Journal of Agricultural and Applied Economics, 40,2(August 2008):581–592

.

Impacts of Expanded Ethanol Production on Southern Agriculture

Dwi Susanto, C. Parr Rosson, and Darren Hudson

This study analyzes the potential impacts of expanded ethanol production on southern agriculture. Results of regression analysis suggest that acreage planted for field crops (corn, cotton, soybeans, and wheat) is inelastic with respect to relative prices. The results provide statistical evidence of potential significant acreage shifts favoring corn over cotton, soybeans, and wheat. Simulations indicate that higher corn prices will increase corn acreage, but the South continues to be a deficit corn region. U.S. corn production is capable of supplying domestic demand for ethanol, feed for livestock and poultry, and other uses, while maintaining exports at more than 2 billion bushels annually.

Key Words: acreage shifts, corn exports, ethanol production, southern agriculture

JEL Classifications: Q11, Q42

Ethanol production in the United States increased fivefold over the last decade, reaching 4.86 billion gallons in 2006. It is expected that ethanol production will grow more rapidly in the future as industry expansion takes place and the mandatory Renewable Fuel Standards (RFS) through the Energy Independence and Security Act (EISA) of 2007 requires fuel producers to use at least 15 billion gallons of ethanol by 2015. The Renewable Fuels Association (RFA) reported that there are currently 141 active plants capable of producing 8 billion gallons of ethanol per year. Most of these existing facilities are located in the Midwest and North Central United States. An additional 59 plants under construction and 7 plants under expansion will add 5.406 billion more gallons of capacity, bringing total biofuels capacity to 13.4 billion gallons.[1]

The rapid expansion of ethanol production affects virtually every aspect of the field crops sector, ranging from domestic demand and exports to prices and the allocation of acreage among crops (Wescott; Elobeid et al.). For the southern states,[2] the impacts have not yet completely manifested themselves but it is likely that the South will face adjustment challenges in the future if requirements of EISA are fully met. First, increased corn demand will initially cause higher corn prices, inducing farmers to increase corn production (Schoonover and Muller). Corn production

Dwi Susanto is postdoctoral research associate and C. Parr Rosson is professor, Department of Agricultural Economics, Texas AgriLIFE Research and AgriLIFE Extension, respectively, Texas A&M University, College Station, TX. Darren Hudson is professor, Department of Agricultural Economics, Mississippi State University, Mississippi State, MS.

The authors benefited from the comments made by participants of the Southern Agricultural Economics Association Annual Meeting, February 2–5, 2008, Dallas, Texas.

[1] Renewable Fuels Association, available at http://www.ethanolrfa.org/industry/locations/, accessed on February 14, 2007.

[2] Southern states include Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, and Virginia.

can be increased by increasing corn acreage or yields. Expansion of corn acreage will likely occur at the expense of other crops such as soybeans, wheat, and cotton or possibly some of the land currently held in the Conservation Reserve Program. This latter outcome is unlikely, however, given the substantial penalties for withdrawing land before the end of the agreed-upon contract period. Second, the South has historically been a grain-deficit region. Therefore, an increase in demand for corn for ethanol feedstock will have a significant impact on the livestock and poultry sectors because they compete directly with the ethanol industry for corn supplies.

The main objective of this study is to analyze the potential impacts of expanded ethanol production on southern agriculture, utilizing the RFS set forth in the EISA 2007. The specific objectives are (1) to analyze the impact of ethanol production on corn area planted and competing commodities: cotton, wheat and soybeans, (2) to project future corn supply and utilization, and (3) to describe the impacts of ethanol production on livestock and poultry industries that rely on corn as an important input.

Crop Acreage

Table 1 shows area planted for the four main crops that were analyzed (corn, cotton, soybeans, and wheat). Grain sorghum was included in the table for discussion purposes, but was not explicitly analyzed in the study. Excluding 2007, area planted for corn had been relatively stable, with slight declines occurring in 2001 and 2006 (Table 1). Soybeans and wheat exhibited a downward trend. Cotton acreage showed a light upward trend over the sample period. Before 2007 it does not appear that higher corn prices had any major impacts on the distribution of crop area. In 2007, however, corn area increased by 51.4% from the previous year, while area planted to cotton dropped by 30.0%. Sorghum area had also been declining, but rebounded in 2007 largely in response to higher corn prices and increased demand for substitutes. The soybean area also experienced a decline, but to

Table 1. Area Planted of Selected Main Crops (Thousand Acres)

	Southern States						United States					
Year	Corn	Cotton	Soybean	Wheat	Sorghum	Total	Corn	Cotton	Soybean	Wheat	Sorghum	Total
1987	7,290	8,552	14,525	18,425	4,372	53,164	66,200	10,259	58,180	65,829	11,756	212,224
1990	7,370	10,348	14,460	20,205	4,165	56,548	74,166	12,117	57,795	77,041	10,535	231,654
1995	7,075	14,655	11,910	17,040	3,524	54,204	71,479	16,717	62,495	69,031	9,429	229,151
2000	7,485	13,780	11,790	16,513	4,046	53,614	79,551	15,347	74,266	62,549	9,195	240,908
2001	6,575	14,060	10,320	15,340	4,624	50,919	75,702	15,499	74,075	59,432	10,248	234,956
2002	7,750	12,505	10,805	16,539	4,269	51,868	78,894	13,714	73,963	60,318	9,589	236,478
2003	7,460	11,993	10,743	16,725	4,147	51,068	78,603	13,301	73,404	62,141	9,420	236,869
2004	7,430	12,076	12,219	15,908	2,764	50,397	80,929	13,409	75,208	59,674	7,486	236,706
2005	7,295	12,745	11,274	13,538	2,624	47,476	81,779	13,975	72,032	57,229	6,454	231,469
2006	6,650	13,808	11,337	13,743	2,548	48,086	78,327	14,955	75,522	57,344	6,522	232,670
2007	10,065	9,689	10,149	15,898	3,749	49,550	93,616	10,554	63,669	60,433	7,718	235,990

Source: Authors' calculation based on USDA data.

a lesser extent (10.5%) than the other crops. Somewhat surprising is the area planted for wheat, which increased from 13.7 million acres (2006) to 15.9 million acres (2007), an increase of 15.7%. These additional wheat acres in the South accounted for 70% of the U.S. wheat area expansion. The most recent data clearly signal the impact of higher demand for corn, particularly from the ethanol industry. The expansion of corn acreage in the South seems to come at the expense of other crops, particularly cotton and soybeans.

Acreage changes among the four main crops were examined using regression analysis acreage planted as a function of relative price ratios and a dummy variable (Dummy post-2006) representing the acreage shift in 2007 as explanatory variables. To detect changes across regions, dummy variables were included for each of the four southern production regions (Green). The 12 southern states were grouped into four different regions: Southern Plains (Texas and Oklahoma), Delta (Arkansas, Mississippi, and Louisiana), South East (Alabama, Florida, Georgia, and South Carolina), and Appalachian (Tennessee, North Carolina, and Virginia).[3] The data used in estimation are from the U.S. Department of Agriculture (USDA) and cover the period of 1995 to 2007. The regression results are presented in Table 2. Because all variables except the dummy variables are in log values, the coefficient estimates indicate elasticities of relative prices.

All estimated price ratio parameters are less than one, indicating that area planted of the four crops is not highly responsive to changes in relative prices. Not all parameter estimates have the expected signs, nor are they significant. Four of the parameters of relative prices have signs contrary to those expected, but these parameters are not significant. The relative price of corn to cotton in corn and cotton equations, relative price of corn to wheat in corn equation, relative price of cotton to soybeans in the cotton equation, and relative price of soybeans to wheat in the soybean equation are all significant. The parameter estimates are similar in magnitude (less than 0.4), except for the relative price of corn to wheat in corn acreage, with a magnitude slightly higher than 0.6. Although the estimates show inelastic responses of acreage to changes in relative prices, there is statistical evidence of possible switching acreage planted between cotton and corn, cotton and soybeans, corn and wheat, and soybeans and wheat. Another point to mention is that none of the parameter estimates of relative prices in the wheat equation is significant. This result may limit the effectiveness of the simulations discussed in the next section.

Another important point is about the relative price of corn to soybeans. The estimates of this variable are not significant in either the corn or the soybean acreage equation. The lack of statistical significance of the relative price of corn to soybeans can be explained in part by the fact that corn and soybeans are normally planted in rotation. Switching soybeans to corn is fairly common, but relative prices have favored corn for most of the analysis period. Data show that the average of the soybean to corn price ratio is 2.3, which is higher than the ratio that is normally required to move acres of soybeans into corn—less than 2:1 (Peel). Inferences using these nonsignificant parameters, if made at all, should be made with caution.

In the case of the dummy variables, 11 of the 12 parameter estimates for regional dummy variables are significant. All parameter estimates of the dummy variables for post-2006 are significant, indicating statistically significant crop changes after 2006.

Impacts of Changes in Commodity Prices

Corn prices have increased to their highest levels in the last decade. Sustained increase in demand for ethanol is one important factor. In 2007 corn prices averaged at $3.04 per bushel, a 52% increase over the 2006 average price (Table 3). The impacts of higher prices will likely go beyond corn. Farmers are likely to switch acreage to corn from soybeans, wheat, and even cotton. This will lead to lower

[3] For simplicity, Kentucky is excluded from the analysis because it does not produce cotton.

Table 2. Regression Results for Acreage Planted in Southern States Using Least-Squares Dummy Variable

	Corn Acreage		Cotton Acreage		Soybean Acreage		Wheat Acreage	
Variable	Parameter	SD	Parameter	SD	Parameter	SD	Parameter	SD
Intercept	7.302	0.506***	8.289	0.251***	7.407	0.441***	0.139	0.385
P value, corn/cotton	0.394	0.240*	−0.353	0.156**	-	-	-	-
P value, corn/soybeans	0.179	0.292	-	-	0.035	0.245	-	-
P value, corn/wheat	0.624	0.302**	-	-	-	-	0.139	0.385
P value, cotton/soybeans	-	-	0.361	0.137**	−0.230	0.206	-	-
P value, cotton/wheat	-	-	−0.204	0.132	-	-	0.550	0.322
P value, soybeans/wheat	-	-	-	-	0.438	0.214**	−0.280	0.357
Dummy post-2006	0.198	0.111**	−0.243	0.052***	−0.228	0.089**	0.289	0.145**
D_1	−0.699	0.064***	0.452	0.043***	−1.217	0.166***	−0.725	0.155***
D_2	−0.489	0.070***	0.641	0.045***	0.505	0.169***	−0.087	0.157
D_3	0.130	0.069*	1.447	0.045***	−1.827	0.158***	2.215	0.151***
R^2	0.843		0.982		0.981		0.974	
DW statistic	1.946		1.908		1.752		1.746	

Note: One, two, and three asterisks are significant at 10%, 5%, and 1% levels, respectively. Dependent variables are area planted in log values. D_1, D_2, and D_3 are regional dummy variable for South East, Delta, and Southern Plains, respectively.

Table 3. Prices Used in Simulations

Year	Corn ($/bu)	Cotton (cents/lb)	Soybeans ($/bu)	Wheat ($/bu)
2005	2.06	42.00	5.74	3.40
2006	2.00	47.70	5.66	3.42
2007	3.04	46.50	6.43	4.26
2008	4.00	61.40	10.40	6.65
Assumed price	7.00	85.00	13.50	8.75

Source: Price data from 2005 to 2007 are from National Agricultural Statistics Service (NASS), USDA. The 2008 price data are from World Agricultural Supply and Demand Estimates (WASDE): average of mid-point prices for January and February. Assumed prices are based on future prices obtained from Chicago Board of Trade (CBOT) and National Cotton Council of America.

production for those other products and thus higher prices. This section presents simulations of the likely impacts of changes in commodity prices on acreage shares, acreage planted, and total production. The analysis is extended to highlight the impacts of changes in production on infrastructure.

Four scenarios were simulated (Table 4), where each scenario is based on changes in commodity prices as described in Table 3. Under scenario 1, both corn and soybean acreage decreased by 8.17% and 4.39%, respectively, whereas cotton and wheat acreage increased by 7.97% and 7.16%, respectively. This is as expected given price changes used under scenario 1 where percentage changes in corn and soybean prices fall, but cotton and wheat prices increase. Scenario 2 shows opposite results to scenario 1. A 52% increase in corn price is associated with an increase in the relative price of corn to the other commodity prices. As a result, corn acreage increased by 41.8% from the base, while cotton acreage declined 20.4%.

Scenario 3 analyzed the situation where all prices increase but the results showed a decline

Table 4. Percentage Price Changes Used in Simulations and Simulation Results with 2007-Based Acreage

Scenario	Price Changes (%)	Base Acreage (1,000 acres)	Simulated Acreage (1,000 acres)	Acreage Change (1,000 acres)	Acreage Change (%)
Scenario 1					
Corn	2.91	8,635	7,930	−705	−8.17
Cotton	13.57	9,689	10,461	772	7.97
Soybeans	−1.39	9,059	8,661	−398	−4.39
Wheat	0.59	15,458	16,566	1,108	7.16
Scenario 2					
Corn	52.00	8,635	12,247	3,612	41.83
Cotton	−2.52	9,689	7,710	−1,979	−20.43
Soybeans	13.60	9,059	9,112	53	0.59
Wheat	24.56	15,458	14,463	−995	−6.44
Scenario 3					
Corn	31.58	8,635	7,488	−1,147	−13.28
Cotton	32.04	9,689	9,363	−326	−3.36
Soybeans	61.74	9,059	9,524	465	5.13
Wheat	56.10	15,458	13,654	−1,804	−11.67
Scenario 4					
Corn	130.26	8,635	9,462	827	9.57
Cotton	82.80	9,689	8,874	−815	−8.41
Soybeans	109.95	9,059	9,421	362	4.00
Wheat	105.40	15,458	14,515	−943	−6.10

in all crop acreage except soybeans. One explanation for this result is that the decision with regard to acreage planted is based on relative prices. Therefore, the results depend on the magnitude of change in relative prices. The high percentage increase in soybean prices in scenario 3 resulted in a net positive increase in soybean acreage. Similarly, a large increase in the prices of the other crops resulted in a lower area planted. The slight reduction in cotton acreage may be attributed to rigidities associated with specialized infrastructure such as cotton gins, especially in the short run.

Scenario 4 was performed assuming there are large increases in all prices. This situation is likely during periods of drought or unusually strong demand, resulting in high commodity prices. The assumed prices were based on future market prices. As shown in Table 3, corn prices increased the most, followed by soybeans, wheat, and cotton prices. Simulations indicate that corn area increased by nearly 20%, or an additional 1.7 million acres. The increase in corn acreage is mainly at the expense of cotton acreage. Cotton-planted area declined by about 12% or 1.1 million acres. Soybeans area increased 4.3% (387,000 acres), while wheat area fell about 5%. One should note that none of the price coefficients in the wheat equation is significant.

The four scenarios show that a relatively large increase in corn prices led to substantial increases in corn acreage. Assuming yields are constant, this will result in an increase in corn production and decrease in production of other commodities. These results have some implications for transportation infrastructure, grain drying, and grain storage facilities. Recent studies have shown that rapid increases in ethanol production will have substantial impacts on infrastructure. Ginder, for example, projected that an increase of corn production in Iowa from the current level of 2.6 billion bushels to 3.96 billion bushels will require an additional storage capacity of nearly 1.4 billion bushels. Furthermore, higher corn production will create a need for an increased availability of trucks and rail cars, along with the receiving capacity at ethanol plants and grain elevators.

Assuming 140-bushel corn yields, scenarios 2 and 4 will result in an addition of 505 million bushels and 236 million bushels of corn, respectively. With such an increase, the South can expect major pressure on existing infrastructure. The pressure will not only strain storage capacity, but also transportation systems such as trucking, rails, and barge shipping. The most important impacts are depicted by the decrease in cotton production. Scenario 2 results in a reduction in cotton acreage of nearly 2 million acres. Assuming cotton yields of 900 pounds of lint per acre, the reduction in cotton acreage is translated into approximately 3.95 million bales. Scenario 4 results in a lower reduction in cotton output, about 2.1 million bales. If this shift in cotton acreage persists, the industry will experience a larger impact than other crop sectors because some gins will be permanently closed and cotton producers will face higher transportation costs and lower prices.

Corn Supply and Utilization: Projection

Methods of Projection

Corn has dominated recent discussions about expanded ethanol production and its impacts on agriculture. The following analysis includes projections of corn supply and utilization, including corn used for ethanol production, livestock feed, and exports. This analysis is very important given the fact that livestock and poultry industries in the South compete directly for supplies of corn used by the ethanol industry. More importantly, the notion of the South as a grain-deficit region will make the analysis more relevant as ethanol production expands.

Several steps were performed in making projections of corn supply and utilization. Corn supply consists of corn production, beginning stocks, and imports. Corn production equals area harvested times corn yield. Area harvested is projected using an exponential growth function. The growth function is first estimated using a nonlinear procedure to obtain the growth rates. To account for the acreage shift in 2007, a dummy variable for the year 2007 is included in the model. Corn yields are projected using estimated geometric means for the period of 1990 to 2006. The estimated growth function and the geometric growth of corn yields are used to project corn area harvested and corn yield, respectively in the southern states and rest of U.S. states (ROS). Corn production in the United States is the sum of corn production in South and ROS. The South was divided into four main subregions: Southern Plains, Delta, South East, and Appalachian.

U.S. corn imports are assumed to grow at a rate of 6.97%, which is the geometric average growth from 1990 to 2006. Ending stocks are assumed to stay constant during the period of projection at 15% of total production. Ending stocks of period t are the beginning stocks of period $t + 1$.

In terms of corn utilization, corn for seed and corn for food and industrial use are projected at the rates of 1.26% and 1.43%, respectively. These growth rates are the geometric average growth from 1990 to 2006. Because data on corn used for feed and residual are only available for the total United States, the regional allocations were based on the relative proportions of grain-consuming animal units[4] in the South.

Ethanol production is broken down into two subregions: southern states and ROS. From 2008 to 2014, ethanol production in ROS is assumed to grow at the rate of 10.7%, which is the estimated geometric average growth from 1985 to 2006. Beyond 2014, ethanol production in ROS is assumed to grow at the rate of 3.5%. Ethanol production in the southern states is estimated on the basis of current plant capacity and capacity under construction (see footnote 4), which according to RFA amounts to 493 million gallons per year for corn-based ethanol. Corn used for fuel is calculated on the basis of the rate of 2.75 gallons of ethanol per bushel of corn.

Ethanol Production, Ethanol Feedstock, and Corn Exports

Table 5 summarizes the projections of ethanol production and corn exports in the Unites States and the southern states. Ethanol production in the South in 2007 was 100 million gallons (Table 5). This represents the total of current capacity of corn-based ethanol (RFA). Ethanol production increased in 2008 as biorefineries currently under construction started to produce. Full capacity in the Appalachian states and Southern Plains is projected to be achieved in 2011 and 2013, respectively. Afterward, production is projected to grow at the rate of 3.5%. As shown in Table 5, ethanol production in the South is projected at 513 million gallons in 2013 and 588.7 million gallons by 2017. This assumes that no additional capacity comes on line during the projection period.

RFA data indicate that U.S. ethanol production recorded in September 2007 was 4.7 billion gallons. With an average monthly production of 0.57 billion gallons per month,[5] 2007 U.S. ethanol production was estimated at 6.4 billion gallons. Total U.S. ethanol production in 2008 is projected to be 7.2 billion gallons. According to the EISA of 2007, fuel producers are required to use at least 15 billion gallons of conventional biofuel by 2022. However, if the 15 billion gallon target is achieved in 2015, additional output will not receive tax credits. Our analysis shows that U.S. ethanol production is projected to reach approximately 14 billion gallons in 2015. This is likely to be achieved given the tax credit schedules. Our analysis also indicates that the mandatory RFS will be achieved if ethanol production grows 11% annually.

When converted into corn feedstock, total ethanol industry demand for corn in the United States is projected at 2.6 billion bushels in 2008. In 2015, demand for corn feedstock is projected at 5.1 billion bushels. In the South, demand for corn for ethanol feedstock is projected at 59.2 million bushels in 2008. This

[4] Due to space limitations, the detailed procedure is not presented here. Interested readers may obtain the detailed procedure by contacting the authors.

[5] This is approximated using 2007 monthly data of U.S. ethanol production as reported by RFA.

Table 5. Projected ethanol production, corn feedstock, and corn exports: United States and Southern States

	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Ethanol Production						(Million Gallons)					
Total USA[a]	6,460.6	7,204.0	8,037.9	8,952.4	9,965.7	11,046.1	12,218.4	13,488.8	13,960.9	14,449.5	14,955.3
Total Southern States[b]	100.0	162.8	243.3	323.8	413.8	472.2	513.0	531.0	549.5	568.8	588.7
Southern Plains	0.0	53.3	124.3	195.3	266.3	319.5	355.0	367.4	380.3	393.6	407.4
Delta	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
South East	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Appalachian	100.0	109.5	119.0	128.5	147.5	152.7	158.0	163.5	169.3	175.2	181.3
Corn Feedstock[c]						(Million Bushels)					
Total US	2,349.3	2,619.6	2,922.9	3,255.4	3,623.9	4,016.8	4,443.0	4,905.0	5,076.7	5,254.4	5,438.3
Total Southern States	36.4	59.2	88.5	117.7	150.5	171.7	186.5	193.1	199.8	206.8	214.1
Southern Plains	0.0	19.4	45.2	71.0	96.8	116.2	129.1	133.6	138.3	143.1	148.1
Delta	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
South East	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Appalachian	36.4	39.8	43.3	46.7	53.6	55.5	57.5	59.5	61.5	63.7	65.9
Corn Exports[d]						(Million Bushels)					
Total USA	2,717	3,364	3,246	3,113	2,951	2,771	2,566	2,332	2,396	2,463	2,531
Total Southern States	−1,101	−1,047	−1,064	−1,077	−1,091	−1,091	−1,081	−1,060	−1,037	−1,009	−979
Southern Plains	−212	−218	−248	−278	−307	−330	−346	−353	−360	−367	−374
Delta	−159	−118	−97	−73	−48	−20	10	42	77	115	156
South East	−430	−428	−432	−435	−438	−441	−444	−447	−450	−452	−454
Appalachian	−300	−283	−287	−291	−297	−299	−301	−302	−304	−306	−307

[a] Total ethanol production in Southern States and Rest of the states.
[b] Projection is based on biorefinery capacity (current and under construction).
[c] Assuming one bushel of corn generates 2.75 gallons of ethanol.
[d] Exports equal total supply less domestic use.

Table 6. Projected Corn Use for Feed and Residuals and Shares of Feed and Residuals to Total Corn Production

	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Corn Use for Feed and Residuals (Million bushels)											
USA	6,121	6,177	6,230	6,281	6,329	6,375	6,418	6,459	6,499	6,536	6,571
Southern States	1,993	2,011	2,029	2,046	2,062	2,077	2,092	2,106	2,120	2,133	2,146
South Plains	466	479	491	503	514	526	538	549	560	571	582
Delta	445	447	450	452	453	455	457	458	459	460	461
South East	518	520	522	524	525	526	527	528	529	530	531
Appalachian	564	566	567	568	569	570	570	571	571	572	572
Percent of Feed and Residual to Total Production (%)											
USA	46.8	46.4	45.8	45.2	44.5	43.9	43.2	42.5	41.8	41.1	40.4
Southern States	178.5	175.2	171.7	168.1	164.3	160.4	156.4	152.2	148.0	143.8	139.5
South Plains	152.5	152.3	152.1	151.8	151.4	150.9	150.3	149.6	148.7	147.8	146.8
Delta	128.3	120.4	113.0	105.9	99.3	93.0	87.0	81.5	76.2	71.3	66.7
South East	494.1	506.7	519.8	533.0	546.4	559.9	573.6	587.5	601.6	615.9	630.5
Appalachian	157.1	157.2	157.2	157.2	157.1	157.0	156.9	156.7	156.5	156.3	156.1

constitutes 5.2% of corn production in the South or 2.7% of total domestic use.

U.S. corn exports are projected to be 3.36 billion bushels in 2008 (Table 5). In the following year, corn exports are projected to decline and reach their lowest level of 2.3 billion bushels in 2014 before starting to rebound in 2015. Our projections show that corn exports start to rebound by the time ethanol production approaches the mandatory RFS of 15 billion gallons. Given these projections, there will be only minimal adjustment in corn markets. Increased domestic demand for corn will be met from additional domestic production. The United States is projected to maintain corn exports at about 2.5 billion bushels annually.

The South also is projected to continue as a corn deficit region. Of the four regions, the corn deficit in the Southern Plains grows at a faster rate than that in the Delta and Appalachian regions. The corn deficit in the Delta, on the other hand, is projected to decline because corn production in the Delta region is projected to grow at a faster rate than that in the other three regions.

Corn Use for Feed and Residuals

Table 6 provides projections of corn use for feed and residuals in both the United States and the South. Corn used for feed and residuals in the South is projected at a level of 2.01 billion bushels in 2008. This consumption level accounts for 75% of annual production and about 92% of total domestic use (on the basis of Tables 6 and 7). Although the South constantly experiences corn deficit, the deficit declines over time.

Impact on Livestock and Poultry Sectors

Livestock and poultry sectors are projected to compete directly with the ethanol industry for corn. This can be seen in the projections in Table 7 where shares of corn for feed and residual use relative to total domestic use decrease constantly during the projection period, from 92% in 2008 to 85% in 2017. On the other hand, shares of corn for ethanol feedstock increase from 3% to 9% during the same period. Although the livestock and poultry sectors will face challenging competition from the ethanol industry, we argue that the impacts may not be as severe as many analysts expect, in the sense that corn will be available from domestic production. One can observe that U.S. corn exports will not be severely affected by growing demand for corn. In fact U.S. corn exports remain above 2 billion bushels annually over the entire projection period.

Table 7. Projected Corn Supply and Utilization: United States and Southern States (Million Bushels)

	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
United States											
Production	13,074	13,307	13,602	13,906	14,218	14,538	14,866	15,204	15,551	15,907	16,274
Beginning Stocks	1,142	1,961	1,996	2,040	2,086	2,133	2,181	2,230	2,281	2,333	2,386
Domestic Supply	14,216	15,268	15,598	15,946	16,303	16,670	17,047	17,434	17,832	18,240	18,660
Imports	11	11	12	13	14	15	16	17	18	20	21
Total Supply	14,227	15,279	15,611	15,959	16,317	16,685	17,063	17,451	17,850	18,260	18,681
Food, Alcohol and Industrial Use	1,345	1,365	1,384	1,404	1,424	1,444	1,465	1,486	1,507	1,529	1,551
Seed Use	24	24	24	25	25	25	26	26	26	27	27
Feed and Residual	5,830	5,911	5,993	6,076	6,161	6,247	6,333	6,421	6,511	6,601	6,693
Fuel	2,349	2,620	2,923	3,255	3,624	4,017	4,443	4,905	5,077	5,254	5,438
Domestic Use	9,549	9,919	10,325	10,761	11,234	11,733	12,267	12,838	13,121	13,411	13,709
Ending Stocks	1,961	1,996	2,040	2,086	2,133	2,181	2,230	2,281	2,333	2,386	2,441
Net Trade (Exports)	2,717	3,364	3,246	3,113	2,951	2,771	2,566	2,332	2,396	2,463	2,531
Southern States											
Production	1,116	1,148	1,181	1,217	1,255	1,295	1,338	1,383	1,432	1,484	1,539
Beginning Stocks	98	169	173	179	184	190	196	203	210	218	226
Domestic Supply	1,214	1,317	1,355	1,395	1,439	1,485	1,534	1,586	1,642	1,701	1,764
Imports	0	0	0	0	0	0	0	0	0	0	0
Total Supply	1,214	1,317	1,355	1,395	1,439	1,485	1,534	1,586	1,642	1,701	1,764
Food, Alcohol and Industrial Use	115	118	120	123	126	129	132	135	139	143	147
Seed Use	2.04	2.09	2.13	2.17	2.22	2.26	2.32	2.37	2.43	2.49	2.56
Feed and Residual	1,993	2,011	2,029	2,046	2,062	2,077	2,092	2,106	2,120	2,133	2,146
Fuel	36	59	88	118	150	172	187	193	200	207	214
Domestic Use	2,147	2,190	2,240	2,288	2,340	2,380	2,412	2,437	2,461	2,485	2,509
Ending Stocks	169	173	179	184	190	196	203	210	218	226	234
Net Trade (Exports)	−1,102	−1,047	−1,064	−1,077	−1,091	−1,091	−1,081	−1,060	−1,037	−1,009	−979

One of the most profound impacts of increased corn demand on the livestock and poultry sectors is high corn prices (as opposed to availability), which consequently generates higher feed costs. The rising market demand for ethanol has created upward pressure on corn prices over the last several years. From 2000 to 2006, for example, corn prices increased from $1.85 per bushel to $3.00 per bushel. If these higher corn prices are sustained, they will likely lead to a reduction in corn use for livestock feed and encourage livestock producers to seek alternative feed sources, such as grain sorghum and possibly wheat in some cases. By-products from ethanol production such as wet and dried distiller grains provide other alternative sources of livestock feed (FAPRI), but this may create problems for poultry and hogs because of their lower and more variable nutritional properties. With limitations that require more intensive management, ethanol by-products may still be used as an alternative source of feed for livestock and these alternatives are also relatively less expensive than corn.

There will likely be some sources of livestock feed than can offset the higher corn prices and reduce dependency on corn. Furthermore, the development of advanced biofuels (renewable fuel other than ethanol derived from corn starch) may also increase corn availability for livestock and poultry (Baker and Zahniser). Finally, new or improved technological efficiency in ethanol production could alter these results. We also assume that current ethanol policies remain in place.

Conclusions

Before 2006, empirical data show that there had not been a significant impact of ethanol expansion on southern agriculture, particularly with respect to area planted to corn and other crops: cotton, soybeans, and wheat. In 2007, however, it appears that a significant shift in area planted occurred in which the share of corn acreage increased from 15% (2006) to 22% (2007) and the share of cotton acreage declined from 30% (2006) to 21% (2007).

Results of regression analysis suggest that the acreage planted for field crops under study are inelastic with respect to relative prices. The results also suggest statistical evidence of acreage changes between cotton and corn, cotton and soybeans, corn and wheat, and soybeans and wheat. Simulations on the basis of these regression results reveal that a relatively larger increase in corn prices than other crop prices leads to an increase in corn acreage. Assuming constant yields, this will result in an increase in corn production and a decrease in production of other commodities that eventually will have a serious impact on infrastructure, particularly for the cotton industry.

The southern states are projected to continue experiencing a deficit in corn. However, the deficit will be met by increased domestic production. Although corn consumption for feed in southern states is projected to increase, its share relative to domestic corn use should decline over time. Corn used for ethanol feedstock, on the other hand, grows at a faster rate such that its share relative to total domestic use increases substantially during the projection period.

The major impacts of ethanol production on livestock and poultry are higher prices of corn instead of less availability of corn supplies. U.S. corn production is capable of supplying domestic ethanol requirements and feed for livestock and poultry as well as other uses, while maintaining exports at current rates, approximately 2.5 billion bushels annually. The development of advanced biofuels may also release additional corn supplies for feed, while the by-products from the ethanol industry provide alternative sources of feed to livestock and poultry producers.

References

Baker, A., and S. Zahniser. "Ethanol Reshapes the Corn Market." *Amber Waves*, Vol. 4, Issue 2, 2006.

Elobeid, A., S. Tokgoz, D.D. Hayes, B.A. Babcock, and C.E. Hart. "The Long-Run Impact of Corn-Based Ethanol on the Grain, Oilseed, and Livestock Sectors: A Preliminary Assessment." Card Briefing Paper 06-BP 49, Center for Rural Development. Ames, IA: Iowa State University, November 2006.

FAPRI, U.S. and World Agricultural Outlook 2007. FAPRI Staff Report 07-FSR 1. Food and Agricultural Policy Research Institute, Iowa State University–University of Columbia, Ames, Iowa, January 2007. Available online at http://www.fapri.iastate.edu/Outlook2007/.

Ginder, R.G. "Potential Infrastructure Constraints on Ethanol Production in Iowa." Iowa State University, University Extension, November 2006. Available online at: http://www.extension.iastate.edu/ag/ginderpresent.indd.pdf.

Green, W.H. *Econometric Analysis*, 5th ed. Upper Saddle River, NJ: Prentice Hall, 2003.

Peel, D.S. "An Overview of the Impacts of increased Corn Demand for Ethanol." Fact Sheet: Livestock Marketing Information Center. Department of Agricultural Economics, Oklahoma State University, February 2007.

Schoonover, H., and M. Muller. "Staying Home: How Ethanol Will Change U.S. Corn Exports." Minneapolis, MN: Institute for Agriculture and Trade Policy, December 2006.

USDA. "USDA Agricultural Projections to 2017." Long-Term Projections Report OCE-2008-1, Office of the Chief Economist. World Agricultural Outlook Board, Washington, DC, February 2008.

Westcott, P.C. "Ethanol Expansion in the United States: How Will the Agricultural Sector Adjust?" ERS, USDA, Washington, DC, May 2007.