliminate Michigan's corn surplus (only 4 million bushels remains). Given expansion in ethanol production in surrounding states, current export users of Michigan corn would likely have to bid up corn prices to assure supply with resulting negative impacts on ethanol plant profitability. Again, further acreage conversion to corn is

likely with detrimental effects on corn yield due to rotation effects and likely diversion from in-state livestock and poultry use. The potential effects on Michigan's competitive position in the crops losing acres to corn would also need to be carefully analyzed, but this analysis is beyond the scope of this briefing paper.

- If acreage conversion occurred in the 10 plant scenario, it would take a 40% increase in corn acreage (800,000) from 2003/05 to maintain the state's corn surplus at 86 million bushels, or about half the baseline surplus of 169 million bushels. Maintaining a 50% surplus may not be enough to avoid substantial disruptions created by export buyers needs for corn. However, even the 50% requires such a substantial shift in corn acres that any additional shift would be unlikely. The long-run impacts of a major shift in acreage to achieve export capacity in balance with in-state livestock and ethanol use would include possibly significant changes in crop rotation and input supply use/availability. These changes would need to be carefully examined for sustainability. Another possibility would be the further dramatic decline in other specialty crops, such as dry beans and specialty wheat, as their acres converted to corn. (See acreages of various other crops at the bottom of Exhibit 1.)
- By estimating changes in corn and ethanol yields over the next ten years (2016), the impacts on corn supply can be modeled. If continuation of historic corn yield improvements occurs (column 6), the near elimination of the corn surplus for 10 plants would be partially reversed with a 41 million bushel surplus reestablished. If seed company projections are realized for doubling the output of ethanol gallons per acre (last column), Michigan would again have a significant corn surplus (estimated at 74 million bushels) by 2016 with ethanol output also dramatically increased. This surplus of corn could be diverted into more ethanol plants in the state or be made available for export or livestock use. *The long-run capacity of the state to produce ethanol is thus substantially increased if these yield changes can be realized. However, the estimated resulting surplus is only 44% of the corn surplus in the baseline year.*
- Finally, the production of the DGS byproduct expands roughly 8 times for the 7 plant scenario and 11 times for the 10 plant scenario. Disposing of this quantity of DGS will be a substantial challenge. It may drive the value of protein for animal feed down substantially, or it may even turn DGS into a waste stream to be disposed of at a cost to the ethanol plants. The challenge would be eased by an expansion of the livestock industry and/or a dramatic improvement in how much DGS can be added to a normal animal feed ration. Substitution of DGS for corn is limited to approximately 8 million bushels (10%) in the analysis presented (columns 3 through 7). Even if one assumes that the substitution effect could double (16 million bushels) or even triple (24 million bushels), the uncommitted DGS only fall to 52 million bushels and 44 million bushels respectively—still representing a substantial disposal issue.
- Extending the implications of the short-term analysis (Exhibit 1) to this analysis leads to the conclusion that any expansion of ethanol capacity beyond 5 plants to 7 or 10 would substantially exacerbate the problems created by yield variability and sustained export demand.

## Exhibit 1: Short-Term Michigan Supply/Use Balance Sheet for Corn

Corn Marketing Year	2004/05	2005/06	2006/07	20% Yield	Trend	10% Yield
				below Trend	Yield	above Trend
Corn Grain Production				2007/08	2007/08	2007/08
				15% Increase in Acreage from 2006/07		
Planted Acres	2200	2250	2150	2472.5	2472.5	2472.5
Harvested Acres	1920	2020	1940	2192.5	2232.5	2262.5
Yield bushels/acre	134	143	149	108	135	148.5
				Million Bushels		
Beginning stocks	29.2	38.9	49.6	24.2	24.2	24.2
Production	257.3	288.9	289.1	236.8	301.4	336.0
Total Supply	286.5	327.8	338.7	261.0	325.6	360.2
<b>Corn Use</b>						
Livestock Feed	76.0	80.0	74.0	72.0	72.0	72.0
Ethanol	16.0	20.0	72.5	104.3	104.3	104.3
Canada for Ethanol	0.0	5.0	15.0	15.0	15.0	15.0
Exports out of Michigan to U.S.	140.6	158.2	138.0	51.0	105.0	130.0
Other Exports to Canda	10.0	10.0	10.0	5.0	10.0	10.0
Other Uses and Residual	5.0	5.0	5.0	3.0	4.0	5.0
Total Use	247.6	278.2	314.5	250.6	310.6	336.6
<b>Ending Stocks</b>	38.9	49.6	24.2	10.7	15.3	23.9
				Previous low ending stocks 11.0		
				Million Bushels		
<b>DGS:</b> Production			23.3	33.5	33.5	33.5
Estimated In-state Feed Use			6.0	8.0	8.0	8.0
Uncommitted (Production less Use)			17.3	25.5	25.5	25.5
<b>Other Crop Acres in Michigan</b>				Thousand Acres		
Soybeans	2000	2000	2000			
Wheat	660	600	660			
Dry Beans	190	235	225			
Sugar Beets	165	154	153			
Hay	1100	1150	1160			
Total Above	4115	4139	4198			
Total Above Five Plus Corn	6315	6389	6348			
Total Field and Misc. Crops	6452	6538	6537			

**Exhibit 2: ESTIMATED LONG-TERM CORN USE FOR ETHANOL AND RESULTING PRODUCTION/USE SURPLUS (DEFICIT)**

	2003/05	2008/09	10 Optg. Plants	Acre Conversion	-----2016-----	
					Yield Trend	Seed Co. Proj.
<b>Assumptions</b>	<i>1 ethanol plant</i>	<i>7 plants (5 optg. + 2 more)</i>	<i>10 plants (7 + 3 more proposed)</i>	<i>10 plants (7 + 3 more; 40% addition to corn acres)</i>	<i>10 plants (Historic yield improvement Continues)</i>	<i>10 plants (Double gal/acre; yield in field + yield in process)</i>
<b>Ethanol Production</b>						
Gal/bu	2.7	2.7	2.7	2.7	2.7	<b>3.36</b> (.66↑)
Total (million gal)	54	459	613	613	613	<b>763</b> (150m↑)
Corn Use (million bu.)	20	170	227	227	227	227
DGS (million bu.)	7	57	76	76	76	???
DGS (tons)	217,778	1,614,667	2,146,667	2,146,667	2,146,667	???
<b>Corn Grain Production</b>						
Harvested Acres (million)*	2.0	2.2	2.2	<b>2.8</b> (0.8↑)	2.2	2.2
Yield/acre (bu)	135	138	138	138	<b>155</b> (20↑)	<b>170</b> (45↑)
Total (million bu)	270	304	304	386	341	374
<b>Corn Demand</b>						
Livestock/other (m bu)**	81	73 ***	73 ***	73 ***	73 ***	73 ***
Ethanol (million bu)	20	170	227	227	227	227
Total (million bu)	101	243	300	300	300	300
Corn Surplus (Deficit)**** (mil. bu)	<b>169</b>	<b>61</b>	<b>4</b>	<b>86</b>	<b>41</b>	<b>74</b>
DGS uncommitted <sup>†</sup> (million bu)		49	68	68	68	???

\*After 2003/05, corn acres are permanently expanded 200,000 acres by conversion from other crops.

\*\*Livestock numbers are assumed to remain unchanged.

\*\*\*Limited replacement of corn with DGS in livestock ration at 10%.

\*\*\*\*Historically, surpluses have been exported out of the state. Significant declines in the surpluses can cause significant adjustments in all sources of demand as each source bids for corn supply. Neither ethanol nor in-state livestock can be assured to displace export (even though the exhibit assumes this).

<sup>†</sup>DGS produced less amount assumed to replace corn in livestock ration.

<sup>††</sup>DGS production with new varieties may vary substantially from current rates of production. No attempt is made is estimate the change.

**Exhibit 3: Assumed Ethanol Production and Corn Use by Ethanol Plant Location**

Ethanol Plant Location	Ethanol Production (million gal/yr)	Corn Use (million bu)	Corn Use (running total)	Scenario Used In
Caro	54	20.0	20.0	Baseline, 5, 7 & 10 plants
Woodbury	53	19.2	39.2	5, 7 & 10 plants
Albion	58	21.0	60.2	5, 7 & 10 plants
Riga 06/07	---	12.3	72.5	5 plants for 2006/07 (7 months)
Riga 07/08	58	21.0	81.2	5, 7 & 10 plants
Marysville	55	23.1	104.3	5, 7 & 10 plants
Watervliet	58	22.3	126.6	7 & 10 plants*
Ithaca	121	43.2	169.8	7 & 10 plants*
Alma	50	19.0	188.8	10 plants*
McBain	50	19.0	207.8	10 plants*
Manistee	50	19.0	226.8	10 plants*

\*A doubling of the Riga plant may substitute in the 7 or 10 plant scenarios for one of the other plants if that plant is not pursued. If all these plants and the Riga expansion occur, the 10 plant scenarios in Exhibit 2 would underestimate the corn use for ethanol because the corn use would be equivalent to an 11 plant scenario. This quasi-11 plant scenario was not estimated in the analysis.

**Exhibit 4:**

**Michigan Corn Yield / Harvested Acre (1970-2006)**  
 Historical Trend vs. Optimistic Trend

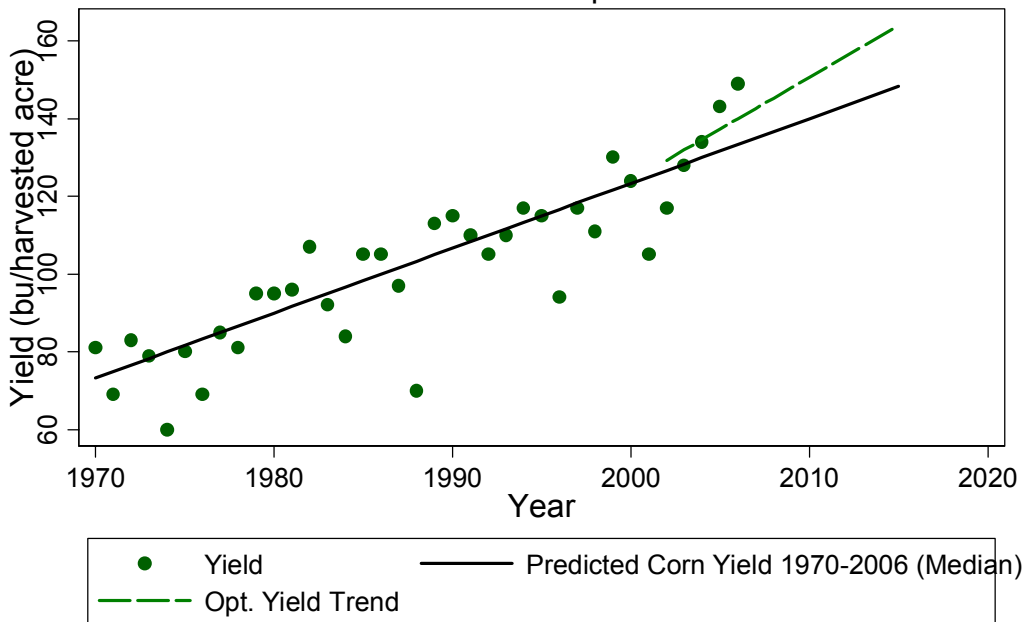




Exhibit 5: Corn Flow from Michigan to the U.S. and Canada

