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by

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Minnesota Ethanol Production
And It's Transportation Requirements

Executive Summary

The official goal of the State of Minnesota is to produce 220 million gallons of ethanol (10% of motor fuel used). This goal is reenforced by a State producer subsidy of 20 cents per gallon up to 200 million gallons per year for 10 years and legislation requiring all motor fuel to be oxygenated after 10/1/96. This goal will probably be surpassed although the current high corn prices and low ethanol and dried distillers grains with solubles (DDGS) prices make financing new plants very difficult at the present time.

Today there are six ethanol plants in Minnesota, with a total production capacity of 65 million gallons per year. Most of these plants are small scale operations with annual production capacities of less than 15 million gallons. In addition there are three more plants, with a total production capacity of 32 million gallons per year, scheduled to begin operating in early 1996. There are fifteen additional communities that have expressed interest in starting ethanol production. These represent a total additional production capacity of more than 250 million gallons per year. Government incentives (in the form of tax breaks, federal and state gasoline standards, direct subsides) have been the main engine to increase US production of ethanol. Because the Minnesota expansion is only possible with the 20 cent per gallon per year subsidy for 200 million gallons, it is unlikely that the goal of 220 million gallons will be exceeded by a large amount.

There is an abundant supply of corn in Minnesota to meet the demand to produce ethanol. Minnesota corn production has averaged more than 700 million bushels in the last five years. The 40 million bushels required by the ethanol industry in 1996 mean that less corn will be shipped out of state. Currently most Minnesota corn is shipped in unit trains to the west coast to serve the export markets in the Pacific Rim, or by rail or rail-barge to the Gulf ports for export. The ethanol industry future expansion will be competing for this "export" corn.

Most existing plants are owned by cooperatives. The farmer-members buy shares or "rights" to deliver corn to the plants. In the future it is expected that less than 20% of the farmers will deliver directly to the plant. Many will contract with a local elevator to deliver corn for them. All corn is currently transported to the ethanol plant by truck. The initial haul from farm-to-elevator-to-ethanol-plant or farm-to-plant will not change the miles hauled on rural roads, although routes might change. There is little or no change anticipated in local road maintenance due to ethanol plant locations. Every bushel of corn processed into ethanol is one less bushel that will leave the state by long distance

movement (rail or rail-barge, or truck-barge) reducing long distance equipment needs and infrastructure capacity and maintenance requirements.

Every bushel of corn processed yields 1/3 of the weight as ethanol, 1/3 as DDGS, and 1/3 of the weight in CO_2 . Most of the CO_2 will not be captured as the scale of plants are too small to support the required equipment. The CO_2 that is processed will move by truck to local markets. Currently all Minnesota ethanol is shipped by truck with 50% of the production sold instate and 50% out of state. Some plants have or will have the capacity to ship by rail. Ethanol truck movement impacts on road congestion and maintenance will not be noticeable. Currently ethanol is shipped to pipeline terminals in Mankato, Roseville, Iowa and Wisconsin. It appears that the ethanol haul to the Twin Cities is done at night to avoid rush hour and daytime traffic. The dominance of Archer Daniel Midland (ADM) in the Twin Cities market has forced local producers to seek out of state markets. The monopoly (oligopoly) power of ADM in the ethanol industry will allow it to keep a 50% market share in Minnesota. The small producers recognize their market vulnerability. Local market share may change as Minnesota ethanol production increases. The DDGS byproduct is currently moving by single rail car to feedlots in the US southeast and southwest. This pattern will continue unless the ethanol plants become very closely involved in feeding the DDGS nearby which would require a short haul over local roads by truck. Less than 15% of the DDGS is consumed in Minnesota. Because DDGS is a more concentrated feed and Minnesota is a feed surplus state, most of the DDGS will be shipped out in one to three railcar shipments to national and international markets rather than in unit trains or barges. The Minnesota ethanol industry expansion is not expected to generate large intra state rail movements. However, short distant truck movements will increase. The existing infrastructure can support these movements.

Other ethanol industry factors that need to be considered and followed include; inefficient plant sizes, gas tax impacts, current producer losses due to corn prices, changing feedstock and energy balance. The economies of size in ethanol production continue beyond a 60 million gallons per year plant size, but the current state program encourages small and relatively inefficient plants. The U.S. Federal gas tax breaks are good until 1999 but changes or extensions need to be watched. Corn prices above $3.00 are certain to cause losses for the typical Minnesota ethanol producer. Recent advances in ethanol conversion and farm production efficiency has changed the net energy balance of corn ethanol so it is now slightly positive. Research continues in the development of microorganisms to convert biomass feedstock into ethanol.

Glossary

Dry Corn Mill Plant- The dry mill process grinds the corn to a flour and the entire product goes through the fermentation procedure where the starch is converted into ethanol. After the ethanol is distilled off, the remainder is dried and sold as a product called *Dried Distillers Grains with solubles (DDGS*, 30% protein feed). Dry mill plants are lower cost than a wet mill plant. The plants opening in Minnesota in 1995-96 are dry mill plants.

Wet Corn Mill Plant - The wet mill process soaks the corn kernels until the components are able to be separated mechanically. The germ is removed for corn oil. The starch is removed for industrial for food uses or converted into sweeteners or ethanol. The remaining *corn gluten meal* (60% protein) and *corn gluten feed* (21% protein) are sold on the protein feed market. The plant in Marshall, MN is a wet mill plant.

Damaged or Off-grade Corn - The ethanol yield in a dry mill plant from a bushel of corn is not significantly reduced even though the corn is damaged. The use of badly damaged corn will lower the value of the DDGS (*Dried Distillers Grains with Solubles*) and will effect the price that is paid for the damaged corn.

Source: Minnesota Dept of Agriculture

MINNESOTA ETHANOL PRODUCTION AND ITS TRANSPORTATION REQUIREMENTS

This report examines the ethanol industry in Minnesota. Ethanol production, demand and sites of production are examined along with initial investment costs of the ethanol industry. The availability of locally produced corn for the ethanol industry in Minnesota is calculated by subtracting county corn feed requirements from production. Finally, the historical corn, ethanol, ethanol by-products movements are analyzed in order to determine future requirements of these products.

Traditionally Minnesota has shipped about two-thirds of its corn production, the state's largest crop, into national and international markets as grain. Development of an ethanol industry in Minnesota has been viewed as a way to increase farmer income by offering marketing alternatives for their corn, and to stimulate economic development in local communities with additional capital invested for the construction of plants, and to increase employment in rural communities.

The ethanol industry in Minnesota is relatively new. In 1987, the state's total production was less than one million gallons per year. In 1990, the state's total production was only 15 million gallons per year. Ethanol demand in Minnesota has always been greater than the supply. Minnesota users have been importing ethanol from other states in order to satisfy demand.

The state of Minnesota has been very supportive of the ethanol industry. As early as 1980, the legislature established a four cent per gallon tax exemption for blenders of ethanol. Since then, the state has taken a number of actions, promoting and encouraging production and use of ethanol, including funding for advertisements. Currently there is a state subsidy of 20 cents a gallon for eligible ethanol producers.

Ethanol production in Minnesota reached 65 million gallons in 1994, whereas total state consumption for that same year was 137 million gallons, resulting in a state deficit of a little over 70 million gallons a year. The state's current goal is to increase ethanol production to 200-220 million gallons by 1997. Gasohol, a mixture of gasoline containing 10% ethanol, is expected to have replaced most gasoline sales in Minnesota by the same year.

Producers receive a subsidy of 20 cents per gallon for ethanol produced for up to 15 million gallons a year. This payment, will continue until the year 2010 or for ten years after a plant is built, whichever is first. Currently state payments to ethanol producers cannot exceed $30 million per year, and no producer can receive more than $3 million a year.

The law's main requirement is that ethanol is produced in Minnesota. Every eligible ethanol producer in Minnesota receives payment regardless of where they acquire corn or other feedstocks or where they market their product.

Currently, there are six ethanol plants operating in Minnesota with a total annual capacity of about 65 million gallons (Table 1). The Kraft operation in Melrose is producing ethanol from whey by-products, from cheese production, and has not been included in this study. In addition, three plants have broken ground in Benson, Buffalo Lake and Claremont which expect to start production in 1996. These plants will have a combined annual production capacity of 32 million gallons per year. When these three plants come on-line in early 1996, combined with the incremental expansion at existing plants, Minnesota ethanol production will be approximately 100 million gallons per year (mgy). Figure 1 shows the location of the currently operating plants and their production capacity. All plants producing ethanol from corn in Minnesota are cooperatives, with the exception of the plant in Morris (Stevens County) owned by a large farm supply firm based in Milwaukee.

The Marshall plant, located in Lyon County, with a production capacity of 36 mgy, is the largest operating plant in Minnesota and has been operating since the early 1980s. Furthermore, it is the only wet-milling process plant in Minnesota. This operation started as a corn sweetener production plant, and later added ethanol production. They have the ability to switch between products according to market needs. In addition, a wider range of by-products gives the wet-milling operation a great advantage over dry milling plants that can only produce ethanol, regardless of ethanol price

Ethanol plants in Minnesota

◯ **Currently operating, mgy.**

☐ **Scheduled to start operating in early 1996, mgy.**

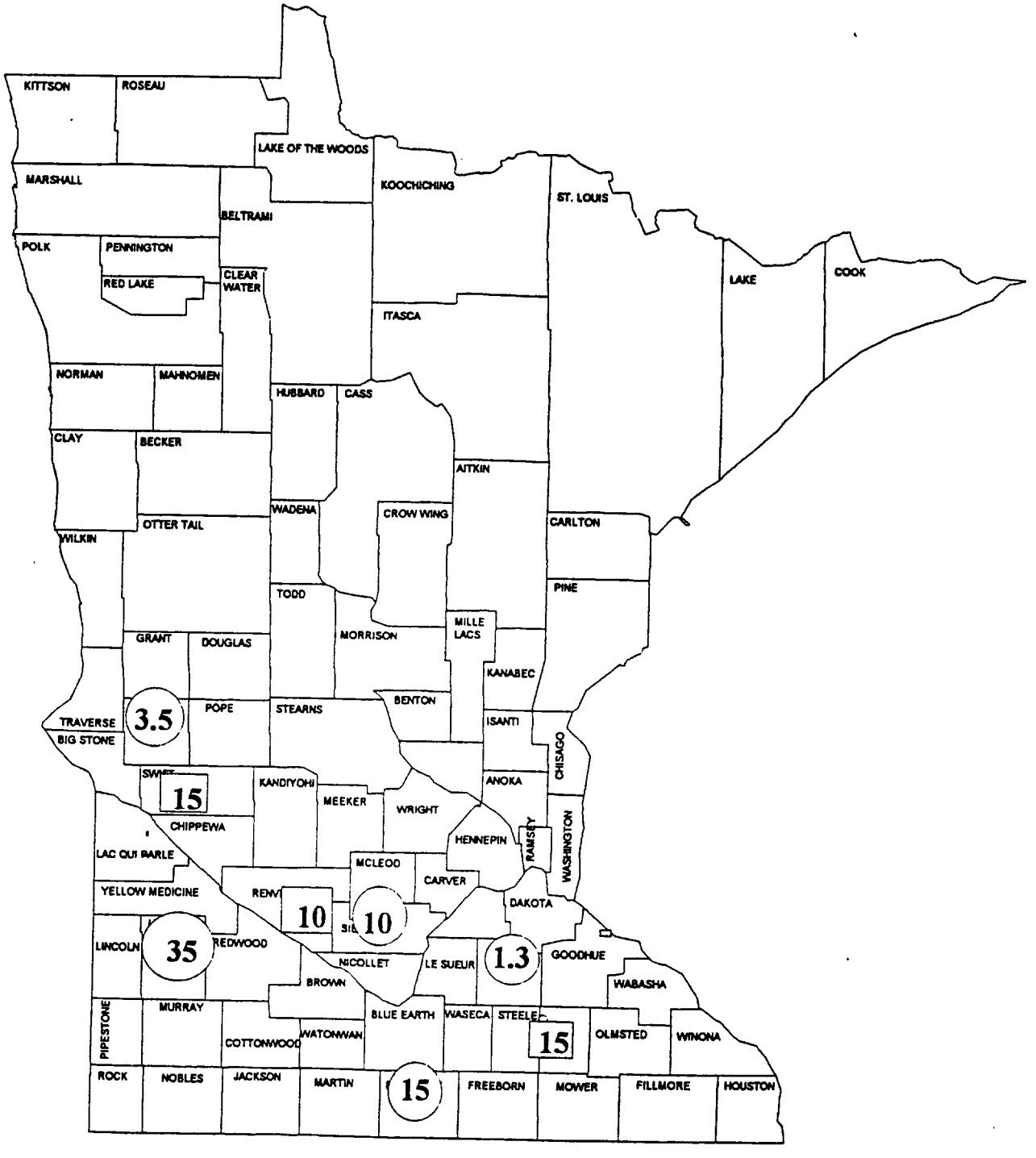


Table 1

Minnesota Ethanol Production Facilities and Capacity, 1995

Name	City	Start-Up	Capacity (mgy)	Type
Minnesota Corn Processors	Marshall	Operational	26.0	Co-op
Morris Ag Energy	Morris	Operational	3.5	Private
Kraft Ethanol	Melrose	Operational	1.4	Private
Minnesota Clean Fuels	Dundas	Operational	1.3	Private
Corn Plus Co-op	Winnebago	Operational	15.0	Co-op
Heartland Corn Products	Winthrop	Operational	10.0	Co-op
Chippewa Valley Co-op	Benson	January 1996	15.0	Co-op
All Corn	Buffalo Lake	April 1996	10.0	Co-op
Minnesota Energy	Claremont	April 1996	8.0	Co-op
Source: Minnesota Department of Agriculture, Marketing Division.				

The remaining plants are small-scale dry-milling process plants, with production capacities ranging from 1.5 to 15 million gallons a year. Their primary by-product is DDGS (Distillers Dried Grain Solubles) which is used as cattle feed. The Winthrop plant (Sibley County) is the only operation that captures and markets CO_2 as a by-product.

In addition to the existing plants and those with planned start-up dates in 1996, fifteen more communities listed on Table 2 (also see Figure 2) have expressed interest in starting ethanol production in Minnesota. Some of the communities have obtained partial financing for their projects while others are in the very first stages of developing their plans. All of the proposed plants, with the exception of the operations in Freeborn County, are small plants with operating capacities of 15 mgy or less.

Table 2. Proposed Plants in Minnesota

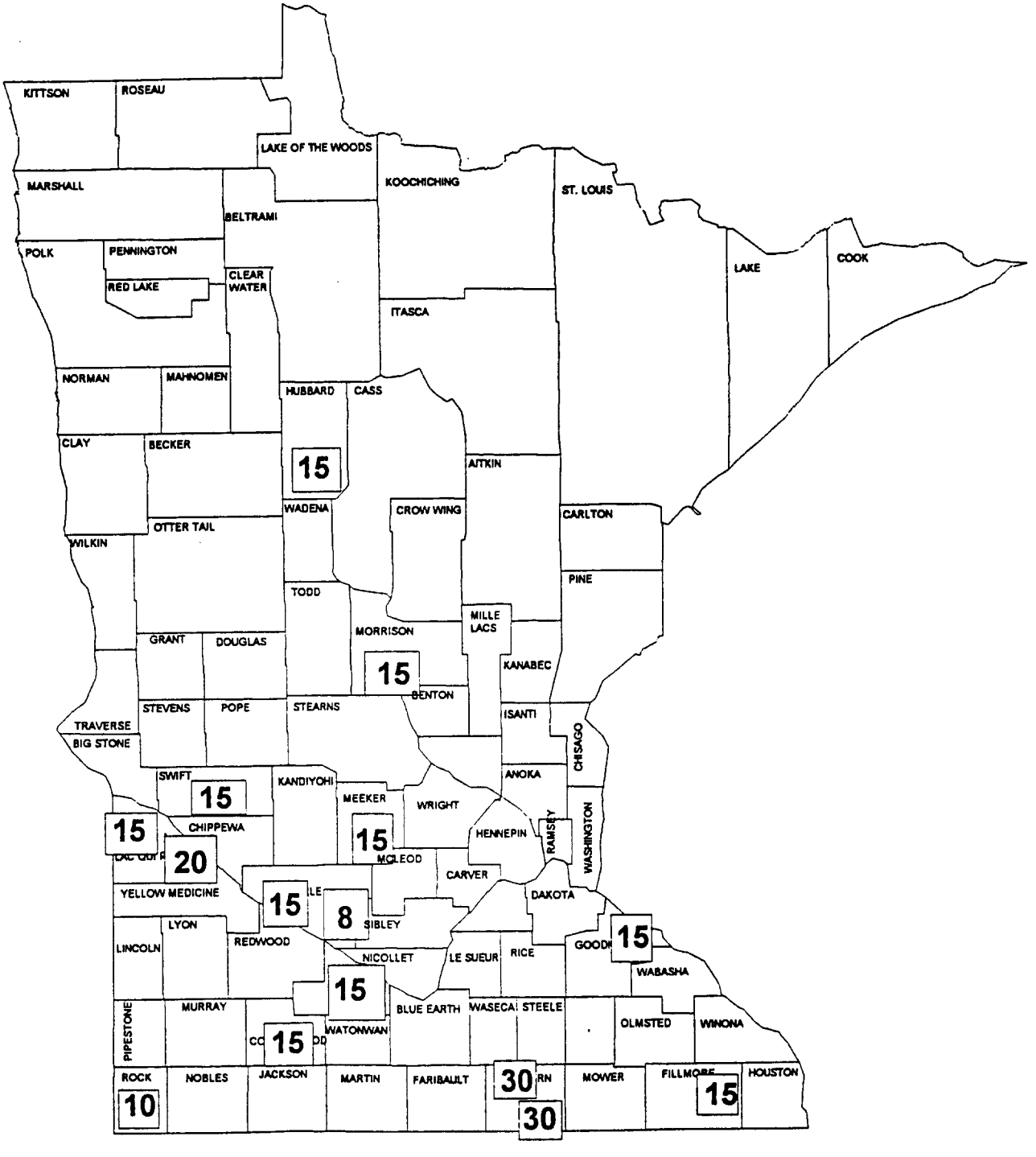
	Location	County	Capacity (Mgy)
1.	Albert Lea	Freeborn	30
2.	Glenville	Freeborn	30
3.	Dawson	Lac qui Parle	20
4.	Red Wing	Goodhue	15
5.	Sleepy Eye	Brown	15
6.	Renville	Renville	15
7.	Olivia	Renville	15
8.	Rushford	Fillmore	15
9.	Madison	Lac qui Parle	15
10.	Park Rapids*	Hubbard	15
11.	Little Falls	Morrison	15
12.	Appleton	Swift	15
13.	Litchfield	Meeker	15
14.	Windom	Cottonwood	15
15.	Luvern	Rock	10
	Total		**255**

*The Hubbard operation also plans to use potato waste to produce ethanol.

The information on the above table was provided by Larry Johnson, Director of the Marketing Division of the Minnesota Department of Agriculture.

As previously noted, individual producers can get a maximum of $3 million per year subsidy, which is an incentive to build plants at 15 mgy producing capacity. (The current producer's subsidy is 20 cents per gallon.) At the current level of state subsidy, each co-op will receive total subsidies over 10 years equal to its capital plant investment (a 15 million gallon dry milling operation, would cost approximately $30 million

Proposed ethanol plants, million gallons per year



to build). If completed, the proposed plants (Table 2) will have a combined production capacity of more than 250 million gallons of ethanol per year.

According to the Marketing Division of Minnesota Department of Agriculture, the state's goal of 200 million gallons per year of ethanol production will be reached by 1997. This goal can be reached with the addition of only two new plants each with a total production capacity of 15 million gallons per year. This projection assumes major expansions of some of the current ethanol plants including those starting operation in early 1996.

Table 3 shows the changes in ethanol production, ethanol demand and imports, and the Minnesota corn requirements of the ethanol industry in Minnesota.

Costs and financing are the main reasons behind the decision to build dry-milling plants rather than wet-milling operations. Currently a wet-milling facility in the 10-15 mgy capacity range would cost twice as much to build as a dry-milling plant.

According to the management of ethanol plants, it would have been impossible to raise the money needed to build wet-milling plants. It appears that ethanol plants in Minnesota have been building their facilities at very reasonable costs. According to people surveyed for this study, the cost of building a dry-milling plant in Minnesota is on average a little less than $2.00 per gallon of production capacity.

Some ethanol operations have been able to reduce their initial investment costs by installing used equipment. Used equipment does not decrease efficiency since the technology of producing ethanol has not changed significantly in the last few years. A reduction of initial investment is an important factor for these operations for two reasons: first, it is easier for co-ops to convince their members to invest in an ethanol plant, and second, in the ethanol industry even a small decrease in production costs can make a difference.

Table 3

Changes in Production, Ethanol Demand and Imports, and Corn Requirements of the Ethanol Industry in Minnesota

	Jan. 1994	June 1995	June 1996	All New*	Total**
MN Ethanol Production (mgy)	42.2	67.2	100	255	355
Ethanol Imports (mgy)	56.8	69.2	85	-	-
Ethanol Consumption (mgy)	99	136	185	210	210
MN Corn Requirements (M bu./yr.)	16.9	26.8	40	102	142

*Plants listed in Table 3.2.

**Projected if all proposed plants come to operation. Does not include expansions of existing plants after June 1996.

Source: Contains information obtained from the marketing Division of the Minnesota Department of Agriculture.

The privately owned plant in Morris moved an existing plants equipment that produced ethanol in the eighties but went out of business. The firm moved the ethanol operation from Illinois to Minnesota because of the state's subsidy. The manager of this plant estimated the cost of expanding at less than 80 cents per gallon.

The technology of producing ethanol does not vary much between plants. Consequently the key to financial success is good management decisions, controlling energy costs, acquiring corn at low prices, and ethanol and DDGS marketing procedures.

Most Minnesota ethanol plants are owned by cooperatives whose shareholder are comprised of farmers and other agricultural co-ops that may hold shares in an ethanol plant. The method of acquiring corn is similar for all co-op owned ethanol operations. Shares are sold with one share generally equal to one bushel of corn. Farmers are responsible for providing a contracted amount of corn to the plant. The minimum number of shares that each farmer-member must buy is generally between 5,000 and 6,000. Farmers in Minnesota have been purchasing their shares for $2.00 - $2.50 each. Discussion with plant managers indicated that very few farmers will deliver more than 10% of their total corn production to ethanol plants.

Most farmer members live within 50 miles of the ethanol plants. Farmers are allowed to deliver their own corn, or contract with local elevators. All plants visited for this study have arrangements with one or more elevators to provide or assist farmers with corn deliveries. Farmers have to deliver their corn in three delivery periods determined by the individual ethanol operation.

The price farmers receive for their corn is based on the local elevator price during each four-month delivery period. Typically they will receive 80% of the estimated corn price at or shortly after delivery, with the rest paid to them later. Many farmers contract with local elevators to deliver their corn. It is expected that this practice will continue in the future, and eventually less than 20% of farmers will be delivering corn directly to the plants. Farmers that continue to deliver corn will generally be located within a 25 mile radius.

All corn is transported to the plants by truck. Quantities needed by the smaller scale operations do no exceed ten to twelve truck shipments per day. (A 15 million gallon per year plant needs about 12,000 bushels of corn per day.) It is cheaper to have a continuous in-flow of corn shipments than to have corn storage facilities.

Some co-ops give farmers a freight allowance transportation of corn to the plant. For example, the Winnebago plant pays an averages allowance of 5 cents per bushel, but can be as high as 13 cents a bushel.

The Winthrop plant has a freight allowance of 4 cents minimum for less than 4 miles and a maximum freight allowance of 10 cents for over 50 miles. The Buffalo Lake operation does not plan to offer a freight allowance to its members for corn delivery. The Buffalo Lake plant is located next to an elevator, therefore corn can be moved to the ethanol plant by an expansion of the elevator legs and distribution system. The Morris plant (Swift County) buys corn from three local elevators. In order to manage their cost, corn is bought both on contract and the spot market.

Currently all ethanol produced is moving out by truck. Some plants have or will have the capacity to ship ethanol by rail. Quantity and final destination are the most important factors that determined the mode of transportation. Larger operations in other states tend to ship long-distance by rail or barge. Availability of rail transportation is important because it increases marketing opportunities for ethanol producers.

Not all ethanol produced in Minnesota is sold in-state because the market is dominated by large firms like ADM and Cargill. Large firms can capture economies of scale in production of ethanol, as well as marketing and transportation. For example, ADM, ships ethanol to the Twin Cities market by owned or leased railcars from Nebraska at a lower cost than some local producers can ship by truck. Consequently, ADM controls more than 50% of the Twin Cities ethanol market. Ethanol produced in Minnesota is currently shipped to pipeline terminals in Mankato and Roseville, and to Iowa, Wisconsin and North Dakota.

The operation in Morris, owned by a large farm supply firm in Milwaukee, is marketing ethanol for a number of producers including Cargill and the operations in Winnebago and Winthrop. There is price competition in the wholesale ethanol market. Marketing the product often requires arrangements in regional and national markets. Local ethanol producers feel that further efforts must be made to expand their markets. A possible way of accomplishing this is to market their product collectively.

The majority (85% plus) of the by-product of DDGS is sold nationwide. The remainder is consumed in Minnesota and is best suited for cattle and dairy cows, but the plants currently operating in Minnesota are not located in counties with large numbers of dairy cattle. Because the local market is not developed, local

ethanol producers have to sell DDGS in the regional and national markets. The availability of rail facilities is very important because DDGS is easily transported long-distance by rail.

Most facilities have a 7 to 10 day DDGS storage capacity that allows them some flexibility to market the product. Normally the product is sold before storage capacity is reached. The operation in Morris has only 2-3 days of DDGS storage capacity, resulting in lower capital and operational costs compared to the other plants in the survey.

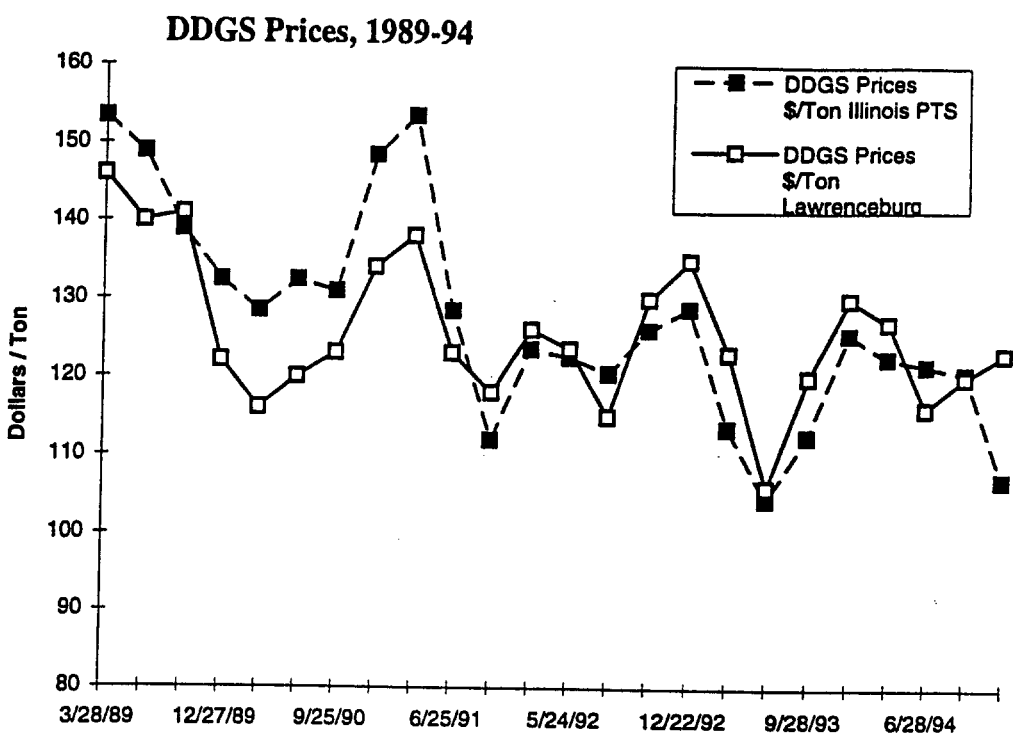
Winthrop is the only facility marketing CO_2 (to local soft drink manufacturers). The cost of equipment needed to capture CO_2 is between \$1.5 and \$2.0 million for a 15 million gallon capacity plant. At Winthrop, this investment was made by an industrial gas business which is responsible for maintaining the equipment, picking-up and marketing the product as well as paying a fee for the CO_2.

Industry people generally believe, it is not economically profitable to invest in equipment to capture CO_2 unless ethanol production capacity exceeds 15 mgy. Currently, none of the plants scheduled to start operating in 1996 plans to capture CO_2, although it is an option in the future.

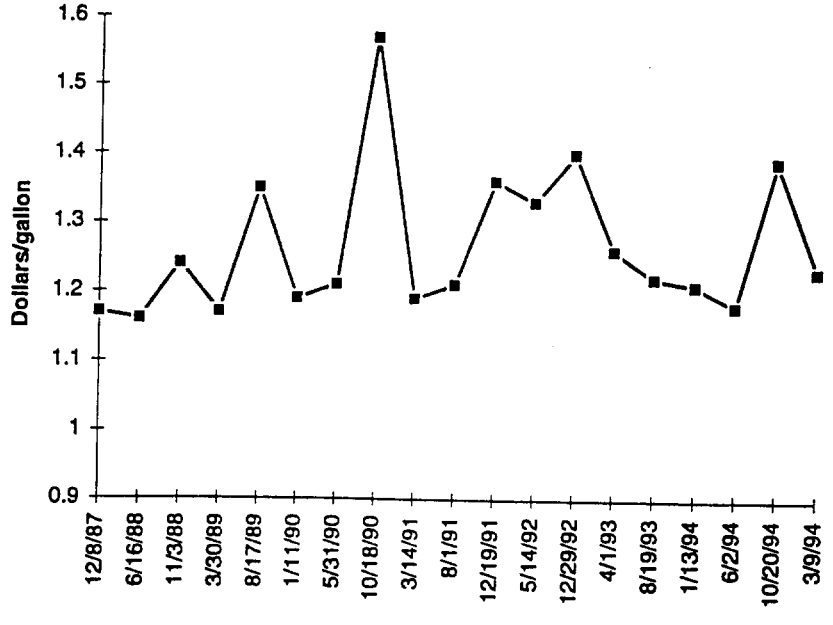
Ethanol prices in the Twin Cities market have experienced the same volatility as at the national market. Prices between 1987 and 1994 have ranged from less than \$1.15 per gallon in December of 1987 to \$1.05 in November of 1994, reaching a high of \$1.55 per gallon during the Gulf War in 1990.

Prices of ethanol are now lower than any time in the last ten years. Currently, Minnesota producers receive \$1.02 - \$1.04 per gallon; some Minnesota producers are losing money. (The tables on the next page were calculated from various issues of *Oxy-Fuel News*.) The price volatility of ethanol and the corn market cause some industry analysts to argue that ethanol could never replace gasoline as a dependable energy source as long as ethanol prices do not show more stability in the future. However, industry experts expect ethanol prices to be more stable once a state law goes into effect which require fuels to contain at least 2.6% oxygen. After October of 1995, gasoline retailers in the ten-county Twin Cities metro area will be required to sell oxygenated fuel. The minimum oxygen content will take effect statewide by 1997. Ethanol made from corn contains 37% oxygen and is expected to be the major fuel blended into gasoline in the Midwest.

DDGS and ethanol prices



Twin Cities ethanol prices 1987-94 ($/gallon)



The marketing division of the Minnesota Department of Agriculture estimates this law will increase the state's ethanol demand by 50 to 75 million gallons per year in addition to the current 135 million gallons per year. They expect by 1997 ethanol (in gasohol) will replace 10% of gasoline consumed in the state.

Historically ethanol has been sold on the spot market. Today ethanol is sold directly to refineries, gasoline chains, or jobbers from storage. The operation in Winthrop hires an ethanol marketer and as noted earlier, the operation in Morris is marketing ethanol for other co-ops. However, there are opportunities for further cooperation among the state's ethanol producers to capture some of the benefits that large producers like ADM have. Most of these operations are not located far from each other, which increases the possibility of more cooperation in the marketing of ethanol among Minnesota producers.

The price of DDGS has been declining since 1989 due to an increase in supply and declining exports (See previous page for prices which were calculated from issues of *Grain and Feed Market News)* According to the Minnesota Department of Agriculture, considerable efficiencies can be achieved by selling DDGS at 30% moisture because it lowers drying costs. However, the shelf life of this product is only three days, therefore, it has to be sold and used locally. None of the plants currently operating in Minnesota sells DDGS at 30% moisture largely because they are not located in large dairy counties.

Roughly 50% of the capital needed for the construction of the ethanol plants in Minnesota comes from farmer equity. The rest are loans, some from the Bank for Co-ops. Most of the plants currently operating have taken seven-year bank loans to finance their construction. It seems that the banking community wants the loans repaid before the 10-year state subsidy period ends.

The plant in Morris, as noted earlier, seems to be an exception. It is a privately-owned company that has been expanding its production capacity since 1989, with plans to continue expanding to a production capacity of 10 mgy. The cost of expanding their operation is less than $1 per gallon of production capacity, a relatively low figure for a plant this size. The case of the Morris plant demonstrates that good management decisions, and low investment costs can make a small ethanol plant profitable. Furthermore, the use of used

equipment can be a determining factor of success for a small operator in an industry that currently faces negative cash flow.

It appears that a decision to start an ethanol plant in Minnesota is not based on economic criteria. Community pride and local jobs, in addition to the 20 cents per gallon subsidy are the major incentives behind construction of new plants. As noted earlier in this report, the total state subsidy at current levels over 10 years will equal the initial capital investment of approximately $30 million for a 15 mgy ethanol plant. It remains to be seen if the ethanol industry in Minnesota will expand as rapidly as projected. Future corn prices and state subsidies will be the main factors influencing the expansion of the industry in Minnesota.

Ethanol plants should have easy access to corn year around in order to maintain constant production. Operating costs will increase with the distance to available corn. In order to determine availability of locally produced corn to the Minnesota ethanol industry, corn feed requirements by county were subtracted from corn supply. Minnesota has on average a total corn production of over 710 million bushels per year.

After feed corn requirements are met, the state has a surplus of close to 485 million bushels per year (Table 4). The ethanol industry is currently using close to 41 million bushels of corn per year. In the future, if all proposed plants come into production, the total demand for corn used in ethanol production will be 142 million bushels, or close to 20% of the total corn production. After the corn feed requirements are met and total corn demand of current and future plants are subtracted from the state's total production, Minnesota still has over 340 million bushels of corn, which is marketed to the national and international markets. The findings of this analysis are summarized in Table 4.

Table 4: Net county balance, after rail shipments, feed, and ethanol (existing and proposed) demands are met

County Number	Name	Corn Surplus/Deficit after feed demand Bushels	Rail shipments (Average 1989-92) Bushels	Existing Plant demand Bushels	Net county Surplus/deficit Bushels	Proposed Plant demand Bushels	Net county Surplus/deficit Bushels
1	Becker	-2,188,441	73,813		-2,262,254		-2,262,254
2	Clay	907,853	270,575		637,278		637,278
3	Clearwater	-852,299			-852,299		-852,299
4	Kittson	-192,623			-192,623		-192,623
5	Mahnomen	-166,746			-166,746		-166,746
6	Marshall	-259,281			-259,281		-259,281
7	Norman	170,499			170,499		170,499
8	Pennington	-282,112	374,634		-656,746		-656,746
9	Polk	195,297	34,639		160,658		160,658
10	Red Lake	-139,880	66,706		-206,586		-206,586
11	Roseau	-1,161,667			-1,161,667		-1,161,667
12	Beltrami	-441,764			-441,764		-441,764
13	Cass	-450,971			-450,971		-450,971
14	Hubbard	254,439			254,439	6,000,000	-5,745,561
15	Itasca	-305,351			-305,351		-305,351
16	Koochiching	-77,308			-77,308		-77,308
17	L. of the Woods	-105,171			-105,171		-105,171
18	Cook	-1,480			-1,480		-1,480
19	Lake	-7,805			-7,805		-7,805
20	St. Louis	-506,970	3,214		-510,184		-510,184
21	Big Stone	3,772,420	415,986		3,356,434		3,356,434
22	Chippewa	11,352,473	9,641,986		1,710,487		1,710,487
23	Douglas	955,181	155,874		799,307		799,307
24	Grant	2,977,010	1,828,745		1,148,265		1,148,265
25	Lac Qui Parle	10,527,182	6,662,308		3,864,874	14,000,000	-10,135,126
26	Otter Tail	1,877,465			1,877,465		1,877,465
27	Pope	5,659,545	1,414,437		4,245,108		4,245,108
28	Stevens	7,173,434	8,329,465	3,200,000	-4,356,031		-4,356,031
29	Swift	12,701,496	19,045,893	6,000,000	-12,344,397	6,000,000	-18,344,397
30	Traverse	3,379,233			3,379,233		3,379,233

Table 4: Net county balance, after rail shipments, feed, and ethanol (existing and proposed) demands are met

County Number	Name	County corn surplus deficit after feed demand	Rail shipments (Average 1989-92) Bushels	Existing Plant demand	Net county Surplus/deficit Bushels	Proposed Plant demand	Net county Surplus/deficit Bushels
31	Wilkin	1,815,955	3,202,509		-1,386,554		-1,386,554
32	Y. Medicine	14,592,977	18,843,560		-4,250,583		-4,250,583
33	Benton	707,254			707,254		707,254
34	Carver	3,676,830			3,676,830		3,676,830
35	Kandiyohi	6,389,755	144,554		6,245,201		6,245,201
36	McLeod	6,003,197	197,869		5,805,328		5,805,328
37	Meeker	5,615,084	2,769,596		2,845,488	6,000,000	-3,154,512
38	Morrison	-1,228,225			-1,228,225	6,000,000	-7,228,225
39	Renville	21,217,880	5,758,416	3,200,000	12,259,464	12,000,000	259,464
40	Scott	2,577,456	211,760		2,365,696		2,365,696
41	Sherburne	1,566,256			1,566,256		1,566,256
42	Sibley	9,973,116		4,000,000	5,973,116		5,973,116
43	Stearns	-1,464,439	608,713		-2,073,152		-2,073,152
44	Todd	-1,737,259			-1,737,259		-1,737,259
45	Wadena	-1,350,254			-1,350,254		-1,350,254
46	Wright	3,957,147			3,957,147		3,957,147
47	Aitkin	-653,352			-653,352		-653,352
48	Anoka	755,973			755,973		755,973
49	Carlton	-443,017			-443,017		-443,017
50	Chisago	1,617,455			1,617,455		1,617,455
51	Crow Wing	-138,522			-138,522		-138,522
52	Hennepin	1,066,270	5,320,638		-4,254,368		-4,254,368
53	Isanti	2,816,373			2,816,373		2,816,373
54	Kanabec	232,754			232,754		232,754
55	Mille Lacs	410,605			410,605		410,605
56	Pine	-851,370			-851,370		-851,370
57	Ramsey	-30,177	392,596		-422,773		-422,773
58	Washington	2,398,076			2,398,076		2,398,076
59	Cottonwood	13,668,270	7,123,529		6,544,741	6,000,000	544,741
60	Jackson	15,634,709	13,735,137		1,899,572		1,899,572

Table 4: Net county balance, after rail shipments, feed, and ethanol (existing and proposed) demands are met

County Number	Name	County corn surplus deficit after feed demand	Rail shipments (Average 1989-92) Bushels	Existing Plant demand	Net county Surplus/deficit Bushels	Proposed Plant demand	Net county Surplus/deficit Bushels
61	Lincoln	5,541,447	103,238		5,438,209		5,438,209
62	Lyon	13,417,989	7,131,573	14,000,000	-7,713,584		-7,713,584
63	Murray	12,076,827			12,076,827		12,076,827
64	Nobles	14,382,826	6,700,151		7,682,675		7,682,675
65	Pipestone	7,313,064	28,393,771		-21,080,707		-21,080,707
66	Redwood	19,868,500	10,162,575		9,705,925		9,705,925
67	Rock	9,150,854	4,124,041		5,026,813	4,000,000	1,026,813
68	Blue Earth	16,859,890	178,586		16,681,304		16,681,304
69	Brown	12,098,452	4,588,226		7,510,226	6,000,000	1,510,226
70	Faribault	21,209,554	27,811,153	6,000,000	-12,601,599		-12,601,599
71	Freeborn	18,512,990	15,176,054		3,336,936	24,000,000	-20,663,064
72	Le Sueur	6,599,685			6,599,685		6,599,685
73	Martin	19,240,755	13,716,247		5,524,508		5,524,508
74	Nicollet	8,959,830			8,959,830		8,959,830
75	Rice	23,232,928		400,000	22,832,928		22,832,928
76	Steele	10,035,387	1,727,043		8,308,344		8,308,344
77	Waseca	12,235,955	2,394,963		9,840,992		9,840,992
78	Watonwan	11,656,471	9,978,793		1,677,678		1,677,678
79	Dakota	8,803,614			8,803,614		8,803,614
80	Dodge	9,430,917	2,521,090	4,000,000	2,909,827		2,909,827
81	Fillmore	11,470,376			11,470,376	6,000,000	5,470,376
82	Goodhue	9,853,565			9,853,565	6,000,000	3,853,565
83	Houston	3,900,528			3,900,528		3,900,528
84	Mower	18,039,582	1,007,129		17,032,453		17,032,453
85	Olmsted	8,519,515	1,198,213		7,321,302		7,321,302
86	Wabasha	4,289,684			4,289,684		4,289,684
87	Winina	3,746,052			3,746,052		3,746,052
	Minnesota	**484,007,672**	**243,539,998**	**40,800,000**	**199,667,674**	**102,000,000**	**97,667,674**

Next, shipments of corn, ethanol and ethanol by-products were analyzed in order to determine future transport requirements of these products.

Corn Shipments from Minnesota

About two-thirds of Minnesota's corn has traditionally left the state as grain. Corn shipments for 1989-92 were analyzed to determine historic corn movements. A four-year average was used because of large fluctuations in U.S. production and exports. The 1989-92 data give a perspective of corn movements in Minnesota before the ethanol industry started expanding. During this period an average of 245 million bushels of corn per year was shipped by rail from Minnesota. This includes intrastate movements as well as interstate and export movements.

For this analysis, percentage calculations were performed for destination states which were based on corn shipped by rail. Destination state groups are as follows:

Region 1. California, Washington, Oregon (West Coast)

Region 2. Twin Cities and river port areas (Hennepin, Ramsey, Washington, Dakota, Scott, and Winona Counties in Minnesota)

Region 3. Iowa

Region 4. Illinois and Indiana

Region 5. Duluth area (St. Louis County in Minnesota and Douglas County in Wisconsin)

Region 6. Tennessee, Alabama, Louisiana, and Missouri (South)

Region 7. Montana, South Dakota, North Dakota, and Nebraska (Near West)

Region 8. Other Minnesota

As noted earlier, an average 245 million bushels per year was moved by rail from Minnesota in the 1989-92 period. Almost 40% went to Region 1 (West Coast), and nearly 31% went to the Twin Cities or Mississippi River terminals. Region 3, Iowa, was the second largest out-of-state destination of corn, receiving approximately 17% of the total rail shipment. Region 4 received about 5% of the total corn rail shipments.

About 5% was shipped to Region 5, the Duluth area, where corn was transferred to ships on Lake Superior. Region 6, South, also received about 5%. Region 7, the Near West, received less than 1.5%. Region 8, the rest of Minnesota, received less than 1% of the total rail corn movements.

Table 5

Destinations of Minnesota Corn Shipped by Rail, 1989-92 Average

Destination	Corn Received, % of Total
Region 1	40
Region 2	31
Region 3	17
Region 4	5
Region 5	5
Region 6	1.5
Region 7	1.3
Region 8	0.6%
Source: *ICC Public Use Waybill*, Minnesota Grain Exchange, Waterborne Commerce of the U.S.	

The areas shipping the most corn are, not surprisingly, the large corn producing areas. Considerable corn movement occurs within the state as can be seen by the negative corn balances of some counties. The south central and south west Minnesota counties ship their corn mostly to Washington and Oregon where much of it is exported to Pacific Rim countries. For extreme southern Minnesota, Iowa is a major destination. For the south central and south east parts of the state, Iowa and Illinois are major destinations.

The ethanol industry currently does not generate large intra-state rail movements and is not expected to in the future. However, an increase in short-distance truck movements is expected to occur. All currently operating plants and the ones that will be operating in the near future are located in areas with a sufficient infrastructure to support these movements.

In summary, the corn shipped within Minnesota is going to counties located on the Mississippi River or Duluth-Superior. Corn shipped to the West Coast goes primarily to the ports of Portland, Oregon or Seattle and Tacoma, Washington.

The ethanol industry in Minnesota will compete with the exports of corn. We can expect a decrease of rail corn movements to the West Coast and Midwestern states. Much of the corn is shipped from the southern and western counties of Minnesota where most of the ethanol plants are located. Rail and barge shipments are expected to decrease as the proposed plants come into production.

Alcohol Shipments to Minnesota

As noted earlier in this paper, ethanol production in Minnesota is currently about 65 million gallons per year. Minnesota's ethanol demand in 1994 was approximately 135 million gallons. Because of the ADM's large market share in the Twin Cities, half of the ethanol produced in the state is sold in surrounding states. Minnesota ships in by rail, truck or barge about 70 million gallons of ethanol per year to meet the state's demand.

As ethanol production in Minnesota increases, more and more ethanol produced in Minnesota will be marketed in-state. However, that will occur only if the small ethanol producers in Minnesota succeed in capturing a larger part of the Twin Cities market currently dominated by ADM. Minnesota's law requiring the use of oxygenated fuel year round on a statewide basis after October 1997, will increase ethanol demand in the state and should increase the use of locally produced ethanol.

The future trends of ethanol shipment from Minnesota are not easy to determine. First, the volatility of ethanol prices makes it very difficult to predict what markets will offer higher prices in the future, and second, the opportunities could change if co-ops market their product collectively. Since ethanol can be transported by barge, rail, or truck, it is relatively easy to ship to national markets that offer higher prices. The fact that most ethanol plants in Minnesota are located close to each other further increases the possibility

of collective marketing. However, the operations currently in Minnesota have some disadvantages that will affect their ethanol marketing decisions in the future. They are:

a. small scale operations

b. located away from the river

c. generally not located on main-line rail roads

Ethanol By-product Shipments from Minnesota

DDGS in Minnesota has to compete with corn and soybean meal markets for feed. All current plants with exception of the Marshall plant, produce DDGS as a by-product. Currently, they market their product as far as New Mexico, Utah and Oregon as well as in nearby states. As DDGS production increases we can expect larger volumes of the product shipped out state to national or international markets.

The proposed ethanol plant in Little Falls is largely supported by local dairy farmers, because their original plan was to sell their by-product at high moisture to area dairy farmers. That option, however, is plausible when the ethanol plant is located close to dairy farms; the by-product at high moisture content has to be consumed by the animals within 3-4 days to avoid spoilage. Other possible DDGS markets are the local feedlots located in southern Minnesota. However, this will require further marketing efforts from the ethanol operations.

In conclusion, it is expected that future rail corn movements from Minnesota will decrease as local ethanol production increases. Local truck movements to ethanol plants, however, are expected to increase. In addition, as ethanol production in Minnesota increases, more locally produced ethanol is expected to be sold in the state, decreasing the quantities imported. Finally, there are local market opportunities for DDGS, especially feedlots in the southern part of the state. However, as production of DDGS increases, we will see an increase in long haul movements of the product, mainly to large dairy states.