

The Future of Corn Production in the Upper Midwest

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Take Home Message

When compared to other countries, the U.S. has a comparative advantage for producing corn, while other countries such as Brazil and Argentina can obtain soybean yields similar to the U.S. If corn acres increase at the expense of soybean in the U.S., states with high corn-to-soybean yield ratios such as Minnesota, South Dakota, North Dakota, Kansas, Kentucky, and Missouri would likely see the biggest shift in acreage. In addition, increases in corn grain yield over the past 40 years have generally been greatest in the Upper Midwest. A 3-year corn-corn-soybean rotation would accommodate more corn acres, and this crop rotation would likely increase soybean yield compared to the 2-year corn-soybean rotation and have better corn yields than continuous corn. Corn silage yield has also increased over the past 40 years in the U.S., but the rate of increase has been much slower than that observed for grain. This is because improvements in corn silage yield have accompanied improvements in silage quality. For both corn grain and silage, hybrid selection will remain a key decision for growers.

Overview

Corn and soybean are the dominant crops in the Upper Midwest of the U.S. In addition, corn grain and silage, co-products from the processing of corn grain for ethanol, and soybean meal are important sources of livestock feed in this region. The objectives of this paper are to consider trends in the yields of these crops, as this will affect future shifts in crop acreage, along with the availability and price of different types of livestock feed.

Global Corn and Soybean Production

The U.S. produces more corn and soybean than any other country in the world, but will this hold in the future? During the last two years, the U.S. harvested an average of 80.5 million acres of corn (Table 1). This was 6% more than China, and nearly equal to that of Brazil, India, the European Union, and Argentina combined. The majority of the corn acreage in the U.S. occurs within the Corn Belt, located east to west from Ohio to Nebraska and south to north from Missouri to the Canadian border. The U.S. Corn Belt is the largest area in the world with warm days and cool nights, fertile soils with good water holding capacity, and abundant precipitation that is relatively evenly distributed during the growing season. The average corn yield over the last two years was 159 bushels/acre in the U.S., which was 30 to 45% greater than that in Argentina and the European Union, 92 to 134% greater than that in China and Brazil, and 354% greater than that in India (Table 2).

In comparison, there was an average of 76.5 million acres of soybean harvested in the U.S. over last two years (Table 1). Although this is 30 and 66% greater than that for Brazil and Argentina, respectively, average soybean yield in the U.S. over the last two years was 2% lower than that in

Brazil and 5% higher than that in Argentina. Based on yield alone, these results indicate that the U.S. has a comparative advantage over other countries for corn production, but not over Brazil and Argentina for soybean production.

Table 1. Corn and soybean acreage and production for selected countries from 2008-2011. Data from USDA-National Agricultural Statistics Service.

Country	Acres harvested for grain, 2009/10 and 2010/11 average		Grain yield, 2009/10 and 2010/11 average	
	Corn	Soybean	Corn	Soybean
	----- million acres -----		----- bushels/acre -----	
United States	80.5	76.5	159	43.7
China	78.6	22.2	83	25.0
Brazil	32.4	58.9	68	44.8
India	20.9	23.5	35	15.1
European Union	20.5	1.0	110	41.5
Argentina	7.3	46.0	122	41.6

U.S. Corn Grain and Soybean Production

Table 2 lists corn and soybean production information for all states in the U.S. with over one million acres of corn planted annually from 2008 to 2010. While this table includes 16 states, over 55% of the total corn acres planted in the U.S. from 2008 to 2010 occurred in Iowa, Illinois, Nebraska, Minnesota, and Indiana. These same states also led the country in planted soybean acres. From 2008 to 2010, the ratio of corn/soybean yield ranged from 3.2 to 3.6 for most states. However, Minnesota, North Dakota, South Dakota, Kansas, and Kentucky had ratios of 3.7 to 4.2. These states with the high corn-to-soybean yield ratios are on the edges of the Corn Belt and had low soybean yields in 2008 to 2010, most likely due to cooler and/or drier growing conditions.

From 1971 to 2010 for the states listed in Table 2, corn grain yield increased by 1.3 to 5.0% per acre/year (average of 2.2%), and was greatest (>2.6% per acre/year) in the northern states of South Dakota, North Dakota, Minnesota, and Michigan. The rate of yield increase in corn from 1971 to 2000 averaged 1.3 times greater than that for soybean. When corn and soybean yields in the year 2030 were predicted assuming a continuation of the same rate of yield increase that occurred over the last 40 years, Minnesota, North Dakota, South Dakota, Kansas, and Kentucky still had the highest corn-to-soybean yield ratios (>3.7), but Missouri was also added to this list. Based on yield alone, these five states are expected to have the greatest comparative advantage for corn over soybean in the future.

The crop yield and acreage information in Table 1 suggest that in the future, the U.S. may need to specialize more in corn production, while counties such as Argentina and Brazil may need to specialize more in soybean production. If corn production is to increase at the expense of soybean in the U.S., states that are expected to have high corn-to-soybean yield ratios in the future (Minnesota, South Dakota, North Dakota, Kansas, Kentucky, and Missouri) would likely see the biggest shift in acreage.

If corn acres are increased at the expense of soybean, there will be an increase in the acreage of corn planted after corn. Although grain yield with corn after corn is typically 5 to 15% less than that

corn after soybean, this yield loss can be minimized if growers select high-yielding and well-drained fields for corn-on-corn, and if they include soybean at some point in the crop rotation. One option would be a corn-corn-soybean rotation rather than continuous corn. For example, over 12 site-years in northern and central Illinois from 2004 to 2007, continuous corn yielded 10% less than corn planted after soybean in a 2-year corn-soybean rotation or a 3-year corn-corn-soybean rotation (Nafziger, 2009). However, second-year corn in the 3-year corn-corn-soybean rotation yielded only 7% less than corn in the 2-year corn-soybean rotation. Furthermore, soybean in the corn-corn-soybean rotation yielded 6% more than soybean in the 2-year corn-soybean rotation.

Table 2. U.S. corn and soybean acreage and production for states with greater than one million acres annually planted to corn from 2008-2010. Data from USDA-National Agricultural Statistics Service.

State	Acres planted, 2008-2010 average		Grain yield, 2008-2010 average		Grain yield increase from 1971-2010		Predicted grain yield in 2030, assuming the 1971-2010 rate of yield increase	
	Corn	Soybean	Corn	Soybean ¹	Corn	Soybean ²	Corn	Soybean ¹
	--- 1,000 acres ---		--- bushels/acre ---		--- %/acre/year ---		--- bushels/acre ---	
Iowa	13,430	9,720	173	49.5 (3.5)	2.1	1.4 (1.5)	213	59.3 (3.6)
Illinois	12,230	9,230	170	48.2 (3.5)	1.7	1.3 (1.3)	202	56.1 (3.6)
Nebraska	9,030	4,950	169	51.2 (3.3)	2.3	2.5 (0.9)	204	61.8 (3.3)
Minnesota	7,670	7,220	172	41.0 (4.2)	2.9	1.8 (1.6)	215	51.1 (4.2)
Indiana	5,730	5,420	163	47.5 (3.4)	1.7	1.4 (1.3)	194	58.2 (3.3)
S. Dakota	4,770	4,180	140	38.0 (3.7)	5.0	1.7 (2.9)	176	44.2 (4.0)
Kansas	4,270	3,770	138	37.8 (3.7)	1.3	1.9 (0.7)	169	42.9 (3.9)
Wisconsin	3,850	1,630	151	41.8 (3.6)	1.7	1.9 (0.9)	181	53.6 (3.4)
Ohio	3,370	4,550	157	44.3 (3.5)	1.9	1.4 (1.4)	188	53.6 (3.5)
Missouri	2,980	5,230	140	41.0 (3.4)	2.0	1.5 (1.3)	176	47.4 (3.7)
Michigan	2,380	1,980	145	40.2 (3.6)	2.6	2.1 (1.2)	177	50.4 (3.5)
N. Dakota	2,180	3,930	124	30.7 (4.0)	3.2	2.7 (1.2)	160	41.4 (3.9)
Pennsylvania	1,350	460	135	42.7 (3.2)	1.6	1.4 (1.1)	148	50.4 (2.9)
Kentucky	1,260	1,410	142	38.8 (3.7)	2.2	1.2 (1.8)	174	46.9 (3.7)
Colorado	1,230	---	147	---	1.4	---	179	---
New York	1,070	260	143	45.7 (3.1)	2.1	2.5 (0.8)	158	53.7 (2.9)

¹ Corn/soybean yield ratio in parentheses.

² Corn/soybean ratio for the rate of yield increase from 1971-2000.

According to the University of Minnesota FINBIN farm financial database, corn in southern Minnesota from 2008 to 2010 yielded 2 to 4 bushels/acre more when planted after soybean than corn. During these years, net return averaged \$17/acre and \$56/acre more for corn than soybean in 2008 and 2010, but \$44/acre less in 2009. Averaged over all three years, net return was \$157/acre for corn after soybean, \$151/acre for corn after corn, and \$145/acre for soybean after corn. Thus, overall net return for a grower with a 2-year corn-soybean rotation would have been equal to that for a grower with continuous corn.

Table 3. Corn and soybean yield and net return in southern Minnesota from 2008-2010. Data from the University of Minnesota FINBIN farm financial database.

Crop and rotation	Number of fields/year	Crop yield			Net return		
		2008	2009	2010	2008	2009	2010
		----- bushels/acre -----			----- dollars/acre -----		
Corn after soybean	878 - 950	175	191	188	143	66	262
Corn after corn	353 - 378	173	187	185	145	67	241
Soybean after corn	1,164 - 1,369	45.2	48.8	51.6	127	111	196

U.S. Corn Silage Production

From 2008 to 2010, corn silage represented 1 to 8% of the planted corn acres for the states listed in Table 4, with the exception of Michigan (11%), Wisconsin (21%), Pennsylvania (31%), and New York (43%). Although silage yield has increased since 1971, the rate of increase has only been 0.3 to 2.3% per acre/year (average of 1.0%). This rate of increase was only 10 to 80% (average of 40%) as large as that for grain. Thus, it is expected that future increases in corn silage yield will continue at a much lower rate than the increases in corn grain yield. Future improvements in corn silage are expected to deal largely with silage quality (digestibility and milk/ton) in addition to silage yield. Thus, hybrid selection will continue to be one of the most important agronomic decisions for corn silage producers.

Table 4. U.S. corn silage production for states with greater than one million acres annually planted to corn from 2008-2010. Data from USDA-National Agricultural Statistics Service.

State	Percentage of total corn acres harvested for silage, 2008-2010 average	Corn silage yield, 2008-2010 average	Corn silage yield increase from 1971-2010
	----- % -----	----- tons/acre -----	----- %/acre/year ¹ -----
Iowa	2	21.3	1.2 (0.6)
Illinois	1	18.0	0.4 (0.2)
Nebraska	2	17.8	0.7 (0.3)
Minnesota	5	18.7	1.4 (0.5)
Indiana	2	20.3	0.9 (0.5)
S. Dakota	6	13.8	1.9 (0.4)
Kansas	4	16.6	0.4 (0.3)
Wisconsin	21	17.5	1.4 (0.8)
Ohio	4	18.0	0.7 (0.4)
Missouri	2	15.0	0.7 (0.4)
Michigan	11	16.8	0.9 (0.3)
N. Dakota	8	12.0	2.3 (0.7)
Pennsylvania	31	18.7	0.7 (0.4)
Kentucky	6	18.0	0.3 (0.1)
Colorado	8	23.2	0.5 (0.4)
New York	43	19.0	1.1 (0.5)

¹ Corn silage yield/grain yield ratio for the rate of yield increase from 1971-2000.

References

- Nafziger, E.D. 2009. Cropping systems. p. 49-63. In: E.D. Nafziger (ed.) Illinois Agronomy Handbook. 24th ed. Univ. of Illinois, Urbana.

Notes
