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Minnesota Agriculture in the New Millennium

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Natural and Historical Antecedents

Minnesota is by any standard one of the leading agricultural places in the United States, both in terms of farm production and as a headquarters for some of the largest agrifood and agronomic enterprises in the world. This position is due partly to its soils, hydrology and climate, partly to its people and institutions, and partly to its location. The rich alluvial soils of southern Minnesota were pushed down from the Arctic 10,000 years ago by the last glaciers and deposited to sustain woodlands and prairies before settlement opened them in the 19th century. Once cleared (and later drained), these soils were highly suitable for crop production and grazing. Rich bottomlands along the Red, Minnesota and Upper Mississippi Rivers and their tributaries such as the Cottonwood and Crow Wing attracted early settlement. The karst geomorphology of the unglaciated Southeast left calcific soils which when cleared of trees were well suited to pasturage and dairying.

The rivers were also a mode of conveyance for agricultural surplus to points south and a source of power for both sawn timber and grain milling, notably at the Falls of St. Anthony in Minneapolis, where General Mills and Pillsbury were born. In 1870, the largest volume of grain exports from a single port was not from New Orleans or New York but Red Wing, Minnesota.[2] The Great Lakes made Duluth a favorable agricultural export platform, at first to the eastern U.S. and with the opening of the Welland Canal and Seaway in 1959, to markets in the North Atlantic.

In the early 19th century, over 200 years after the first explorations of the rivers and lakes of Minnesota by French missionaries and voyageurs, permanent settlement began. Minnesota's first settlers were mainly Canadians and Yankees, experienced in the timber and lumber trades, who sought to exploit the white pine resources

of the Upper Mississippi and St. Croix watersheds, establishing the first territorial settlement at Stillwater. Within a few years, before and after the Civil War, a steady flow of immigrant farmers from Germany, Norway, Sweden and the British Isles began to filter into the state. Many had come from farms in the Old World, and their communities could be distinguished by the architectural and linguistic traces of their homelands. These people put high stock in the value of education by supporting local schools and the Land Grant institution of the University of Minnesota. Founded in 1851, it closed during the Civil War and reopened in 1867 with the support of John Sargent Pillsbury. While Governor, Pillsbury helped it receive land grant status under the Morrill Land Grant Act of 1862. By the turn of the 19th century the U of M was one of the preeminent schools of agriculture in the world, a position that it retains today.

In rough terms, Minnesota can be divided into five agro-ecological zones. In the Northwest, the Red River flows toward Lake Winnipeg and ultimately Hudson's Bay. In its alluvial plain heavy soils are especially suited for potato and sugar beet production, resulting in major processing facilities in Moorhead and Renville. Further south, across a divide where water drains to the Mississippi, lies an area of former prairie and oak savanna where corn and soybeans are grown and cattle and beef are raised. In Willmar, due largely to the efforts of early entrepreneurs such as Earl Olson, a turkey industry has made Minnesota the number one producer of the birds in the nation. In the driftless (non-glaciated) Southeast, from Rochester to the Mississippi and south to the Iowa border, lies the picturesque, rolling country that is the historic center of Minnesota's dairy industry. Many small creameries there and throughout Minnesota formed the Minnesota Cooperative Creamery Association in 1921, which changed its name in 1924 to market its new sweet cream butter, becoming Land O'Lakes. The cooperative, now the nation's second largest, holds a dominant position in the U.S. butter market, but has expanded into many other agricultural enterprises, employing over 6,000 people. The northwoods, stretching from 30-40 miles east of Fergus Falls, north to the Canadian border and east to the Arrowhead and Lake Superior, was the land excoriated by the glaciers, where pine timber dominated. At the southern reach of these pineries, lands cut over for timber were planted to grain until the thin soils gave out and they reverted to pasture and annual grasses such as rye and legumes such as alfalfa. Finally, in the area to the immediate south and west of the Twin Cities was a region of hardwood forests (the "Big Woods") that became mixed farms serving nearby urban markets. In 2002, the leading agricultural

counties ranked according to percent of total state farm receipts were Stearns, Renville, Martin, Kandiyohi and Redwood, which together accounted for about 16 percent of Minnesota's total agricultural product value in that year of $8.6 billion dollars.

The Present State

These natural and historical antecedents help to define the more recent characteristics of Minnesota agriculture. Most of Minnesota agriculture is in rural areas, but rural areas are not exclusively agricultural. In 1980, of the roughly 4 million people living in Minnesota, 33 percent lived in these rural areas. By 1990, Minnesota's population had grown to 4.4 million, of which 28 percent were rural. In 2000, of 4.9 million people, 28 percent remained rural. Latest estimates for 2004 indicate a population total of 5.1 million of which 27.5 percent were rural.[3] It thus appears that the rural proportion of Minnesota has stabilized just above a quarter of the total. Not all of these people live on farms, although many are employed in businesses that depend directly or indirectly on production agriculture. In the mid-1980s, a study conducted for the U.S. Senate's Governmental Affairs Committee estimated that a $1,000 increase in income for commercial farmers, other things equal, produced about a $120 increase in income in the rural consumer goods sector.[4] Even after the farm economy emerged from the financial crisis of the 1980s, rural incomes continued to trail urban averages. In 2003, Minnesota's rural population earned an average of $27,828, while urban dwellers earned an average of $45,845. Even so, the poverty rate in rural areas fell from 13.5 percent in 1989 to 8.9 percent by 2002. Unemployment in 2004 was 5.1 percent in rural areas, compared to 4.5 in urban Minnesota.[5]

Although non-farm employment in rural areas is significant, it is not surprising that jobs of Minnesotans are twice as likely to be in farming or farm-related activities in rural areas. While 24 percent of rural Minnesotans work in farming or related jobs, 12.5 percent of urban dwellers have agriculturally based jobs. Yet, only 2.9 percent of all Minnesotans work directly in production agriculture as active farmers. A much higher percentage, 9.8 percent, work in wholesale and retail businesses that are agriculturally based, including agricultural cooperatives such as Cenex Harvest States (CHS) or Northrup King Seeds (a subsidiary of Swiss-based multinational Syngenta), both of which are headquartered in the Twin Cities.

In general, the rural population of the state is less well educated than urban residents. In 1980 about 38 percent of both rural and urban dwellers had no education beyond high school. By 2000, 35

percent of rural Minnesota had finished only high school, while the percent in urban areas dropped to 26 percent. Those completing college in rural areas rose from 11 percent in 1980 to 17 percent in 2000, but in urban areas the percentage rose from 21 percent to 32 percent.

Minnesota's rural and urban land base totals about 51 million acres, of which farmland comprised 27.5 million acres in 2002, or 54 percent of the total. Of this agricultural land, 22.7 million acres (82.6 percent), was in crops and the remainder in woodlots, pasture, or other uses. The average farm size was 340 acres, although most profitable commercial farms were larger. Farms from one to 500 acres accounted for 81 percent of the total, while the remaining 19 percent of farms were larger than 500 acres, especially in Southern and Southwest Minnesota. Sixty-seven percent of all Minnesota farms had less than $50,000 in sales, and 48 percent had less than $10,000 in sales. Substantial crop and livestock operations with sales from $50,000 to $100,000 accounted for about 10 percent of the total, but commercial sales were concentrated in the $100,000-$500,000 sales bracket, with 18.5 percent of the total, while 4.5 percent of Minnesota farms sold more than $500,000 in product.[6]

The majority of Minnesota farms are fully owned (63.5 percent in 2002), although many farmers, especially large land operators, rent land (30 percent in 2002). Only about 7 percent of Minnesota's farmers are tenants. Contrary to some popular myths, very few farms in Minnesota are owned and operated by corporations. In 2002, fully 90 percent of Minnesota farms were held by individuals as sole proprietors, another 3 percent as family-held corporations, and only two-tenths of one percent as non-family corporations, with one-half of one percent held by cooperatives, estates or trusts. The average age of Minnesota's farmers is 53, and 63 percent list farming as their primary occupation. Of the 80,000 Minnesota farms in 2004, only 6,370 were managed primarily by women, although this statistic seriously understates the role of women in the farm family.

Net farm income in 2004 was at record levels, as good yields combined with relatively favorable prices and ample government crop subsidies for many Minnesota farms. Net farm income rose from $1.6 billion in 2003 to $2.6 billion in 2004. Farm debt in 2003 was $10 billion, compared to asset values of $57 billion. These values result from production of a number of commodities which together place Minnesota seventh in state farm production in the nation. In 2003, the largest share of farm receipts came from Minnesota corn, accounting for nearly 20 percent of total receipts ($1.7 billion), equal to 9 percent of the nation's total production value. Close behind was

soybeans, with 18.5 percent of total state receipts ($1.6 billion), or 10 percent of the nation's total value. The next three commodities in order of value were hogs, dairy products and cattle and calves. Hog receipts were $1.3 billion, accounting for 15 percent of the state's total and 12 percent of national totals. Dairy products' receipts were $1.0 billion, 12 percent of the state total and about 5 percent of national dairy production value. Cattle and calves' receipts were $989 million, 12 percent of the state total and 2.2 percent of the national total. The remaining 12 percent of state receipts were mainly accounted for by wheat, poultry, sugar beets and small grain and oilseed production.

One of the key features of Minnesota agriculture is that the state's 80,000 farms produce substantially more agricultural product than its 5 million people can consume, putting it on an export footing in relation to the nation and the world. Although located at the virtual center of the North American land mass, the Mississippi River and Great Lakes connect Minnesota to world agricultural markets in ways vital to Minnesota farmers. By one estimate, the cost to transport a bushel of corn by truck from Mankato to Port Cargill on the Minnesota River at Shakopee is about equal to the barge transport cost from the elevator at Shakopee to the Port of New Orleans. From there, the cost is about the same to move the corn from the Gulf to the Port of Rotterdam.

In 2004 Minnesota ranked third in the nation in exports of soybeans and soybean products (oil, meal, cake); these exports were valued in 2004 at $878 million. The state ranked fourth in the nation in feed grain and product exports (mainly corn); these exports were worth $718 million in 2004. Wheat was the state's third most important export, placing Minnesota sixth in the nation with a value of $213 million. Minnesota also exported substantial quantities of fresh and processed vegetables, such as peas, potatoes and beans, ranking fourth in the nation and accounting for $257 million in value in 2004. The final category of exports in which Minnesota plays a leading role, and the primary means by which Minnesota's feed grains and oilseeds are converted to add value, is live animals and meat, in which category (excluding poultry) Minnesota ranked sixth in the nation, with $250 million in market value in 2004. Taken as a whole, Minnesota ranked seventh among the states in agricultural exports, which in the categories mentioned accounted for $2.9 billion in value in 2004.[7]

In short, farming in Minnesota is generally a profitable enterprise, and has become more so in each of the last four years. In 2001, average net farm income in Minnesota was $36,406. It rose to $46,944 in 2002, $59,205 in 2003 and $74,391 in 2004. This is well

above per-capita incomes for the state as a whole, and in 2004 was nearly three times the state average per-capita income of all rural residents.[8] A significant part of this income resulted from direct government payments to farmers through the commodity price support programs of the U.S. Department of Agriculture. In 2004, the average Minnesota farm received payments of $24,231 from the U.S. government, almost exactly a third of the average per-capita farm income of $74,391.

Given the strong performance of Minnesota agriculture in 2004 (granting that cyclicity in crop and livestock prices and rising fuel costs make doubtful that future years will be as profitable), it is curious that many farmers and non-farmers alike wax nostalgic over what the family farm was like in the past. The Minnesota Extension Service has compared farm returns and costs of living in the 1950s and 1970s with those of today.[9] In the 1950s in south central Minnesota the average farm was 190 acres and generally more diversified than today, raising 20 sows, 12 milk cows, and planting corn, soybeans, cutting corn for silage and alfalfa hay for the cows. If the total income derived from this 1950s farm is adjusted and updated to 2004, it equals $16,429. This compares to average farm household expenses in 2004 of $56,073 assuming the household is debt free and pays no taxes. Hence a 1950s farm would leave an average farm family today $39,643 in the red, necessitating off-farm employment of 40 hours per week at an average wage of $20 per hour to make up the shortfall. If the same exercise is performed for an average farm in south central Minnesota in 1974, when average farm size had risen to 261 acres, with 23 sows and 25 milk cows, the adjusted net income is still only $22,935, which is $33,137 short of farm household expenses in 2004. In this case, full-time off-farm employment at a wage between $16-$18 per hour would be necessary to meet family living expenses. These exercises illustrate why farms that resemble those of the past struggle to survive, and why so many farm families must seek off-farm employment in order to meet household needs.

One of the most vexing problems facing the farm sector of Minnesota is that good returns and generous government payments are relatively quickly reflected in farm land values, bidding up the costs of entry for younger and beginning farmers. This places a premium on low levels of farm debt, encourages renting rather than purchase of land and tends to push the average age of farmers upward. In 2000, the average per-acre values of farmland and buildings in Minnesota was $1,280. In 2001 this rose to $1,360, in 2002 to $1,450 and in 2003 to $1,550, an increase of 6.9 percent from

2002-2003 alone.[10] While this may seem like a good thing to those already owning farm land, the costs associated with this process of "capitalization" have negative long-term implications for the capacity of Minnesota farmers to compete with exporting countries, such as Brazil and Argentina, where land prices are much lower.

Future Trends

Several factors are likely to affect the future of Minnesota agriculture in the 21st century. First, the state is likely to remain a center of agribusiness activity and is emerging as a leader in the development of new technologies based in genomics and renewable fuels. Second, Minnesota agriculture will remain highly dependent on global markets and thus has a major stake in world trade. Third, domestic farm and fiscal policies will determine the extent to which the state continues to receive federal payments to farmers, who also depend on the overall health of the economy. Finally, the rising cost of fossil-fuel based energy has major implications for Minnesota farmers' costs for fuel, fertilizer and transport. Together, these four factors describe an environment that will challenge Minnesota agriculture in the years to come.

Because Minnesota has a long history as an agricultural center, it has produced or attracted hundreds of agricultural and food companies. These range from giants like Cargill (the largest privately held firm of any kind in the world), to food companies such as General Mills, Pillsbury and International Multifoods. As noted above, it is also home to major cooperatives, such as Land O'Lakes and Cenex Harvest States, as well as seed companies such as Northrup King and Beta. Hundreds of smaller firms work alongside these large ones, providing an important part of Minnesota's employment base. In order to attract a well-trained work force these companies rely heavily on the University of Minnesota and the Minnesota State Colleges and Universities (MnSCU). To the extent that the state underinvests in these post-secondary institutions, it will cause employers to seek young talent from elsewhere.

Among the spin-offs from this concentration of agrifood activities are new investments in emerging agricultural technologies. Two areas of technology development are likely to be of especial importance to Minnesota agriculture in the years ahead. The first, generally known as "biotechnology," is really a branch of genomics, the application of genetic knowledge and information to the development of new plant varieties and uses.

Although the first 20 years of biotech research clustered on the East and West Coasts (especially in the biopharmaceutical

sector), plant and agricultural biotechnology may find a niche in the Upper Midwest, notably in Minnesota and Wisconsin.[11] In May, 2003, the University of Minnesota opened a $20 million, 64,000-square-foot Microbial and Plant Genomics building, the first of its kind at a public university. Less than a year earlier, the University opened an $80 million, 260,000-square-foot Molecular and Cellular Biology building. Already a global leader in biosciences research, the University of Minnesota is expanding the breadth and depth of its work in genomics-based plant and animal science. Apart from transgenic crops, which are having major impacts at the farm level (to be discussed below), markets for "functional" foods, "nutraceuticals" and new industrial uses for plants are emerging that may create numerous opportunities for Minnesota farmers. Cargill and Dow Chemical formed a joint venture, for example, to make plastic out of genetically engineered corn in a process developed by a newly graduated University of Minnesota Ph.D. working at Cargill. The plastic biodegrades to organic compost after use.

The number of agricultural biotech patents held by firms and universities in Minnesota and Wisconsin also suggests their leadership. In a 2003 article, University of Wisconsin-Madison economists found that the University of Wisconsin led the nation in agricultural biotech patents, while the University of Minnesota was eighth. As they noted, ag-biotech has its greatest impact in areas around major research universities such as the Twin Cities and Madison, and "local business spillovers seem to take place where universities happen to be located in the same state as major agribusiness companies."[12] The Federal Reserve Bank of Minneapolis, although noting that biotech innovation may not always yield local payoffs, nonetheless described "Cargill, General Mills and Land O'Lakes" as "just a few of the likely catch basins inside the district."[13]

At the farm level, the Minnesota impact of plant biotech's first generation of traits (herbicide resistant corn and soybeans and insect resistant corn) has been dramatic. Since the introduction of commercial transgenic varieties of corn and soybeans in 1996, farm-level adoption in Minnesota has continued unabated. By 2003, the U.S. Department of Agriculture reported that 53 percent of Minnesota corn acres were planted to biotech varieties, compared to 40 percent in the nation as a whole. In 2004, the proportion of biotech corn varieties in Minnesota rose to 57 percent, compared with 46 percent in the nation as a whole. In soybeans, Minnesota planted 79 percent of its soybean acres to biotech varieties in 2003 and 83 percent to them in 2004. This compared to 81 percent of national

soybean acres in biotech varieties in 2003 and 86 percent in 2004.[14]

The second major area of technology in which Minnesota agriculture is increasingly invested is the renewable fuels sector. There is a bridge from plant biotech to renewable fuel due to the development of transgenic varieties of corn specifically adapted to ethanol production. Ethanol from corn and biodiesel made from soybean oil are both technologies which will benefit from biotech innovation and will find markets more easily as the price of petroleum-based fuels continues to rise. However, the impact of higher energy costs on farmers in Minnesota (discussed below) will probably overwhelm the benefits of increased markets for renewables, at least in the near term.

Even so, Minnesota has been aggressive in mandating the use and supporting the manufacture of ethanol and soy biodiesel. Ethanol production technology, until recently, involved the extraction of alcohol from corn slurry or other biomass in a process not unlike a giant whiskey still. In the last several years, however, significant steps forward have increased efficiency and lowered the costs of production.[15] In January 2005 a new process for breaking plant cellulose into sugars (which are in turn fermented to make ethanol) was announced by two California companies who were already producing enzymes for weathering blue jeans. Using genetic engineering techniques, the companies found that they could reduce the cost of producing the key enzymes to 20 cents per gallon of ethanol. This compared to a prohibitive $5.40 per gallon as recently as 2000. Lee R. Lynd of Dartmouth College has developed a combined-step ethanol process that could reduce costs even more.[16] At the University of Wisconsin, George Huber and others are developing methods to derive biodiesel from cellulose sugars instead of the usual fractioning process from soybean or sunflower oil or waste grease. The most optimistic assessment, by the Natural Resources Defense Council, concluded that ethanol and biodiesel fuels, coupled with improved vehicle efficiency, could meet all the transportation fuel needs of the United States by 2050.[17]

The implications of these technological developments for Minnesota agriculture are significant. The U.S. Department of Agriculture estimated that 12 percent of the U.S. corn crop (1,370 million bushels) was required to produce 3.7 billion gallons of ethanol in 2005. By 2007, 20 percent of the crop (2,222 million bushels) will be required to produce a projected 6.0 billion gallons. Each billion gallons of ethanol requires 2.5-3.0 million acres of corn. As a major corn producing state, Minnesota will contribute a disproportionate share of this total.[18]

The Minnesota Department of Agriculture reported in early 2005 that in 2004 Minnesota produced 400 million gallons of ethanol at 14 plant locations throughout the state, from Luverne and Albert Lea to Morris and Little Falls. The Department estimated that the ethanol industry generated 5,300 jobs. Minnesota produced about 10 percent of the nation's total ethanol, placing it fifth behind Illinois, Iowa, South Dakota and Nebraska.[19]

In addition to ethanol, biodiesel fuels have been advanced aggressively in Minnesota. Available in Europe for over 40 years, biodiesel in Minnesota was promoted in 2002 by a legislative mandate calling for all diesel fuel sold in the state to contain 2 percent biodiesel so long as 8 million gallons of capacity had been installed by 2005. This made Minnesota the first state to mandate its use.[20] As of late 2005, plants had been established at Redwood Falls, Albert Lea and Brewster, with a combined capacity of 63 million gallons. Its impact will be primarily on soybeans, since much of it will be derived from soybean oil. The Minnesota Department of Agriculture estimated that the increased demand for soybean oil under the mandate would be 92 million pounds, equivalent to 8.5 million bushels of soybeans. Apart from its impact on the soybean market, biodiesel can also utilize (at lower cost than soybean oil) wastes from the fast food industry, specifically brown grease and inedible tallow and yellow grease. The Energy Information Administration estimated that in 2005-06, the costs of producing diesel fuel from soybean oil were $2.49 per gallon in 2002 dollars, compared to $1.39 per gallon for yellow grease. Together, waste greases accounted for 7,156 million pounds of available feedstock to make biodiesel in 2004 compared with 4,572 million pounds of soybean oil.[21]

A second factor that will determine the future of Minnesota agriculture is trade and competition with the rest of the world, as well as ongoing negotiations in the Doha Round of world trade talks. As described earlier, Minnesota is a leading exporter of its surplus production, and therefore depends on robust demand in the rest of the world to maintain farm incomes at home. If costs of production in Minnesota exceed those of exporting nations such as Argentina, Brazil and Canada, Minnesota's competitiveness will depend on maintaining higher levels of farm productivity, resulting from investments in science and technology. Moreover, growth in demand from other countries for Minnesota grains and livestock means that our farmers have a stake in their economic prosperity.

A central element defining opportunities in world markets for Minnesota farmers is the ongoing multinational trade negotiations

in agriculture, part of the larger Doha Round of trade talks. In 2002, and again in July 2005, the U.S. put forward a negotiating position saying that it was prepared to make significant reforms in domestic agricultural policies in exchange for increases in access to export markets abroad.[22] This position, even a watered-down version of it, would result in cuts to the domestic subsidies received by Minnesota farmers. As discussed above, even in 2004, with farm incomes at record levels, average government subsidy payments accounted for an average of one-third of net Minnesota farm income. In years with weaker market conditions, cuts to the subsidy component of farm income might reduce net returns by 10-20 percent or even more. In particular, sugar producers and the dairy industry would be likely to see cuts.[23] In addition, the tariffs and quotas that are used to protect the U.S. sugar, dairy and beef producers would likely be reduced. This would put added pressure on Minnesota producers.

A third and closely related factor will be the shape of 2007 farm legislation, as well as the overall health of the U.S. economy. Due in part to the U.S. trade negotiating position, but even more to huge U.S. budget deficits made worse by hurricane Katrina and the (off-budget) obligations of war in Iraq and Afghanistan, there will be pressure to cut farm subsidies under the new farm bill. How large these cuts will be is essentially a political, not an economic question. More broadly, however, U.S. budget deficits will put upward pressure on interest rates. Agriculture is highly sensitive to the cost of credit. Both seasonally and over longer periods, farmers must borrow substantial sums to finance their operations. Hence, any upward pressure on interest rates will increase Minnesota farm costs and reduce margins.

A fourth area that will define Minnesota's agricultural future is energy use. Even before the run-up in fuel prices in the wake of hurricane Katrina, these prices were pinching Minnesota farmers' bottom line. In a widely cited study, oil industry analysts concluded in early 2004 that global totals of available reserves of oil had probably peaked and would head downward over the next century.[24]

Reflecting these expectations, as well as bottlenecks in refinery capacity and natural gas production, both crude oil and fuel prices began rising dramatically in 2004. Crude oil prices rose from $35 per barrel in June 2004 to $68 per barrel in August 2005, and moved above $70 per barrel in the fall of 2005. Natural gas, a major feedstock for nitrogen fertilizer as well as feed ingredient methionine, rose from $5.25 per mmbtn in March 2004 to over $9.75 in August 2005 and even further after Katrina interrupted refinery capacity in the Gulf. The result: higher fuel and fertilizer prices.

These prices are affecting everyone, but they hit farmers especially hard because of the number and size of their gasoline and diesel-powered vehicles, their harvesting and tillage equipment, grain dryers, dependence on truck transport, and their annual need for fertilizers. In April 2005, farm energy prices were estimated by two North Dakota State researchers at $18-$22 per acre. But from May 2005 to August, gasoline and diesel prices rose from $1.80 and $1.43 per gallon to $2.68 and $2.23 per gallon. The result was to almost double the share of fuel prices as a percentage of farm expenses from in the range of 5-10 percent to 10-20 percent. Fertilizer prices increased by about 75 percent.[25] The impact on farm incomes in Minnesota will be dramatic, although the full effect will not be felt until 2006, because many farmers contract forward for fuel and fertilizer. If predictions that we have entered a new era of higher energy costs prove accurate, it will pressure Minnesota farmers to find ways to conserve energy by using it more efficiently and perhaps restrict applications of nitrogen fertilizer, reducing yields.

Conclusions

Minnesota has a long and impressive tradition of agricultural production and productivity (at least by New World standards). From its frontier beginnings in the mid-19th century, it has emerged as a center of agricultural research, production, and business activity. It is currently a world leader in biotechnology and renewable plant-based fuels. To maintain this position, however, it will need to sustain and expand investments in technical capacity and the human skills necessary to stay at the edge of the life sciences frontier. This will not come on the cheap, for either the public or private sector. In the face of global competition, subsidy reductions, economic weakness, and rising energy costs, maintaining Minnesota's agricultural productivity is more important than ever.

Endnotes

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