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# Where will the corn come from?

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## Where will the corn come from?

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The recent boom in ethanol production and the planned expansion could significantly shift the demand for corn. One of the major questions is how high the market price for corn will have to rise to pull enough acres out of other crops and into corn to satisfy this new demand.

The total number of acres planted to the principal crops (corn, wheat, oats and hay) in Iowa has been relatively constant over the past 70 years. In 1930, there were 21,969,000 acres planted and in 2006 there were 24,625,000 acres. This is an increase of approximately 12 percent. The highest number of acres planted to the principal crops occurred in 1980, when there were 26,610,000 acres planted. The fewest number of acres planted occurred in 1940, when there were 20,381,000 acres.

The composition of those planted acres has changed dramatically. In 1930, corn occupied approximately half the planted acres (52%), oats almost a third (29%) and all hay 15%. The remainder of the acres was divided among the other crops (soybeans represented less than 1%). By 1970, corn still represented almost half the acres (48%), but oats had dropped to 12% and soybeans had increased to 26% of the acres. In 2005, corn still occupied almost half the planted acres (51%), but soybeans represented 41% and all hay 6%. Corn acres have consistently accounted for almost half the acres planted in Iowa for many decades, even with all the changes that have occurred.

Corn and soybeans, in 2005, occupied 92% of the crop land acres and the division between the two crops was 56 percent corn versus 44 percent soybeans.

The percentage of acres in corn and soybeans has been increasing over the past several decades. Also, there has been a move towards a more equal division between the two crops.

Ethanol and the new demand for corn could change this pattern in Iowa. Corn based ethanol and the possibility for using corn

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stover for cellulosic ethanol provides a new market outlet for corn. This new demand raises several interesting prospects for Iowa agriculture. Corn has never accounted for more than 55 percent (in 1976) of the planted acres in the past 75 years. The acres devoted to corn and soybeans have been moving closer together over the past several years. These facts raise several questions: how high will the market price will have to go to attract the corn acres(?); are there enough acres for all the corn in Iowa(?); and what will be the impacts of significant increases in corn prices on other sectors of the economy?

### Rotation Studies

Many factors go into a farmer's decision regarding what crop to grow or which rotation to follow. One of the primary considerations is the relative profitability. We have undertaken a study examining the relative profitability of alternative rotations for Iowa farmers. This article presents a broad overview of the initial phases of this work.

Iowa State University has conducted a number of rotation-fertility studies on the Experiment Station farms. These studies involve several different possible rotations and, usually, four levels of nitrogen use. We will discuss four rotations from the Iowa State University Northeast Research farm; continuous corn (CC), corn/soybeans (CS), corn-corn-soybeans (CCS), and corn-corn-corn-soybeans (CCCS). There are other rotations, but for our purposes these are the only ones we examined. All the rotations were repeated using four different levels of nitrogen fertilizer; 0, 80, 160, and 240 pounds per acre. The nitrogen was applied as urea and it was only applied to the corn. For a complete description of the

Northeast project see Mallarino, Ortiz-Torres and Peckinovsky, ISRF04-13. (This report is available on the Web at <http://www.ag.iastate.edu/farms/reports04.html>)

Table 1 shows the average yields for 1985 to 2005 and for 2000 to 2005 based on the rotation and nitrogen level. The two different time periods were used to show: (1) a longer time period, which would include more variable weather; and (2) the recent history, which shows both favorable weather and the improvements in varieties. This table reveals some interesting observations that should be considered as the farmer thinks about changing rotations.

The table shows the response to nitrogen and the impact of the rotations on yields. Notice for any given crop in the rotation, the yields increase as the N increases but, at a decreasing rate.

Table 1 also shows the rotational effect on corn yields. This effect has been documented elsewhere and is evident from Table 1. As part of this study we are examining the rotational effects. For now, however, we simply conclude that it does exist and it is one of the primary reasons for the differences in returns to different rotations.

These data show that, in almost all years, corn following soybeans, regardless of the rotation, yields

**Table 1. Average Yields Based on Rotation and Nitrogen Fertilizer Level and Time Period, Northeast Research and Demonstration Farm**

Crop	0 N	1985 – 2005				2000 - 2005			
		80 N	160 N	240 N	0 N	80 N	160 N	240 N	
Continuous Corn	51	111	137	146	49	122	150	154	
Corn in CS	100	149	161	168	105	163	181	191	
1st corn in CCS	102	145	163	163	106	160	183	180	
2nd corn in CCS	51	110	138	147	47	123	153	167	
1st corn in CCCS	100	143	160	161	104	158	182	181	
2nd corn in CCCS	50	109	139	149	46	117	153	166	
3rd con in CCCS	53	104	133	145	51	115	145	157	
Soybeans in									
CS	48.3	49.9	49.9	49.5	54.2	54.1	54.3	54.8	
CCS	52.3	51.1	51.8	52.2	56.1	57.5	56.6	57.2	
CCCS	53.8	54.1	53.8	53.9	57.7	58.3	58.4	58.9	

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better than corn following corn. There have been many reasons postulated for this effect. Regardless of the reason, there is a definite yield advantage for corn following soybeans and this advantage persists even today.

### Costs and Returns

Our goal is to find a corn price where the relative profitability of the rotation shifts from a corn soybean rotation to one where there is more corn in the rotation. We used the following steps in calculating the return to the various rotations and nitrogen levels. There are a different number of crops in each rotation so in every case we computed the return on a rotated acre basis. We assumed that all crops in the rotation were grown each year and we simply averaged the results by the number of crops to get the average per rotated acre.

We first calculated the gross returns per year. We simply calculated the yearly average yield times the price. The corn price varied and we held the soybean price constant at \$5.50 per bushel.

Cost estimates were divided into three categories. One category was the standard cost estimates for such items as seed, chemicals, interest, labor and so-forth. These estimates came from the ISU Extension publication *Estimated Costs of Crop Production - 2005* (FM 1712). We assumed a cash rent charge of \$140 for all rotations.

The second cost category estimated was for the costs that would be sensitive to the yield. These costs were phosphorus, potassium, drying and hauling. We used a fixed cost per unit for each of these items but varied the cost in any given year by the yield reported.

The third cost category was for nitrogen. This study allowed us to examine the impact of different nitrogen prices on the returns and to find corn prices that could induce farmers to plant more corn. We call these “break-even prices” for the various rotations and nitrogen levels.

### Results

The price of corn and the cost for nitrogen do have an influence on the most profitable rotation and N use level. Table 2 presents the corn prices necessary to determine the most profitable rotation. With \$.20-per-pound N and using the 1985 – 2005 yields, at \$3.40-per-bushel corn, the most profitable rotation shifts from CS to CCS. Then at \$3.55-per-bushel, the most profitable rotation shifts from CCS to CC.

The breakeven corn price between CS and CCS goes from \$3.40 with \$.20 N to \$3.45 with \$.30 N and at corn prices above \$3.60 the CCS rotation is the most profitable. These breakeven corn prices shift slightly higher when using the yields from 2000 – 2005.

**Table 2. Most Profitable Rotation by Corn Price Using Yields from the Northeast Research Farm**

1985 – 2005 Yields	2000 – 2005 Yields
Corn price for Breakeven	Corn Price for Breakeven
<b>\$.20 Nitrogen</b>	
CS up to \$3.40	CS to \$3.55
CCS from \$3.40 - \$3.55	CCS from \$3.55 to \$4.00
CC above \$3.55	CC above \$4.00
<b>\$.30 Nitrogen</b>	
CS up to \$3.45	CS to \$3.55
CCS from \$3.45 to \$3.80	CCS from \$3.55 to \$4.15
CC above \$3.80	CC above \$4.15
<b>\$.40 Nitrogen</b>	
CS up to \$3.60	CS to \$3.50
CCS from \$3.60 to \$4.10	CCS from \$3.50 to \$4.30
CC above \$4.10	CC above \$4.30

The changing corn prices also affect the most profitable level of N to use. As shown in Table 3, the general pattern is to find CS with 80 pounds of N the most profitable when corn prices are low. As the corn price rises, the most profitable treatment shifts to 160 pounds of N and finally to 240 pounds of N before the CCS becomes the most profitable rotation. It is interesting to note that the CCS rotation tends to be most profitable with 160 pounds of N.

### Final Thoughts

We have seen a dramatic change in the Iowa landscape over the past several decades. In spite of these changes,

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corn has occupied about half of our principal crop acres. There has been a dramatic increase in soybean acres and a corresponding decrease in acreage of other crops.

The percentage of Iowa land devoted to corn and soybeans has steadily increased. For the past several years over 90 percent of our principal crop acres have been devoted to these two crops. Corresponding to this change has been a steady move towards a more equal division between corn and soybean acres.

Corn prices will have to reach close to \$3.40 before adding more corn to the rotation becomes more profitable than the standard corn/soybean rotation. The primary driver for this higher price is the yield penalty experienced with corn after corn. Another factor is the increased costs for nitrogen and insecticides.

This analysis has not considered harvesting corn stover. Some of the discussion on biofuels has focused on using cellulose for ethanol production. Corn stover has been a leading candidate in this discussion. If corn stover becomes a more valuable by product then this will lower the break-even prices.

Will corn prices go to \$3.40 and above? What will happen to the livestock sector if they do? How many more acres will need to be shifted to corn to meet the new demand? How long will the demand last? What will be the impact on land values and beginning farmers? And, finally, what will be the impact on water quality?

**Table 3. Most Profitable (Least Loss) Rotation and N Rate Using**

1985 – 2005 Average Yields		2000 – 2005 Average Yields	
N = \$.20			
Corn Price	Rotation and N level	Corn Price	Rotation and N Level
< \$1.70	CS 80	< \$1.20	CS 80
\$1.70 - \$2.90	CS 160	\$1.20 - \$1.75	CS 160
\$2.90 - \$3.40	CS 240	\$1.75 - \$3.55	CS 240
\$3.40 - \$3.55	CCS 240	\$3.55 - \$4.00	CCS 240
> \$3.55	CC 240	> \$4.00	CC 240
N = \$.30			
Corn Price	Rotation and N Level	Corn Price	Rotation and N Level
< \$2.40	CS 80	< \$1.70	CS 80
\$2.40 - \$3.45	CS 160	\$1.70 - \$2.55	CS 160
\$3.45 - \$3.85	CCS 160	\$2.55 - \$3.55	CS 240
> \$3.85	CC 240	\$3.55 - \$4.15	CCS 160
		\$4.15 - \$5.25	CC 160
		> \$5.25	CC240
N = \$.40			
Corn Price	Rotation and N Level	Corn Price	Rotation and N Level
< \$3.05	CS 80	<\$2.10	CS 80
\$3.05 - \$3.60	CS 160	\$2.10 - \$3.30	CS 160
\$3.60 - \$4.10	CCS 160	\$3.30 - \$3.50	CS 240
> \$4.10	CC 240	\$3.50 - \$4.30	CCS 160
		> \$4.30	CC 160

No one knows the answer to these questions with any degree of certainty. The one thing that is certain is there will be changes, and the changes over the next few years will dramatically influence Iowa's cropping pattern. There will be winners and losers and everyone must carefully evaluate their positions and options when assessing the opportunities the bioeconomy is offering to them. Thirty years ago the rise in foreign trade caused a significant change in corn prices that has persisted. Since then, we have seen promises of a new plateau for corn but they never materialized. Will the ethanol demand be different? Time will tell.