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2010 Outlook of the U.S. and World Corn and Soybean Industries, 2009-2019

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ABSTRACT

This report evaluates the United States and world corn and soybean markets for the 2009-2019 time period using the Global Corn and Soybean Policy Simulation Model. This analysis is based on a series of assumptions about general economic conditions, agricultural policies, weather conditions, and technological change.

The major influence in the corn market will be U.S. corn based ethanol production. If the production of corn based ethanol remains strong, corn prices will likely remain strong. However, if the U.S. Federal government subsidies or mandates change, the world corn market could be negatively impacted. Under the current assumptions in the model, corn price is expected to remain in a range between $3.70 and $4.10 per bushel. The level of Chinese soybean imports is the leading factor in the world soybean market. China currently imports 60% of the available soybeans, and that is expected to increase to about 65% by 2019. Major exporters will continue to be the U.S., Brazil and Argentina. However both Brazil and Argentina should increase exports while U.S. exports will remain at the current level. Soybean prices are expected to fluctuate, but remain in the $9.70 per bushel range throughout the forecast period.

Keywords: corn, soybeans, production, exports, consumption, ethanol, ending stocks

HIGHLIGHTS

World corn trade is projected to increase 13% between 2009 and 2019. U.S. exports are expected to remain at the current level as domestic ethanol use will require increasing amounts of corn. Both Argentina and Brazil would increase exports while China is expected to become an importer of corn by 2019.

World soybean trade will increase 66% between 2009 and 2019 as China is expected to increase imports by 55% in 2019 from the 2008-2009 average. U.S. soybean exports are expected to remain flat as cultivated acres are limited in the U.S. Since 2007, Argentina has been increasing soybean production rapidly due to restrictions on the exportation of beef. Brazil will continue to increase soybean exports to satisfy Chinese soybean demand.

World corn production is expected to increase 11%, from 48 billion bushels in 2008-2009 to 53 billion bushels in 2019. The U.S. will increase corn production by 12% while Argentina will increase corn production by 10%. Brazil is expected to reduce corn production because of competition with soybeans for acres.

The U.S. is projected to increase soybean production about 14% by 2019. U.S. production growth is limited because of land constraints. Argentina and Brazil are expected to increase soybean production by 59% and 36%, respectively.

U.S. corn yields are expected to increase in all states/regions except for the south. The reason for lower yields in 2019 than in 2008-2009 in the south is that the corn yield in the south region for 2009 was much higher than normal. Harvested acres in the U.S. are expected to remain around 79.7 million acres throughout the forecast period.

U.S. soybeans yields are expected to increase in most states/regions in the country. Yields for Minnesota and the south are projected to be 2.4% and 12.8% lower in 2019 than in 2008-2009 due mainly to high yields in 2008 and 2009. The largest harvested acres are in the south region followed by the west region and the north east. Iowa has the largest harvested acres of any state followed by Illinois and Minnesota. The U.S. planted 73.8 million acres of soybeans in 2009 and harvested acres are expected to increase to 76.5 million acres by 2019.

Total U.S. corn production in 2009 was 15.2 billion bushels which is expected to increase 6% to 16.0 billion bushels by 2019. The fastest growth is expected to be in Indiana (20%), followed by Nebraska (14%), and Illinois (12%). Total U.S. production is projected to increase 6% between 2009 and 2019.

U.S. exports of corn are expected to vary between 1.4 billion bushels in 2012 to 2.1 billion bushels in 2017. By 2019, corn exports are expected to be 3% less than 2009. The feed use of corn is projected to increase 11% from 5.4 billion bushels in 2009 to about 6 billion bushels in 2019. Ethanol use of corn is expected to increase 15% from 4.2 billion bushels in 2009 to 4.8 billion bushels in 2019.

U.S. exports of soybeans are expected to remain flat during the forecast period between 1.2 billion bushels and 1.3 billion bushels. U.S. domestic processing is projected to increase 16% from 1.7 billion bushels in 2009 to about 2.0 billion bushels in 2019.

Corn price is expected to increase slightly to $3.80 per bushel in 2010 and continue to increase to $4.08 by 2013 and 2014 before slowly decreasing to $3.40 per bushel by 2019. Soybean price is expected to increase slightly in 2010 to $9.70 per bushel, rising to $9.90 per bushel in 2013. After 2013, soybean price is projected to vary between $9.60 per bushel to $9.80 per bushel throughout the forecast period.

2010 Outlook of the U.S. and World Sugar Markets, 2009-2019

Richard D. Taylor
Won W. Koo

INTRODUCTION

World corn and soybean production is concentrated in a few countries unlike other agricultural crops. The U.S. produces 41% of the world's corn and 28% of the world's soybeans. In contrast, the U.S. produces 9% of the world's wheat. China is the next largest corn producer followed by Brazil and the European Union. These four countries produce over 60% of the world's corn. Brazil produces 21% and Argentina produces 18% of the world soybeans compared to 28% for the U.S.

Increased ethanol production under the Energy Act of 2007 resulted in a significant increase in the price of corn which impacted soybeans along with most other commodities. The increased price of corn led to major structural changes in the corn industry in the U.S. as well as other corn producing and consuming countries. Corn production in the U.S. and other countries increased in response to higher prices in 2007. However, prices and production returned to normal levels in 2008 and 2009. Changes in corn prices affect prices of other commodities, especially soybeans, mainly because they are close substitutes in production.

In addition to the corns impact on soybean prices, Argentina had a small soybean crop in 2008. Argentine soybean production fell 31% in 2008 compared to 2007 but, soybean production returned to normal levels in 2009.

Industrial use of corn has increased dramatically during the past two decades. The most recent increases are due mainly to rising ethanol production, which is expected to continue growing at a significant pace. High fructose corn syrup (HFCS) production, used as a substitute for sugar in the soft drink industry, caused a major increase in demand for corn during the 1980s, utilizing 500 million bushels of corn per year. During the late 1990s and early in the 2000s, the corn required for ethanol production increased to approximately 4.2 billion bushels. These two non-traditional uses of corn account for almost 40% of the current U.S. corn crop. This level of ethanol production is likely to increase given recent federal legislation mandating increased ethanol use.

World soybean production has increased in recent years due mainly to the introduction of soybeans into Argentina and Brazil in the mid 1980s. Soybean production in those two countries reached 4.2 billion bushels in 2009 compared to 3.1 billion bushels in the U.S. Soybean consumption in China is the main reason for increased world soybean production. In 1995, China consumed 517 million bushels of soybeans and produced 640 million bushels. By 2009, China consumed 2.0 billion bushels and produced 631 million bushels. In 2009, China imported 60% of the world soybean exports.

WORLD CORN INDUSTRY

Figure 1 shows the world corn production in the major corn producing countries. U.S. corn production has increased by 55% between 1995 and 2009 with harvested acres increasing 15%. China's corn production increased 24% while Brazil and the EU increased production 60% and 18%, respectively, during the same time period.

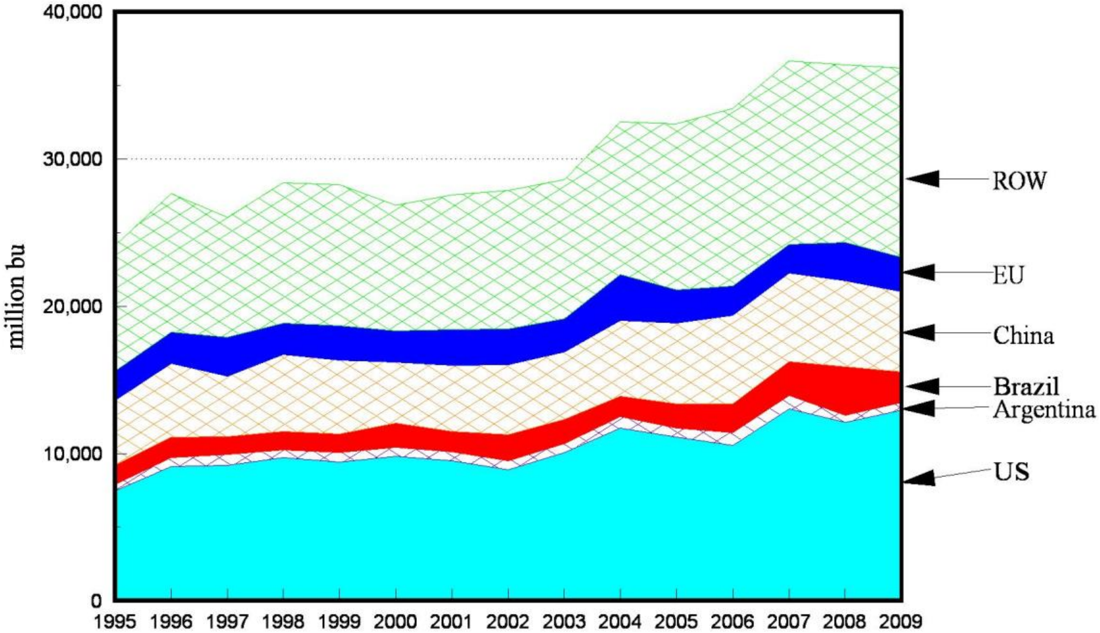

Figure 1. World Corn Production, 1995- 2009

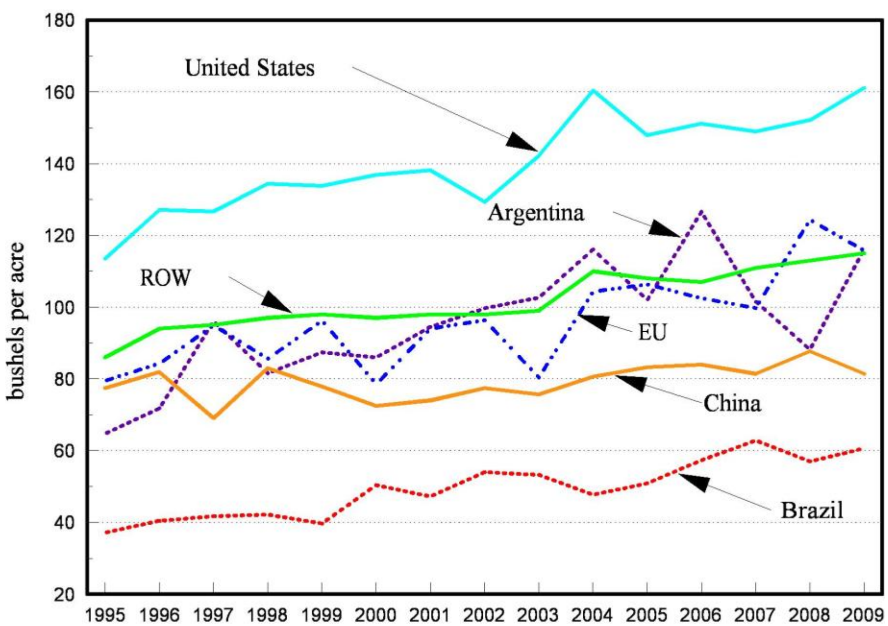

Figure 2. World Corn Yields, 1995-2009

In addition to larger world corn acres, world average yields have increased 34% between 1995 and 2009. Yields for other agricultural crops increased 23% and 22%, respectively, for soybeans and wheat. Corn yields in the U.S. increased 42% from 113 bushels per acre in 1995 to 161 bushels per acre in 2009. Corn yields increased in other countries. Chinese corn yields increased 5% while in Brazil and the European Union corn yields increased 63% and 46%, respectively. Brazil's corn yield is low because corn is a secondary, low input crop rotated with soybeans.

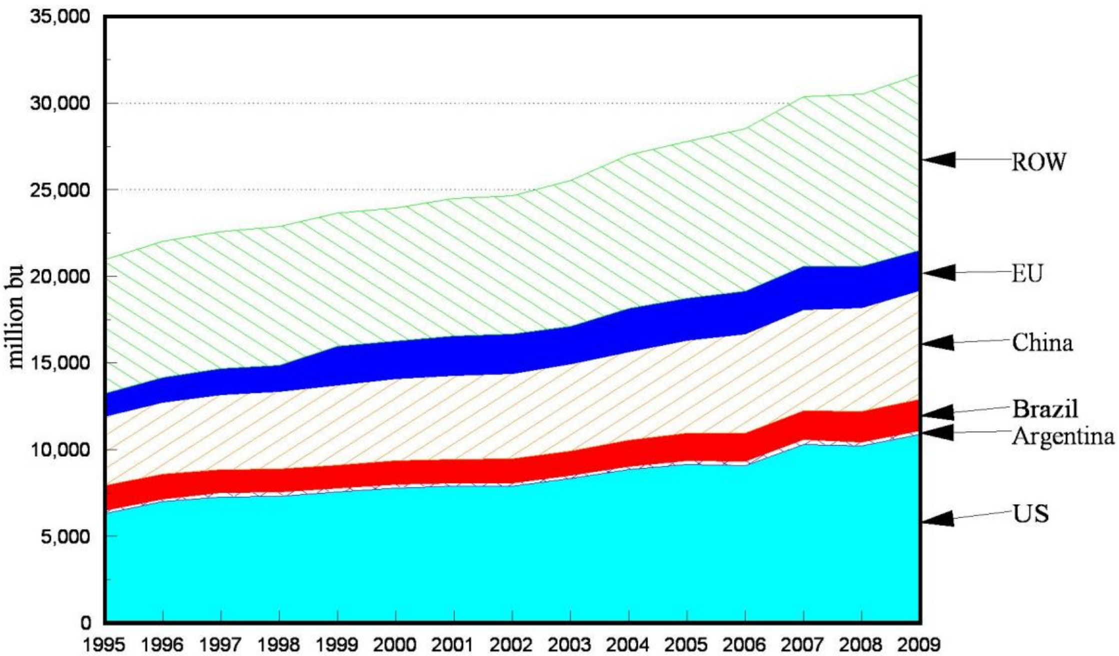

Figure 3. World Corn Consumption, 1995-2009

World corn consumption increased 52% between 1995 and 2009 (Figure 3). The countries with the largest growth in corn consumption have been EU, the U.S. and China. China's growth is due mainly to growth in the livestock sector and the U.S.' growth is a result of corn based ethanol production. Corn consumption in China increased 65% between 1995 and 2009, while that in the U.S. increased 72% during the same time period. Corn consumption in the European Union increased 76% and the Rest of world (ROW) region increased 32% during the same time period.

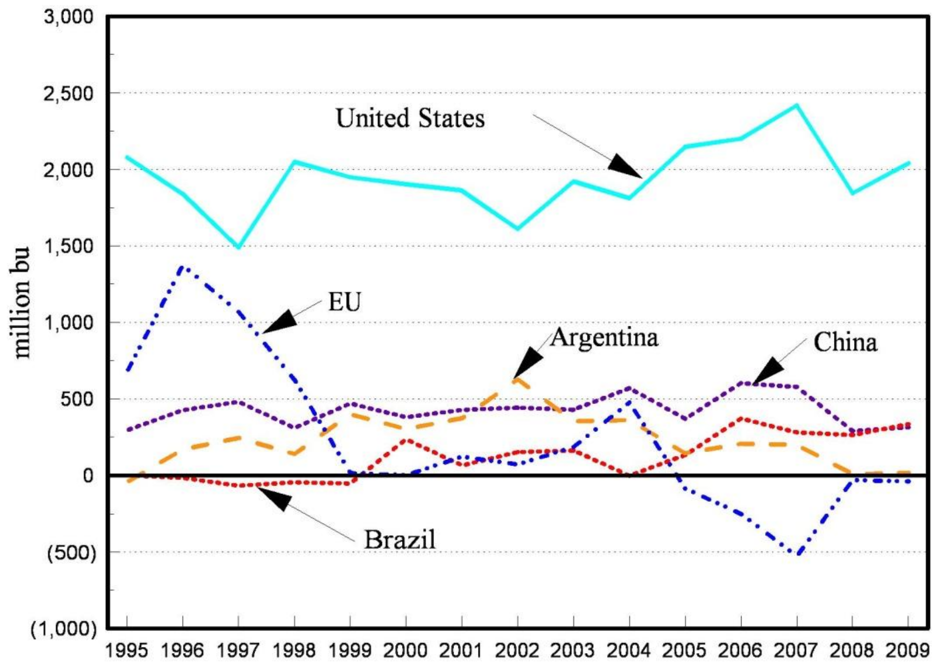

Figure 4. World Corn Exports, 1995-2009

The U.S. is the main exporter of corn, although China, the EU, Argentina and Brazil exported corn during some years. During the past 15 years, corn exports in the U.S. have remained relatively flat, at about 2 billion bushels per year. The ROW region increased imports of corn from less than 1 billion bushels in 1995 to 2.7 billion bushels in 2009.

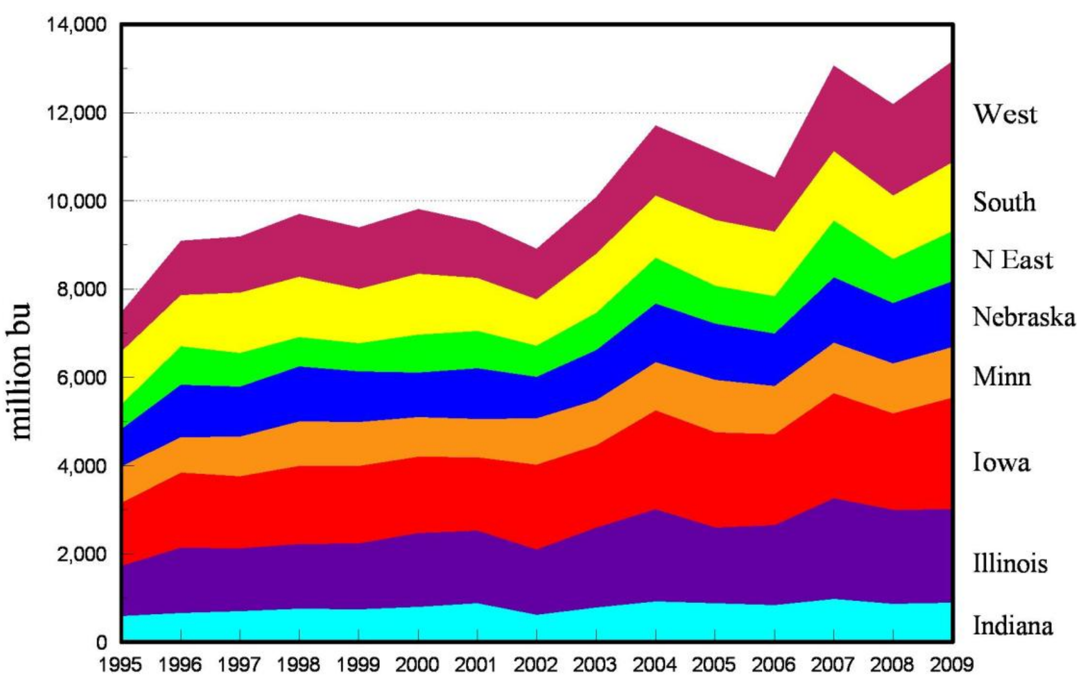

Figure 5. US Corn Production by Region/State, 1995-2009

Corn Production in the U.S.

The five largest corn producing states in the U.S. are Iowa (2.5 billion bushels), Illinois (2.1 billion bushels), Nebraska (1.5 billion bushels), Minnesota (1.2 billion bushels), and Indiana (0.9 billion bushels). Those five states produce 62% of the total quantity of corn production in the U.S. Iowa increased corn production 77% between 1995 and 2009, while Illinois and Indiana increased corn production 87% and 51%, respectively, during the same time period. Minnesota and Nebraska increased corn production 39% and 75%, respectively. The other regions of the country also increased corn production. The North East, South and West increased corn production 30%, 108%, and 160%, respectively. The large increases in the south and west regions are due to increased acres planted to corn.

Table 1 shows the states that are included in the three corn growing regions of the U.S. Several states have no corn production and are not listed in the table.

Area harvested for corn increased in most regions/states between 1995 and 2009. Corn acres increased 54% in the West region because of profit incentive and participation in the 1996 Farm Bill did not require planting wheat and barley program acres. Illinois and Iowa increased corn acres 18% and 16%, respectively, while the South region, Nebraska, and Indiana increased corn acres 14%, 9% and 3%. Minnesota and the North East region reduced corn acres 2% and 17%, respectively.

Table 1. Corn Producing States Divisions by Regions

Major	**North East**	**South**	**West**
Iowa	Delaware	Alabama	Arizona
Illinois	Maryland	Arkansas	California
Indiana	Michigan	Florida	Colorado
Minnesota	New Jersey	Georgia	Idaho
Nebraska	New York	Kentucky	Kansas
	Ohio	Louisiana	Montana
	Pennsylvania	Missouri	North Dakota
	Virginia	Mississippi	New Mexico
	Wisconsin	North Carolina	Oklahoma
	West Virginia	South Carolina	Oregon
		Tennessee	South Dakota
			Texas
			Utah
			Washington
			Wyoming

Table 2 shows corn yields by states/regions for the U.S. for the years 1995 through 2009. Iowa had the highest average corn yield for the years 1995-1998 at 133 bushels per acre compared to Nebraska at 129 bushels per acre. For 2007-09, Illinois had the highest average corn yield at 178 bushels per acre compared to Iowa at 177 bushels per acre. The fastest growth in yields was in the South region, 58%, followed by the North East, 43%, and Illinois, 41%. The lowest yield growth rate was in Nebraska and Minnesota.

Table 2. U.S. Corn Yields by Region/State

	1995-98	2007-09	% Change
	----------bushels per acre----------		
Indiana	119.3	160.0	34.1
Illinois	126.0	177.7	41.0
Iowa	133.0	176.7	32.8
Minnesota	125.3	160.0	27.7
Nebraska	128.7	167.0	29.8
South	84.8	133.8	57.8
North East	97.4	138.8	42.5
West	97.4	136.4	40.0

Figure 6 shows the U.S. utilization of corn for the years 1995 through 2009. The largest increase was for corn used in ethanol production, an increase of 961%, from 396 million bushels in 1995 to 4.2 billion bushels for 2009. Feed use increased 15%, other industrial uses increased 4% and exports decreased 2%. Total utilization increased 72% during the time period.

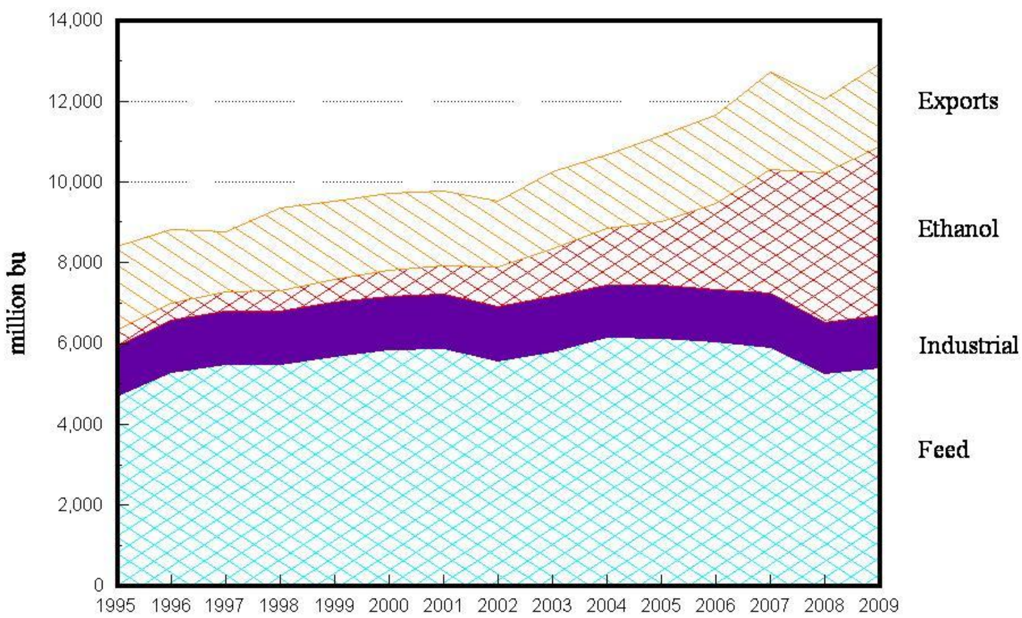

Figure 6. US Corn Utilization, 1995-2009

WORLD SOYBEAN INDUSTRY

Figure 7 shows the world soybean production by country/region. World soybean production increased 106% from 4.5 billion bushels in 1995 to 9.3 billion bushels in 2009. Argentina and Brazil increased soybean production 320% and 150%, respectively, during the same time period. The U.S. increased soybean production 43% between 1995 and 2009. Soybean production increased 299% in the ROW region. Most of that increase took place in other South American countries.

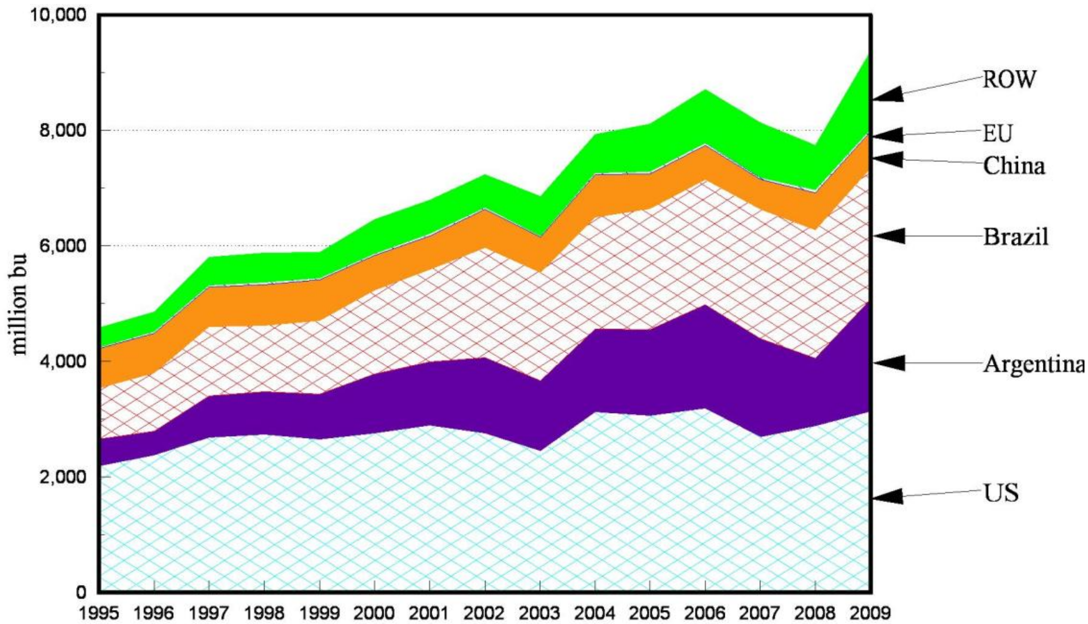

Figure 7. World Soybean Production, 1995-2009

World soybean yields have increased 23% in the last 15 years. Soybean yields in the U.S., Brazil and Argentina are very similar throughout the time period as shown in Figure 8. In 1995 they ranged between 32 bushels per acre and 35 bushels, increasing to between 40 bushels and 45 bushels per acre in 2009. Soybean yields in China have remained at about 25 bushels per acre and ROW soybean yield increased from 30 bushels per acre to 36 bushels per acre.

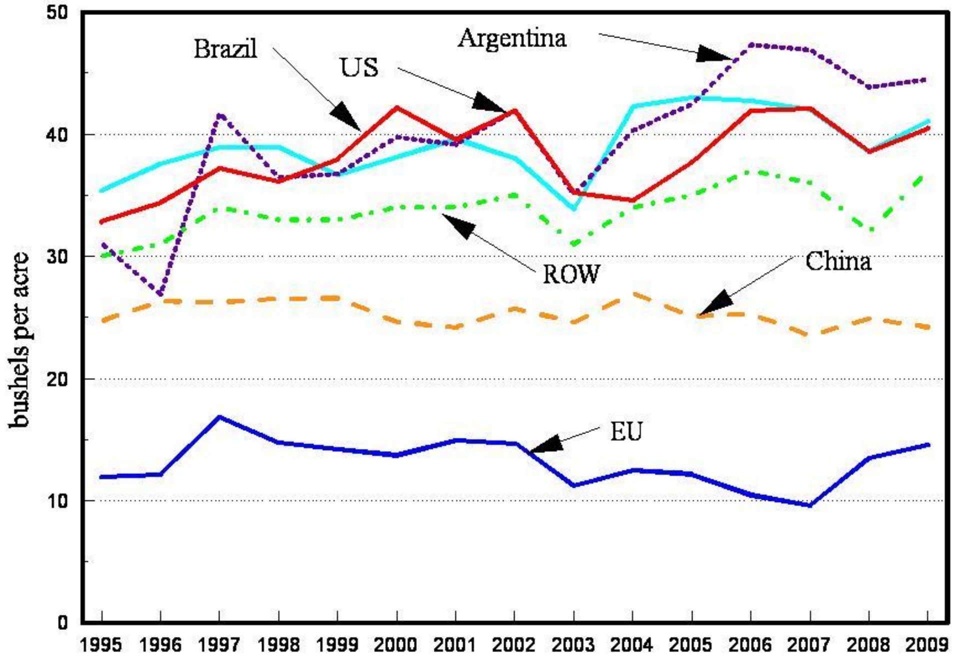

Figure 8. World Soybean Yields, 1995-2009

World soybean consumption increased 79% between 1995 and 2009 (Figure 9). Soybean consumption in China increased from 517 million bushels in 1995 to 2.0 billion bushels in 2009. In 2009 China became the largest soybean consumer in the world, passing the U.S. Soybean consumption increased 49% in Brazil and 238% in Argentina for the 1995-2009 period. U.S. consumption increased 26% from 1.5 million bushels in 1995 to 1.9 million bushels in 2009.

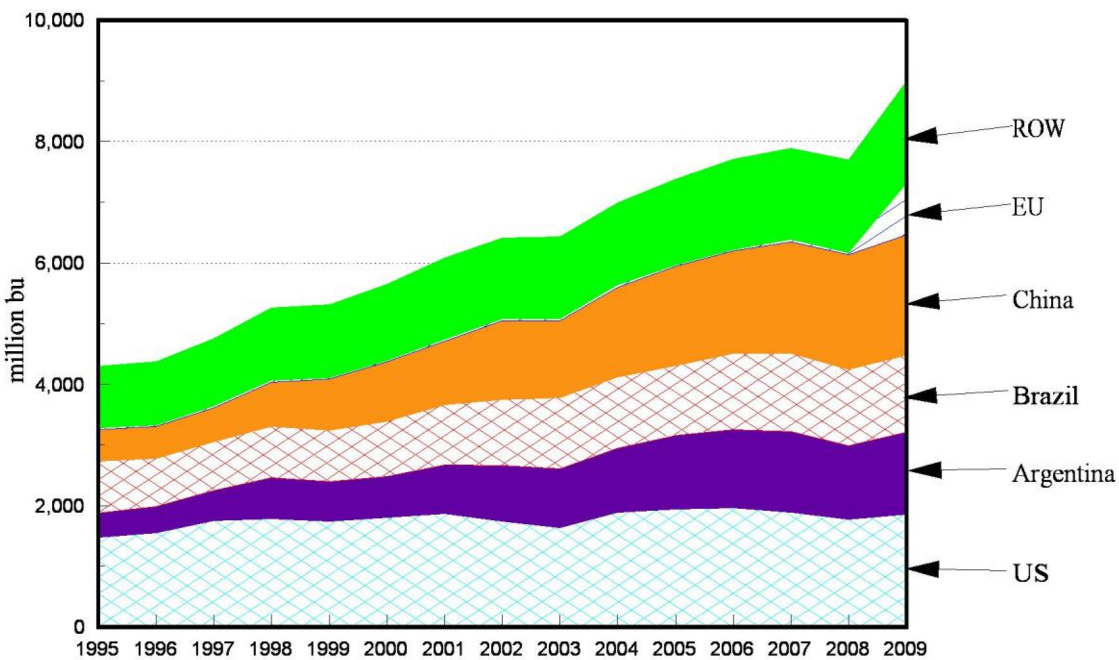

Figure 9. World Soybean Consumption, 1995-2009

The U.S., Brazil and Argentina export over 90% of the world's soybeans (Figure 10). China imports almost 60% of the world's exportable supplies of soybeans. The U.S. is the largest exporter of soybeans (52%), followed by Brazil (35%), and Argentina (14%). In 1995, the U.S. exported 84% of the soybeans traded in the world market.

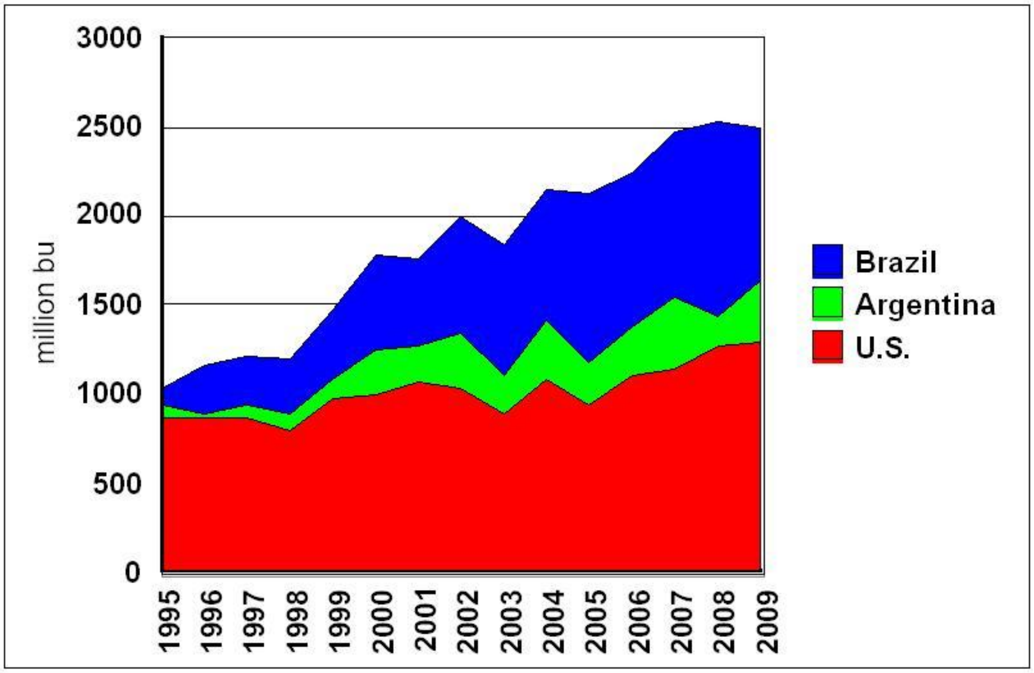

Figure 10. World Soybean Exports

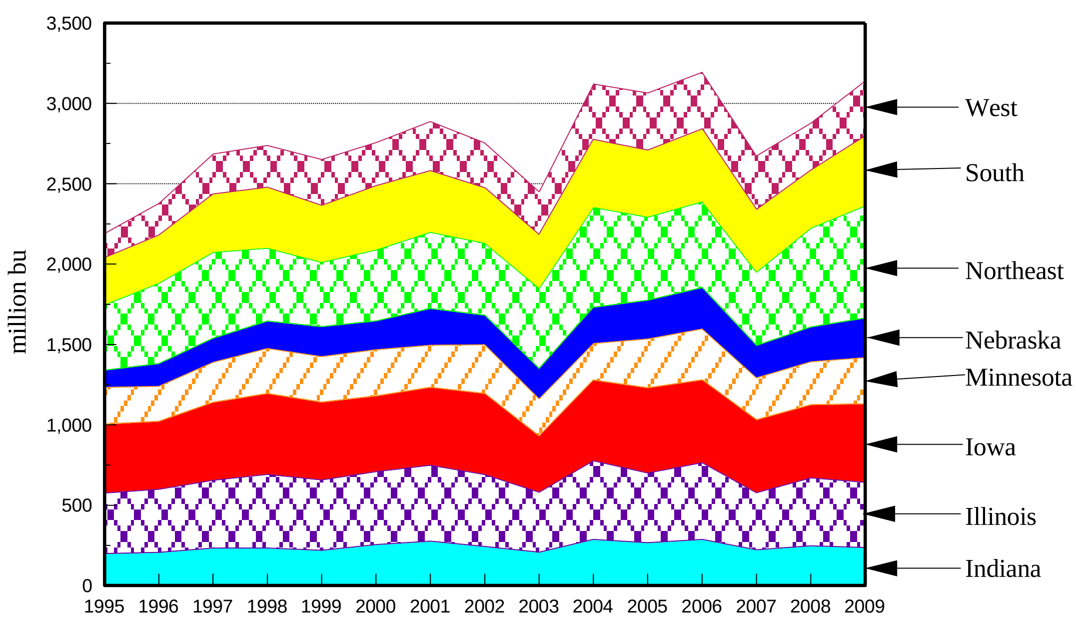

Figure 11. US Soybean Production, by Region/State, 1995-2009

U.S. Soybeans

Figure 11 shows the U.S. soybean production by state/region. Iowa is the largest producer of soybeans (482 million bushels), followed by Illinois (411 million bushels), and Minnesota (293 million bushels). The fastest growth has been in Nebraska (140%), followed by the West (123%), and South (70%), regions.

Much of the production growth has been in harvested acre as yield growth has been moderate (Table 3). Highest soybean yields are in Iowa, followed by Nebraska and Illinois. The fastest growth is in Nebraska (26.2%), followed by the South region (17.4%), and Iowa (12.3%). The increase in soybean yields has trailed behind corn yield growth.

Table 3. U.S. Soybean Yields by Region/States

	1995-98	2007-09	% Change
	------------bushels per acre--------------		
Indiana	40.3	44.7	10.7
Illinois	40.8	44.8	9.8
Iowa	44.7	50.2	12.3
Minnesota	39.2	40.2	2.6
Nebraska	39.5	49.8	26.2
South	30.9	36.2	17.4
North East	36.7	39.8	8.4
West	31.7	35.2	10.9

In spite of the increased production of soybeans in Argentina and Brazil, US exports of soybeans have increased 50% between 1995 and 2009, compared to a 2% decrease in corn exports. The bio-fuel use of soybeans has not been a major factor compared to corn. Biodiesel makes up a very small percentage of diesel use in the U.S. Domestic crush of soybeans has increased 23% and feed, seed, and waste have increased 56% between 1995 and 2009.

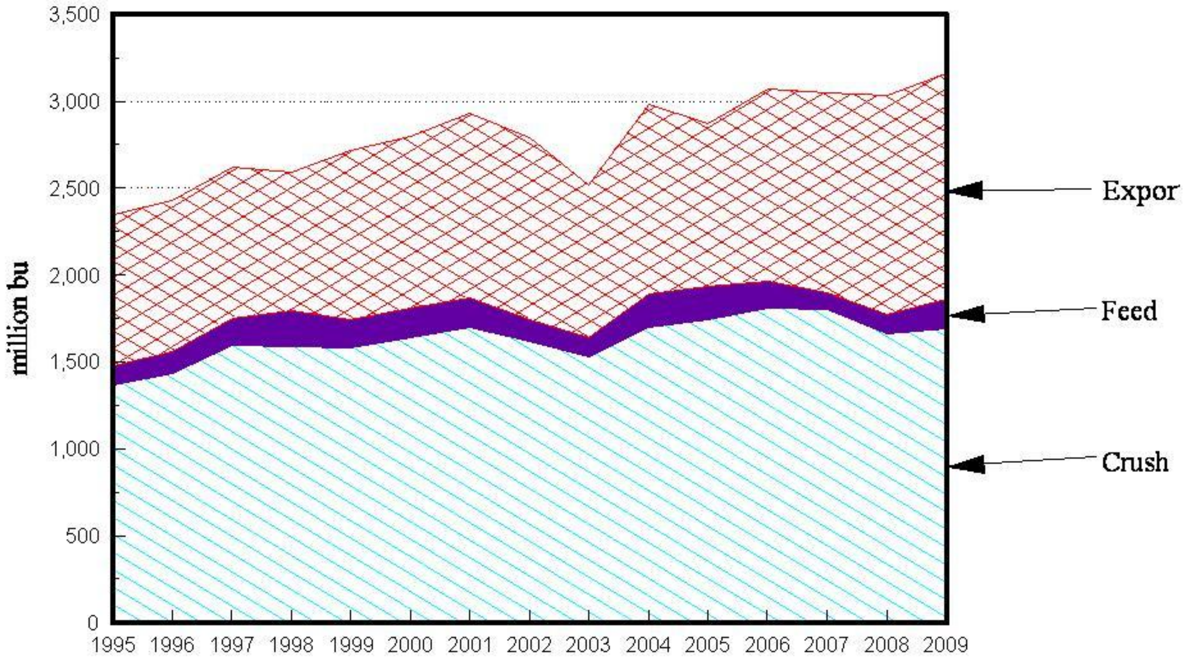

Figure 12. US Soybean Utilization, 1995-2009

AN ECONOMETRIC SIMULATION MODEL FOR CORN AND SOYBEANS

The empirical model for this study is a global multi-commodity partial equilibrium econometric simulation model, focusing on the world corn and soybean industries. The basic structure of the model is similar to the global wheat model by Benirschka and Koo. The world is divided into six regions in the model, the U.S., Argentina, Brazil, China, the European Union (EU) and the rest of the world (ROW). Commodities considered in this study are corn and soybeans, which compete with each other for crop-land. Wheat also competes with corn for crop-land. However, it is not included in the model since the competition is limited in only Plains states in the U.S. Supply, demand, and carry-over stock equations are estimated for the crops in all the countries/regions. The behavioral equations are equated, based on changes in the prices of the crops, so that the aggregated demand for all the countries/regions is equal to the aggregated supply for each crop. The model is used to forecast production, consumption, exports, and price of each crop over the next 10 years. It is assumed that U.S. and world agricultural policy remains unchanged, normal weather patterns continue, and there are no dramatic macroeconomic or political changes in the future simulation period.

The behavioral equations of corn and soybeans are estimated for the countries/regions and included in the model. The behavioral equation is supply, demand and carryover stocks of each crop.

<u>Supply of Corn and Soybeans</u>

Supply of corn and soybeans consists of production, beginning stocks, and imports. Harvested area of corn or soybeans is affected by the lag of the real prices of the crop and competing crops. The real price of corn or soybeans is expected to have a positive impact on the crop. The prices of the competing crops are expected to have a negative impact on harvested area. In addition, lagged harvest area (HA_{t-1}) is included as an independent variable to capture dynamics in a producer's response. The harvested area equation is specified as:

$$HA_t = \mathrm{f}(HA_{t-1}, P^c{}_{t-1}, P^{sb}{}_{t-1}, P^w{}_{t-1}) \tag{1}$$

where HA_t = harvested area in time t, $P^c{}_{t-1}$ = corn price in time t-1, $P^{sb}{}_{t-1}$ = soybean price in time t-1, and $P^w{}_{t-1}$ = wheat price in time t-1. The lagged dependent variable is used as an independent variable to capture dynamics in corn production based on the partial adjustment hypothesis (Nerlove).

The yield equation of each crop includes the real price and a trend variable to account for advance in farming technology. The yield equation is specified as:

$$Y_t = \mathrm{f}(P^c{}_t, T_t) \tag{2}$$

where Y_t = yield of corn or soybeans in time t, $P^c{}_t$ = price of corresponding crop in time t, and T_t = trend.

Total U.S. production of each crop is harvested area times yield as follows:

$$Pd_t = HA_t, *Y_t \tag{3}$$

where Pd_t = U.S. production in time t.

Demand for Corn and Soybeans

Domestic demand for corn and soybeans is comprised of domestic consumption and carry-over. These two crops are used for different purposes in the U.S. Corn is mainly used for animal feed and industrial uses, while soybeans are used for producing edible oil, soybean meal and bio-energy.

Demand for Corn

Corn used for feed is the total feed used for beef, pork, poultry, turkey and dairy production.

Feed Use: Feed use for cattle is specified as a function of the price of corn and a trend variable, as follows:

$$Fd^b{}_t = \mathrm{f}(P_t, T^b{}_t) \tag{4}$$

where $Fd^b{}_t$ = the quantity of corn used for cattle feed in time t, P_t = real price of corn in time t, and $T^b{}_t$ = trend variable.

Feed use for pork is specified as a function of the price of corn and a trend variable, as follows:

$$Fd^p{}_t = \mathrm{f}(P_t, T^p{}_t) \tag{5}$$

where $Fd^p{}_t$ = the quantity of corn used for cattle feed in time t, P_t = real price of corn in time t, and $T^p{}_t$ = trend variable.

Feed use for poultry is specified as a function of the price of corn and a trend variable, as follows:

$$Fd^c_t = f(P_t, T^c_t) \tag{6}$$

where Fd^c_t = the quantity of corn used for poultry feed in time t, P_t = real price of corn in time t, and T^c_t = trend variable.

Feed use for turkey is specified as a function of the price of corn and a trend variable, as follows:

$$Fd^t_t = f(P_t, T^t_t) \tag{7}$$

where Fd^t_t = the quantity of corn used for turkey feed in time t, P_t = real price of corn in time t, and T^t_t = trend variable.

Feed use for dairy is specified as a function of the price of corn and a trend variable, as follows:

$$Fd^d_t = f(P_t, T^d_t) \tag{8}$$

where Fd^d_t = the quantity of corn used for dairy in time t, P_t = real price of corn in time t, and T^d_t = trend variable.

It is expected that all feed variables will have a negative relationship with corn price.
Total feed use is $Fd_t = Fd^b_t + Fd^p_t + Fd^c_t + Fd^t_t + Fd^d_t$. (9)

When ethanol is produced from corn in the U.S., by-products can be used for animal feeding, thus, the quantity of by-product (*BP*) from ethanol should be subtracted from Fd_t as:

$$NFD_t = Fd_t - BP_t\,. \tag{10}$$

where NFD_t is net consumption of corn for feed use.

The quantity of by-product (bp) from ethanol production for feed is calculated as :

$$BP_t = a(b*E_t) \tag{11}$$

where E_t = corn used for ethanol, a = conversion rate from by-product to animal feed, and b = conversion rate from corn to by-product.

We assumed that a=70%, b=30%, and the by-products (BP) are being fed to cattle. One pound of corn used in ethanol production will produce about 0.3 pounds of BP that can be fed to livestock (FAPRI 2005, Lardy 2003, Iowa Beef Center 2002). One pound of BP can substitute for about 0.7 pounds of corn (FAPRI 2005, Oleson 2005).

Demand for Soybeans Crush:

Domestic soybean crush is specified as a function of the price of soybeans and a trend variable, as follows:

$$Cd^s_t = f(P_t, T^s_t) \tag{12}$$

where Cd^s_t = the quantity of soybeans used for domestic crush in time t, P_t = real price of soybean in time t, and T^s_t = trend variable.

Other Uses: Other uses of soybeans include, food, seed, and bio-energy. It is specified as a function of the price of soybeans and a trend variable, as follows:

$$Ud^s_t = f(P_t, T^s_t) \tag{13}$$

where Ud^s_t = the quantity of soybeans used for other uses in time t, P_t = real price of soybean in time t, and T^s_t = trend variable.

Corn Used for Ethanol Production

It is expected that high corn prices will have a negative impact on ethanol production, while high gasoline prices are expected to have a positive impact on ethanol production. Government subsidies are expected to have a positive impact on ethanol production. A dummy variable is used to indicate the year in which California mandated the removal of MTBE from gasoline within the state, which created an immediate increase in demand for ethanol. Demand for corn for ethanol use is specified as:

$$E_t = f(P^c_t, P^g_t, E_{t-1}, G^c_t) \tag{14}$$

where E_t = corn used for ethanol production in time t, P^c_t = real price of corn in time t, E_{t-1} = corn used for ethanol production in time t-1, P^g_t = gasoline price and G^c_t = government subsidy. The lagged dependent variable is used as an independent variable to capture dynamics in the use of corn for ethanol production based on the partial adjustment hypothesis (Nerlove).

Corn Used for Other Industrial Purposes:

It is expected that a high corn price will have a negative impact on other industrial use of corn such as HFCS, starch, glucose, and dextrose, and that a high soybean price will have a positive impact on the industrial use of corn. The demand model for other industrial use is specified as:

$$I_t = f(P^c_t, P^{sb}_t) \tag{15}$$

where I_t = the quantity of corn used for other industrial uses in time t, P^c_t = real price of corn in time t, P^{sb}_t = real price of soybeans.

Carry-over Stocks:

Crop price should have a positive impact on carry-over. As the price of a crop increases, total production of a crop increases while demand for a crop decreases, resulting in increases in carry-over.

The opposite will occur as the price of a crop decreases. Thus, the carry-over stocks equation is specified as a function of the price of a crop, and lagged carry-overstock as follows:

$$ES_t = f(P^c_t, ES_{t-1}) \tag{16}$$

where ES_t = carry-over stocks.

ROW Import Demand and Export Supply: ROW import demand is the summation of the import demand from other countries (Canada, Taiwan, Mexico, Japan, South Korea, Algeria, Egypt, and Latin American countries). The price of a crop is expected to have a negative impact on import demand, while the price of the other crop is expected to have a positive impact. The import demand model for the ROW is specified as:

$$ED^w_t = f(P^c_t, P^{sb}_t, Y_t) \tag{17}$$

where ED^w_t = ROW import demand for a crop in time t, P^c_t = real world price of a crop in time t, P^{sb}_t = real world price of the other crop in time t, and Y_t = weighted average real per capita income in t.

ROW export supply increased from about 700 million bushels in 1998 to 1 billion bushels in 2009. ROW export supply is a function of export price and a trend variable to capture changes in technology. The ROW excess supply equation is specified as:

$$ES^w_t = f(EP_t, T_t) \tag{18}$$

where ES^w_t = ROW excess supply in time t, EP_t = real export corn price in time t, and T_t= trend variable. It is expected that both the export price of corn and trend variable will have a positive impact on excess supply.

Corn to Soybean Price Ratio

Harvested acres of corn and soybeans, traditionally, have followed the corn to soybean price ratio. Since the land area is limited, producers make planting decisions based on the prices of both crops. If the corn price is high compared to soybeans, more corn is planted and vice-versa. Historically the ratio has varied between 2.2 and 2.7 (USDA 1998). The corn to soybean price ratio and the area of corn and soybeans are determined for each region and country in the model. The forecasted area for corn and soybeans is required to be less than the maximum available land area planted to the two crops during the past 10 years. If the estimated areas for the two crops were greater than the maximum area, both crops are reduced based on the estimated corn soybean ratio for that year.

Equilibrium conditions:

The equilibrium conditions for corn and soybeans are established in such a way that the aggregated excess supply of corn equals the aggregated demand. Excess supply of corn and soybeans equals beginning stocks plus production minus domestic feed use, used for bio-energy production, other industrial use, and carry-over stocks of the corresponding crop in county/region n, as follows:

$$XS^n_t = ES_{t-1} + Pd_t - NFd_t - E_t - I_t \tag{19}$$

where XS^n_t = export supply in country/region n in time t.

The excess supply of each crop in county/region n and ROW excess supply of each crop should be equal to total excess demand under the equilibrium condition, as follows:

$$\sum_{1}^{n} \overline{ES}^{n}_{t} + (ES^{w}_{t} - ED^{w}_{t}) = 0.0 \text{ for corn and soybeans.} \tag{20}$$

Equation 20 represents two equilibrium conditions; one for corn and the other for soybeans. These equations are a function of prices of corn and soybeans. The equations, therefore, are solved for the prices of corn and soybeans. Equilibrium demands, supply and carry-over stocks of corn and soybeans are determined simultaneously. Since the base year for the simulation is 2009, the simulation is continued for 10 years until 2019. The simulation results in 2019 represent the full effects of the Energy Act of 2007 which requires the production of 15 billion of corn based ethanol.

Data

Historical harvest area, yield, production, feed use, import demand, domestic consumption, and carry-over stocks data were obtained from the PS&D database from the Economic Research Service (ERS) for the years 1980 to 2009. Corn and soybean prices and corn use for ethanol were obtained from ERS. Actual gasoline prices, as well as forecasted prices were obtained from the U.S. Department of Energy, and cattle on feed numbers were obtained from the National Agricultural Statistics Service (NASS). All price data were converted to real terms using the GDP deflator (International Monetary Fund). Ethanol production data were obtained from ERS and the Renewable Fuels Association website .

OUTLOOK FOR THE CORN AND SOYBEAN INDUSTRIES

World Trade of Corn and Soybeans

World corn trade is projected to increase 13% between 2009 and 2019 (Table 5). U.S. exports are expected to remain at the current level as domestic ethanol use requires increasing amounts of corn. Both Argentina and Brazil will increase exports while China is expected to become an importer of corn by 2019. World soybean trade will increase 66% between 2009 and 2019 as China is expected to increase imports by 55% in 2019 from the 2008-2009 average (Table 4). U.S. soybean exports are expected to remain flat as cultivated acres are limited in the U.S. Since 2007, Argentina has been increasing soybean production rapidly due to restrictions on the exportation of beef. Pasture land is being converted to soybeans. That trend is expected to continue into the near future. Brazil will continue to increase soybean exports to satisfy Chinese soybean demand.

Table 4. World Corn and Soybean Trade

	2008-2009	2009	2019	Change
Corn	----------------million bu------------			%
US	1,942	2,040	1,970	1.4
Arg	302	314	422	39.7
Brazil	300	335	484	61.6
China	13	18	(1,113)	NA
EU	(35)	(39)	102	NA
ROW	(2,522)	(2,668)	(1,865)	-26.1
Soybeans				
US	1,280	1,295	1,299	1.5
Arg	254	338	1,069	321.7
Brazil	982	863	1,801	83.5
China	(1,457)	(1,433)	(2,256)	54.8
EU	(466)	(454)	(699)	50.2
ROW	(593)	(609)	(1,614)	172.2

Figure 13 shows the projected corn exports for the U.S., Brazil and Argentina. U.S. exports are expected to decrease through 2012 and 2013 before increasing towards the end of the forecast period. The exports for both Brazil and Argentina are expected to remain relatively constant with a slight increase towards the end of the forecast period. Figure 14 shows the projected soybean exports for the major exporting countries. The U.S. is currently the largest exporter of soybeans but Brazil is projected to surpass the U.S. in soybean exports by 2012. The U.S. soybean production is expected to remain near current levels until later in the forecast period which allows Brazil to increase soybean exports to satisfy world demand. Argentina is also expected to increase soybean exports throughout the forecast period.

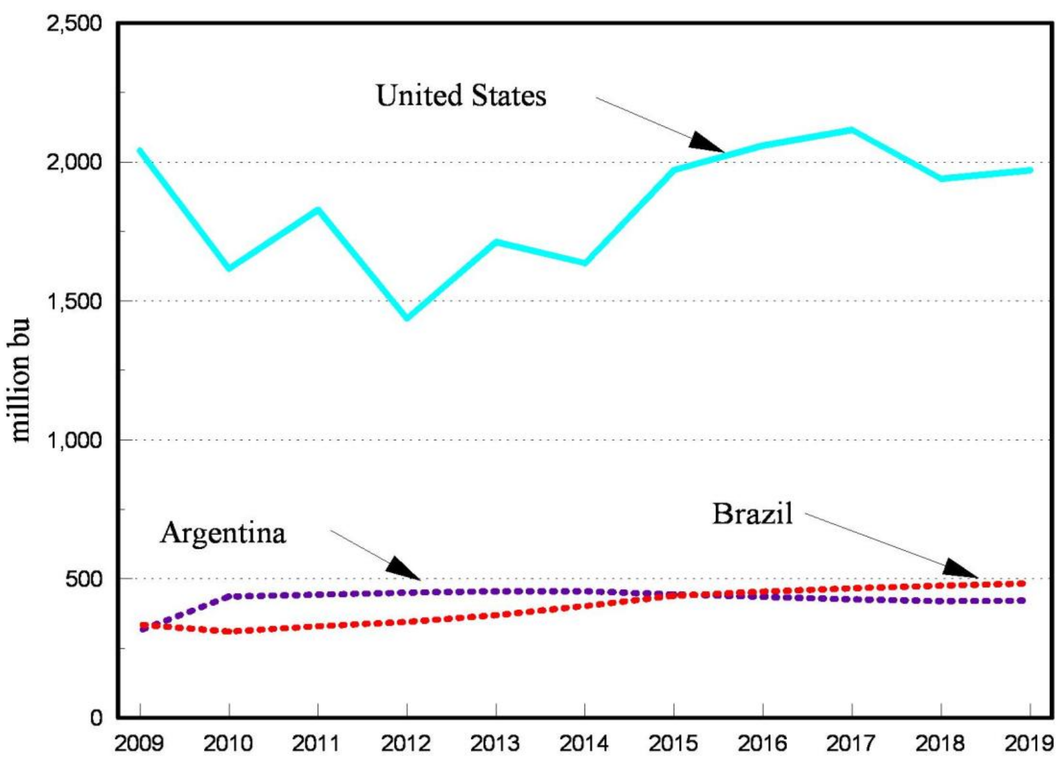

Figure 13. Projected Corn Exports by Major Exporters

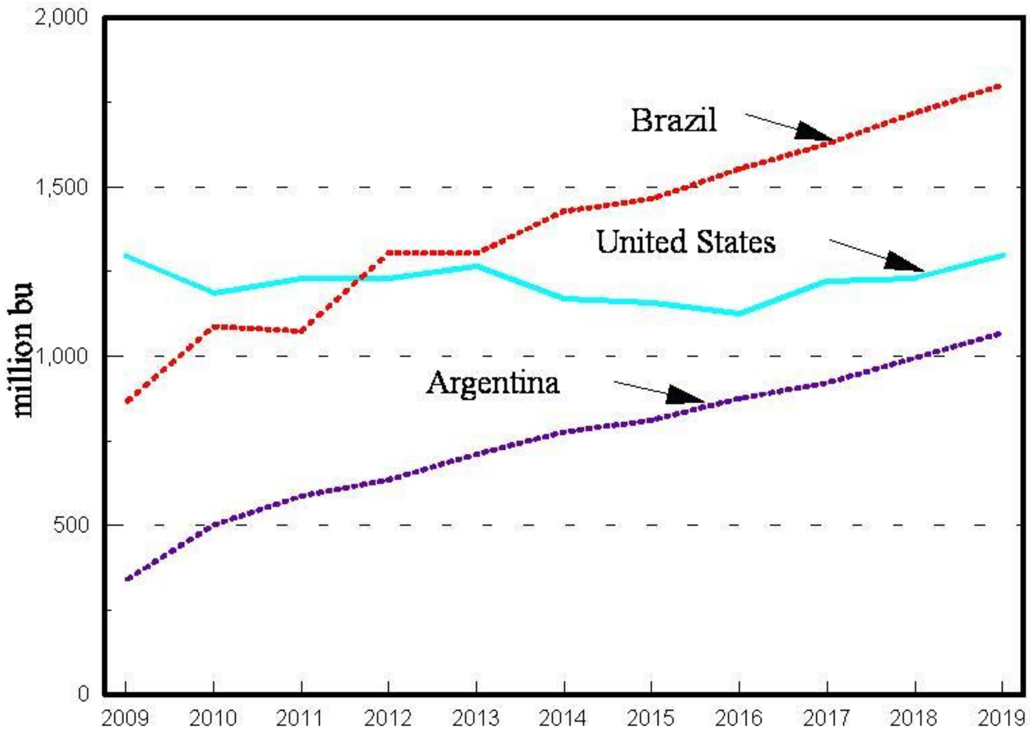

Figure 14. Projected Soybean Exports by Major Exporter

World Production of Corn and Soybeans

World corn production is expected to increase 11%, from 48 billion bushels in 2008-2009 average to 53 billion bushels in 2019. The U.S. will increase corn production by 12% while Argentina will increase corn production by 10% (Table 5). Brazil's production in 2019 is expected to be larger than 2009 but smaller than the 2008-2009 average because the country had a large corn crop in 2008. Historically, Brazil has produced about 2 billion bushels of corn per year. Chinese corn production is expected to increase about 9% to 6.1 billion bushels by 2019 but not enough to prevent the importation of corn for domestic use. Corn production in the European Union is expected to increase from 2.3 billion bushels in 2009 to about 3.1 billion bushels in 2019 which will satisfy domestic needs. Corn production by the major producing countries is shown in Figure 14. U.S. corn production is expected to decrease slightly during 2010 through 2012 before increasing to over 14 billion bushels. Argentine corn production has been around the 550 million to 600 million bushels per year and it is expected to remain near that level.

Table 5. World Corn and Soybean Production

	2008-2009	2009	2019	Change
Corn	-------------million bu	--------------		%
US	12,511	12,921	14,029	12.1
Arg	526	557	579	10.2
Brazil	2,663	2,049	2,514	-5.6
China	5,659	5,456	6,143	8.6
EU	2,465	2,339	3,147	27.7
Soybeans				
US	3,012	3,143	3,444	14.3
Arg	1,553	1,929	2,463	58.6
Brazil	2,248	2,278	3,059	36.1
China	640	632	963	50.4
EU	46	44	67	44.6
ROW	7,499	8,026	9,996	33.3

The U.S. is projected to increase soybean production about 14% by 2019. U.S. production growth is limited because of land constraints. However the U.S. is the largest producer of soybeans and will remain as it is during the forecast period. Production is expected to increase from about 3 billion bushels in 2009 to about 3.4 billion bushels in 2019. Argentina and Brazil are expected to increase soybean production by 59% and 36%, respectively. Brazil's soybean production is projected to increase from 2.3 billion bushels to 3.1 billion bushels during the same time period. Brazil has range and pasture land available for conversion and Argentina is converting pasture land into cultivated land due to government regulations concerning beef exports. Argentine soybean production should increase from 1.9 billion bushels to 2.4 billion bushels between 2009 and 2019. Figure 16 shows the projected soybean production for the major producing countries China's soybean production will increase during the forecast period but remain below 1 billion bushels. EU's soybean production will remain small into the near future.

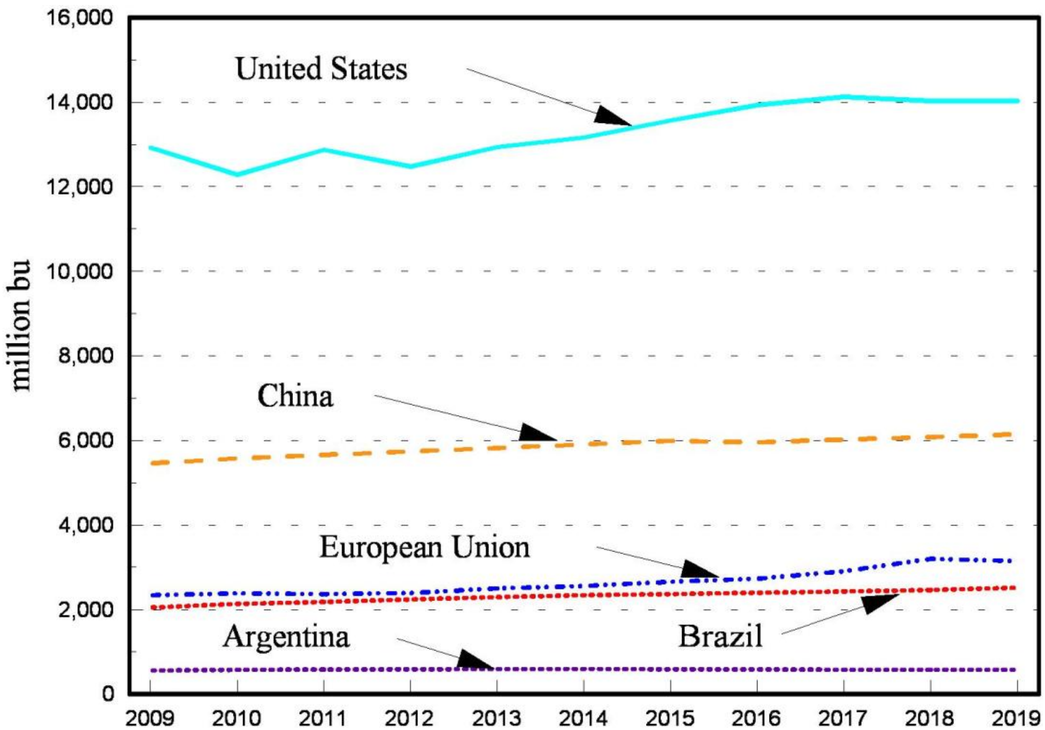

Figure 15. Projected Corn Production by Major Producers

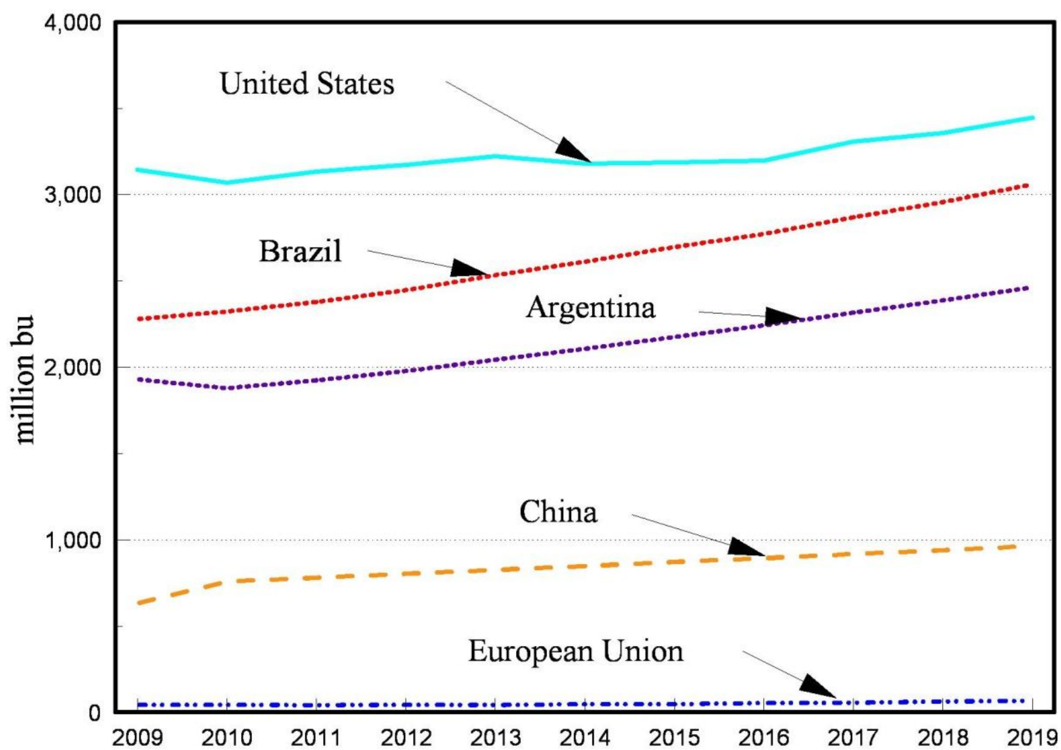

Figure 16. Projected Soybean Production by Major Producers

Corn and Soybean Production in the U.S.

Table 6 shows the yield and harvested acres for the states/regions in the U.S. Iowa has the highest average yield of 180 bushels per acre followed by Illinois and Nebraska. Outside of the major corn producing states, the northeast has the highest yield at 142 bushels per acre. Yields are expected to increase in all states/regions except for the south. The reason for lower yields in 2019 than in 2008-2009 in the south is that the corn yield in the south region for 2009 was much higher than normal. Corn yields in the south during the last few years have ranged between 115 bushels per acre in 2004 to 132 bushels per acre in 2006. Harvested acres in the U.S. are expected to remain around 79.7 million acres throughout the forecast period.

Table 7 shows yields and harvested acres for U.S. soybeans. Soybeans yields are expected to increase in most states/regions in the United States. Yields for Minnesota and the south are projected to be 2.4% and 12.8% lower in 2019 than in 2008-2009. The main reason is that both areas had high soybean yields in 2008. Highest yields are expected in Nebraska followed by Iowa. The largest harvested acres are in the south region followed by the west region and the north east. Iowa has the largest harvested acres followed by Illinois and Minnesota. The U.S. planted 73.8 million acres of soybeans in 2009 and harvested acres are expected to increase to 76.5 million acres by 2019.

Figure 17 shows the production of corn by state/region for the U.S. Iowa is the largest corn producing state in 2009 (2.5 million bushels), followed by the west region and Illinois. Total U.S. corn production in 2009 was 12.9 billion bushels which is expected to increase 9% to 14.0 billion bushels by 2019. The fastest growth is expected to be in Indiana (20%), followed by Nebraska (14%), and Illinois (12%). Total U.S. production is projected to increase 6% between 2009 and 2019. Production increase for 2019 from the 2008-2009 average is almost 18%.

In Figure 18 shows the production of soybeans by state/region. The south region was the largest soybean producing region in 2009 with 429 million bushels, followed by Iowa and the northeast region. However, the south region had an unusually large crop in 2009. The fastest increase in soybean production is projected to be in the West region (36%), followed by Nebraska and Minnesota. The production in the south is projected to decrease in 2019 due mainly to the very large soybean crop in 2009.

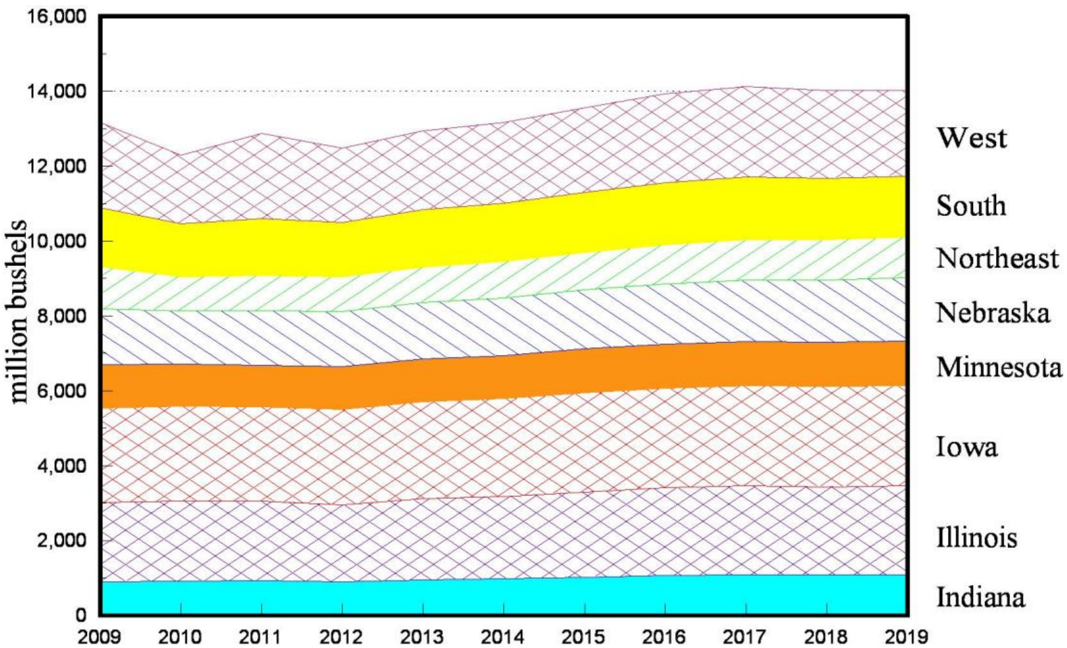

Figure 17. Projected U.S. Corn Production by State/Region

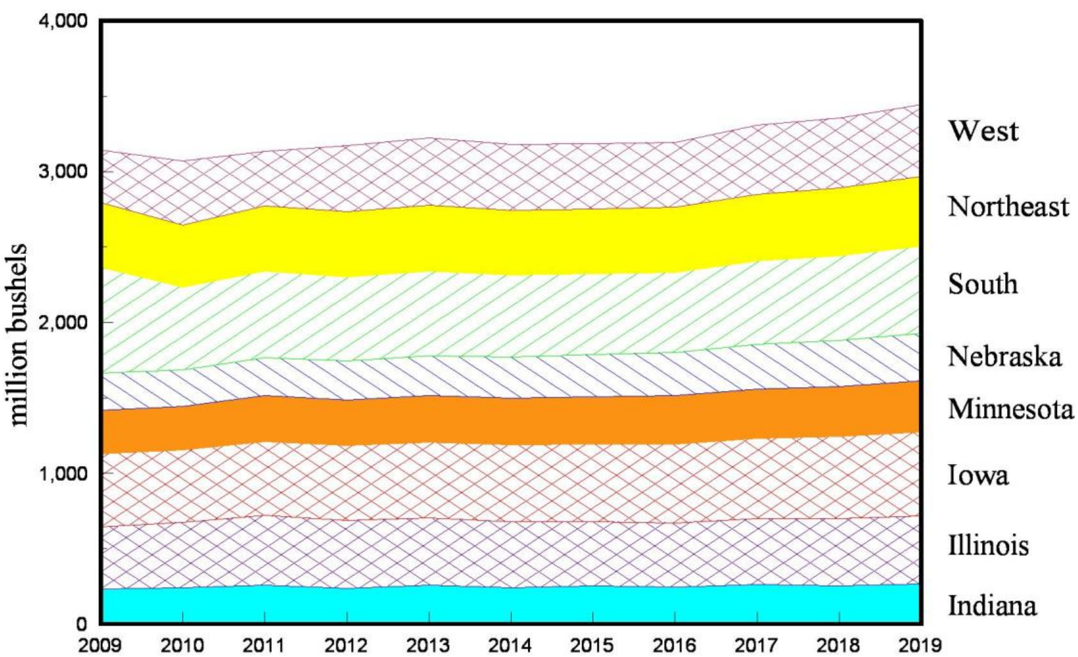

Figure 18. Projected U.S. Soybean Production by State/Region

Table 6. U.S. Corn Yields and Harvested Acres

Yields	2008-2009	2009	2019	change
	---------bushels per acre--------			%
Indiana	163	166	191	17.1
Illinois	179	179	201	12.2
Iowa	180	188	211	17.7
Minnesota	167	170	191	14.3
Nebraska	171	178	187	9.4
South	135	141	130	-3.7
Northeast	142	149	151	6.5
West	138	144	151	9.5
Harvested acres				
	------------million acres------------			
Indiana	5,450	5,440	5,681	4.1
Illinois	11,850	11,800	11,798	-0.4
Iowa	13,119	13,438	12,712	-3.2
Minnesota	6,848	6,781	6,208	-10.3
Nebraska	8,382	8,398	9,097	7.9
South	7,915	8,065	8,322	4.9
Northeast	10,563	10,474	10,808	2.3
West	15,666	15,833	15,140	-3.5

Table 7. U.S. Soybean Yields and Harvested Acres

Yields	2008-2009	2009	2019	change
	--------bushels per acre---------			%
Indiana	44	43	49	10.7
Illinois	45	44	50	10.5
Iowa	47	52	55	14.5
Minnesota	44	40	43	-2.4
Nebraska	44	52	58	23.3
South	44	39	39	-12.8
Northeast	38	42	42	9.2
West	37	36	37	1.8
Harvested acres				
	-----------million acres-------------			
Indiana	5,430	5,430	5,421	-0.2
Illinois	9,235	9,350	9,004	-2.6
Iowa	9,476	9,282	10,008	5.3
Minnesota	7,252	7,319	7,892	8.1
Nebraska	4,599	4,654	5,464	15.8
South	17,472	17,920	15,036	-16.2
Northeast	10,097	10,222	10,932	7.6
West	9,406	9,609	12,764	26.3

Prices of Corn and Soybeans in the U.S.

Figure 19 shows the projected corn and soybean prices for 2009 through 2019. Corn price is expected to increase slightly to $3.80 per bushel in 2010 and continue to increase to $4.08 by 2013 and 2014 before slowly decreasing to $3.40 per bushel by 2019. Soybean price is expected to increase slightly in 2010 to $9.70 per bushel, rising to $9.90 per bushel in 2013. After 2013, soybean price is projected to vary between $9.60 per bushel to $9.80 per bushel throughout the forecast period.

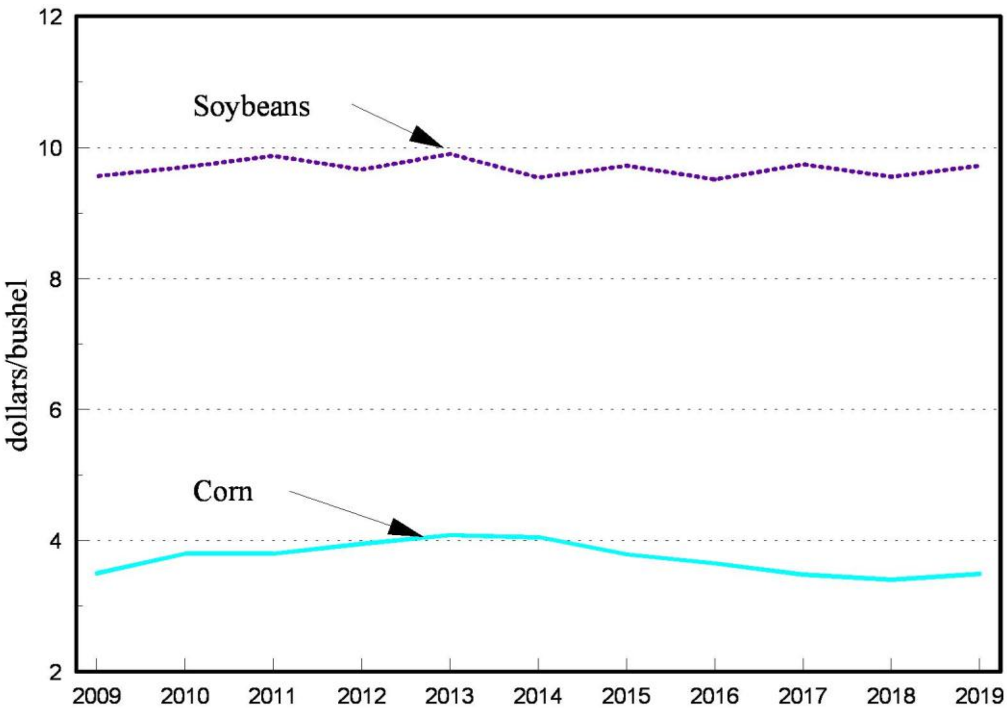

Figure 19. Projected Corn and Soybean Prices

U.S. Export and Utilization of Corn and Soybeans

Figure 20 shows the projected utilization for U.S. corn. Exports are expected to vary between 1.4 billion bushels in 2012 to 2.1 billion bushels in 2017. By 2019, corn exports are projected to be 3% less than 2009. The feed use of corn is projected to increase 11% from 5.4 billion bushels in 2009 to about 6 billion bushels in 2019. Ethanol use of corn is expected to increase 15% from 4.2 billion bushels in 2009 to 4.8 billion bushels in 2019. Other industrial uses are projected to increase 4% between 2009 and 2019. Total U.S. consumption of corn is expected to increase 12% during the forecast period.

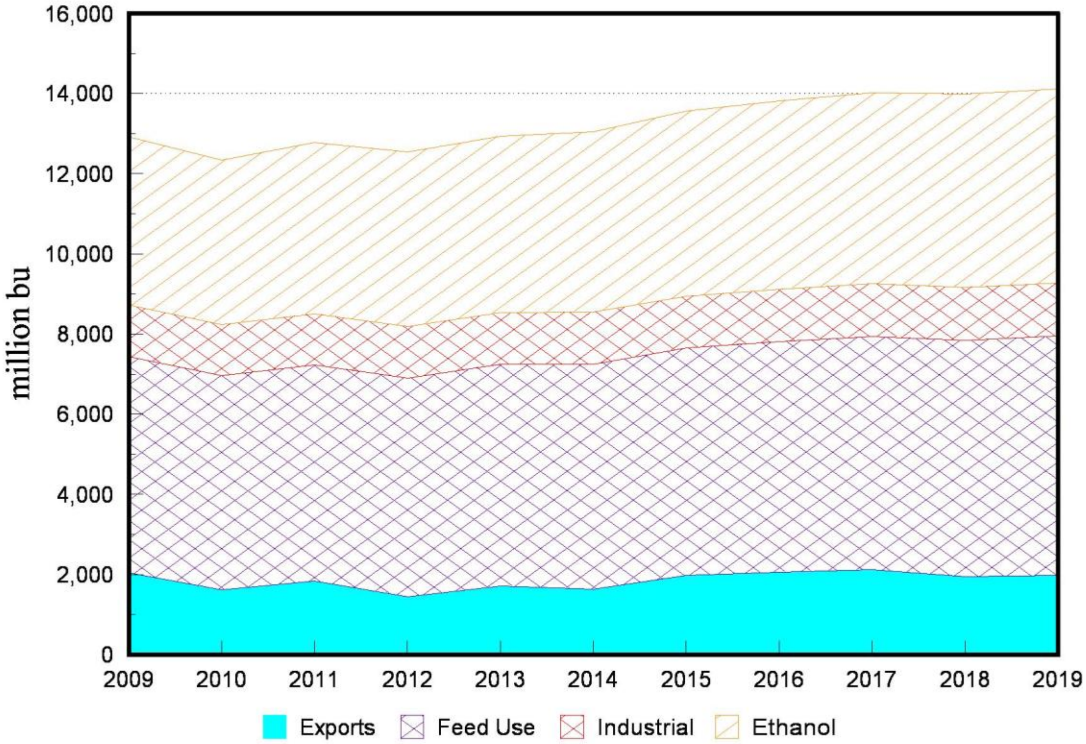

Figure 20. Projected U.S. Corn Utilization

U.S. exports of soybeans are expected to remain flat during the forecast period between 1.2 billion bushels and 1.3 billion bushels (Figure 21). U.S. domestic processing is projected to increase 16% from 1.7 billion bushels in 2009 to about 2.0 billion bushels in 2019. Feed and other uses are expected to increase about 6%. Total domestic consumption is expected to increase about 15% during the forecast period.

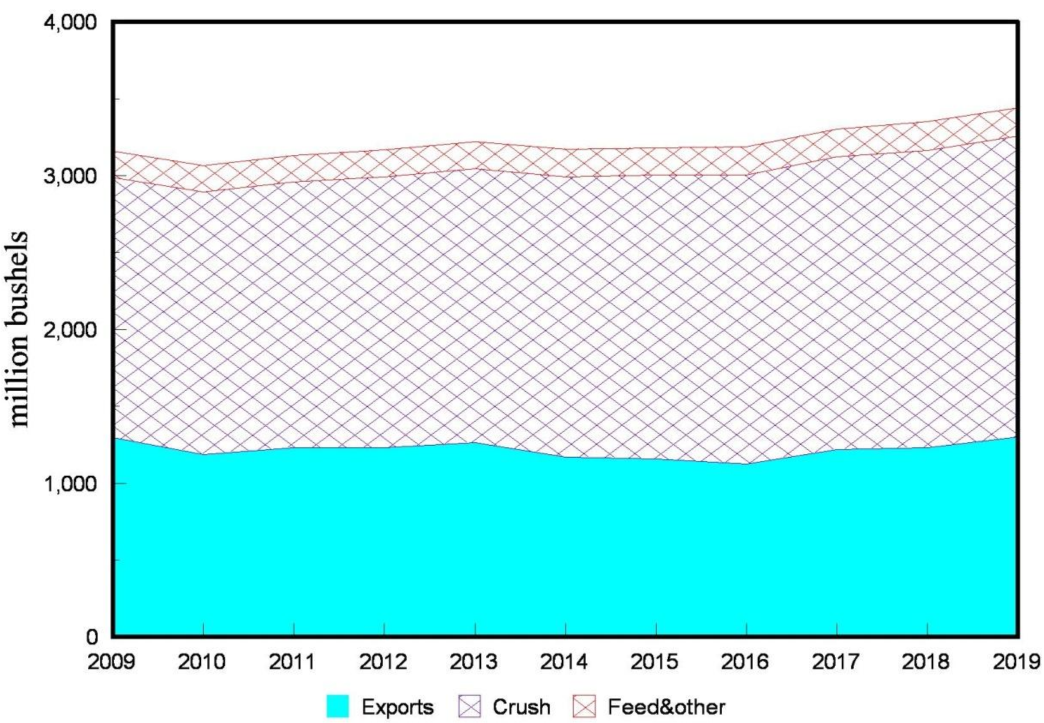

Figure 21. Projected U.S. Soybean Utilization

CONCLUSIONS

Recently, the commodity markets experienced price increases which were caused, in the most part, by forces outside of agriculture. Late 2005 and early 2006 the price of crude oil doubled which drove up the price of energy. Increased energy prices increased the demand for and price of ethanol. The high price of corn caused by increases in ethanol production impacted all other commodities. During 2008, commodity prices returned to levels near historical levels.

In spite of high commodity prices, world trade of corn and soybeans remained strong, due mainly to the weakening of the U.S. dollar against major currencies. China, the largest importer of soybeans, continued to import increasing amounts of soybeans for its domestic use.

The U.S. will be the largest exporter of corn, however exports should remain near current levels. Production increases in the U.S. will be absorbed by the growing corn based ethanol industry. Feed use for corn will also increase, but only moderately. Some of the increased demand will be absorbed by DDGs.

The ethanol industry in the U.S. will continue to grow but at a slower rate than in the past. The capacity increases in recent years will not continue since profit margins have narrowed in the past 2 or 3 years. The Energy Security and Independence Act of 2007 requires 36 billion gallons of ethanol to be blended with the U.S. gasoline supply with about 25 billion gallons coming from bio-mass based ethanol by 2025. The corn based ethanol industry is currently at or near the expected production of 11 billion gallons. Bio-mass ethanol production has not moved beyond the testing and research stage due to high production costs.

China's demand for soybeans continues to increase into the future as increases in income continue to change dietary patterns in the country. In 2009, China imported 1.4 billion bushels of soybeans. By 2019, it is projected to import about 2.3 billion bushels of soybeans. Most of the additional soybeans demand in China will come from the South American nations since the U.S. does not have additional land to increase soybean production.

The prices of corn and soybeans are expected to remain strong in the near term but weaken towards the end of the forecast period. Corn price is projected to remain strong through 2014, $4.05 per bushel, and then weaken through 2019. Soybean price should remain strong through 2011 but weakening through 2019.

The U.S. ethanol industry is expected to continue to grow but at a slower rate than in the past. In 2009, 4.2 billion bushels of corn was used for ethanol production and by 2019 it is projected that 4.8 billion bushels of corn will be used for the production of ethanol.

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