Agribusiness & Applied Economics Report No. 682 **July 2011**

2011 Outlook of the U.S. and World Corn and Soybean Industries, 2010-2020

Richard D. Taylor and Won W. Koo

Center for Agricultural Policy and Trade Studies
Department of Agribusiness and Applied Economics
North Dakota State University
Fargo, North Dakota 58108-6050

ACKNOWLEDGMENTS

The authors extend appreciation to Andrew Swenson and Bruce Dahl for their constructive comments and suggestions. Special thanks go to Edie Watts, who helped to prepare the manuscript**.** The authors assume responsibility for any errors.

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ABSTRACT

This report evaluates the United States and world corn and soybean markets for the 2010-2020 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.

Corn-based ethanol production has influenced United States corn industry. As long as the production of corn-based ethanol remains strong, corn prices will likely remain at a level higher than the long term average. However, changes in the U.S. Federal government subsidies or mandates could significantly impact the world corn market. Under the current assumptions in the model, corn price is expected to remain in a range between $4.68 and $5.35 per bushel.

Chinese soybean import is the leading factor influencing the world soybean market. China currently imports 65% of soybeans trade in the world market, and that is expected to increase to about 70% by 2020. Major exporters will continue to be the U.S., Brazil and Argentina. However both Brazil and Argentina could increase exports while U.S. exports will remain at the current level. Soybean prices are expected to remain strong but slowly decrease to about $9.82 by 2020.

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

HIGHLIGHTS

World corn trade is projected to increase by 13% between 2010 and 2020. 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 2020.

World soybean trade will increase by 66% between 2010 and 2020. China is expected to increase imports by 43% in 2020 from the 2009-2010 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 23%, from 31 billion bushels in 2009-2010 to 38 billion bushels in 2020. The U.S. will increase corn production by 18%, while Argentina will increase corn production by 25%. Brazil is expected to reduce corn production because of competition with soybeans for acres.

The U.S. is projected to increase soybean production about 11% by 2020. U.S. production growth is limited because of land constraints. Argentina and Brazil are expected to increase soybean production by 28% and 26%, respectively.

U.S. corn yields are expected to increase in all states/regions. Harvested acres in the U.S. are expected to increase from 81 million acres in 2010 to 85 million acres in 2020. U.S. soybeans yields are expected to increase in most states/regions in the country. The largest corn harvested acres are in the South region, followed by the West region and the Northeast region. Iowa has the largest corn harvested acres in the United States, followed by Illinois and Minnesota. The U.S. planted 73.0 million acres of soybeans in 2010 and harvested acres are expected to increase to 76.0 million acres by 2020.

Total U.S. corn production in 2010 was 12.4 billion bushels and is expected to increase by 20% to 15.0 billion bushels by 2020. The fastest growth is expected to be in Nebraska (28%), followed by Indiana (27%), and Illinois (18%).

Exports are expected to increase from 2.0 billion bushels in 2010 to 2.6 billion bushels in 2016 before decreasing to 1.8 billion bushels in 2020. The feed use of corn is projected to increase by 13% from 5.4 billion bushels in 2010 to about 6 billion bushels in 2020. Ethanol use of corn is expected to increase by 15% from 5.2 billion bushels in 2010 to 5.9 billion bushels in 2020. Other industrial uses are projected to decrease by 6% between 2010 and 2020. Total U.S. consumption of corn is expected to increase by 14% during the forecast period.

U.S. exports of soybeans are expected to remain flat during the forecast period between 1.4 billion bushels and 1.5 billion bushels. U.S. domestic processing is projected to increase by 21% from 1.7 billion bushels in 2010 to about 2.0 billion bushels in 2020. Feed and other uses are expected to increase by about 16%. Total domestic consumption is expected to increase by about 24% during the forecast period.

Corn price is expected to decrease slightly to $4.68 per bushel in 2015 and then increase to $5.35 by 2020. Soybean price is expected to increase to $11.01 per bushel in 2011 before falling to $9.82 in 2020.

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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 only 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 Independence and Security 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. Prices and production returned to normal levels in 2008 and 2009, however prices increased again in late 2010 and early 2011. The main reason for the increase in corn price is due mainly to the small carry-over stocks in the United States. In 2010 US corn production fell 4% while consumption increased 6% which resulted in a reduction of carry-over stocks by 60% from 1.7 billion bushels to 675 million bushels between 2009 and 2010. Changes in corn prices affect prices of other commodities, especially soybeans, mainly because they are close substitutes in production.

In addition to the impact of corn on soybean prices, Argentina had a small soybean crop in 2008. Argentine soybean production fell by 31% in 2008 compared to 2007, but soybean production returned to normal levels in 2009. Both Brazil and Argentina had smaller soybean corps in 2010 compared to 2009, but the United States soybean crop was slightly larger.

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. 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 soybeans traded in the world market.

WORLD CORN INDUSTRY

Figure 1 shows the world corn production in the major corn producing countries. U.S. corn production has increased by 67% between 1996 and 2010 with harvested acres increasing by 14%. China's corn production increased by 28% while Brazil and the EU increased production by 57% and 19%, respectively, during the same time period.

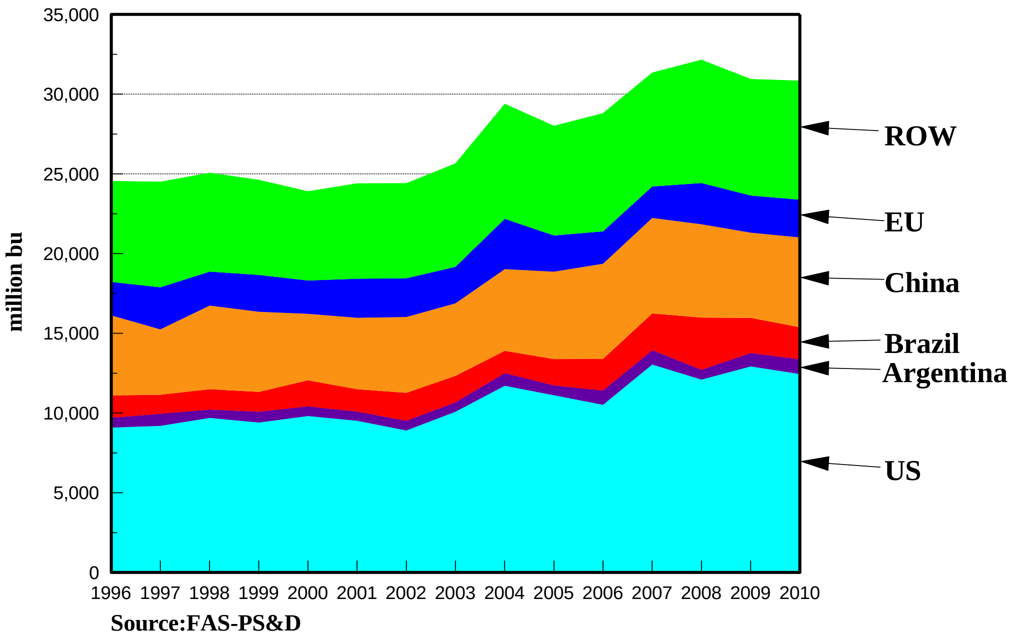


Figure 1. World Corn Production, 1996-2010

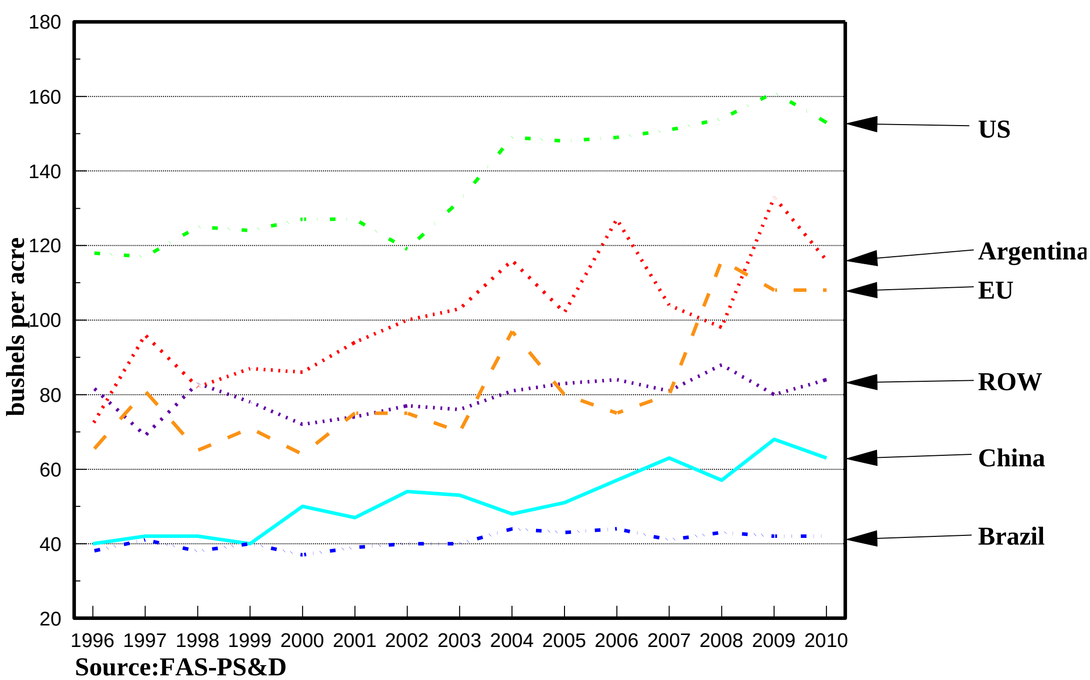


Figure 2. World Corn Yields, 1996-2010

In addition to larger world corn acres, world average yields have increased by 34% between 1996 and 2010. Yields for soybeans and wheat increased by 23% and 22%, respectively for the same period. Corn yields in the U.S. increased by 30% from 118 bushels per acre in 1996 to 153 bushels per acre in 2010. Corn yields increased in other countries. Chinese corn yields increased by 2% while in Brazil and the European Union corn yields increased by 56% and 67%, respectively. Brazil's corn yield is low because corn is a secondary, low input crop rotated with soybeans.

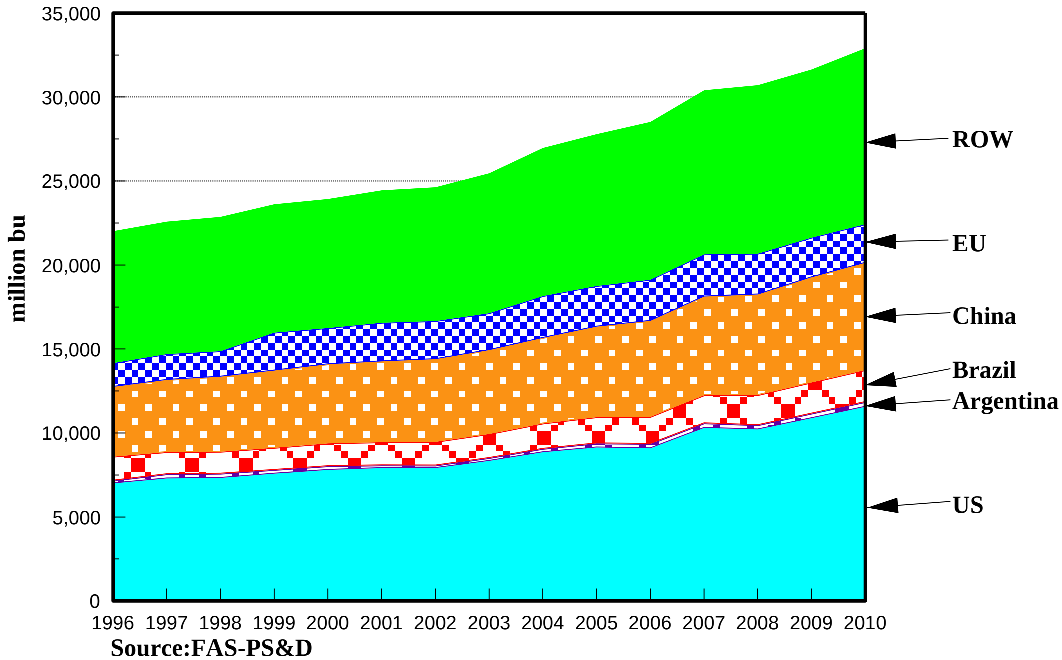
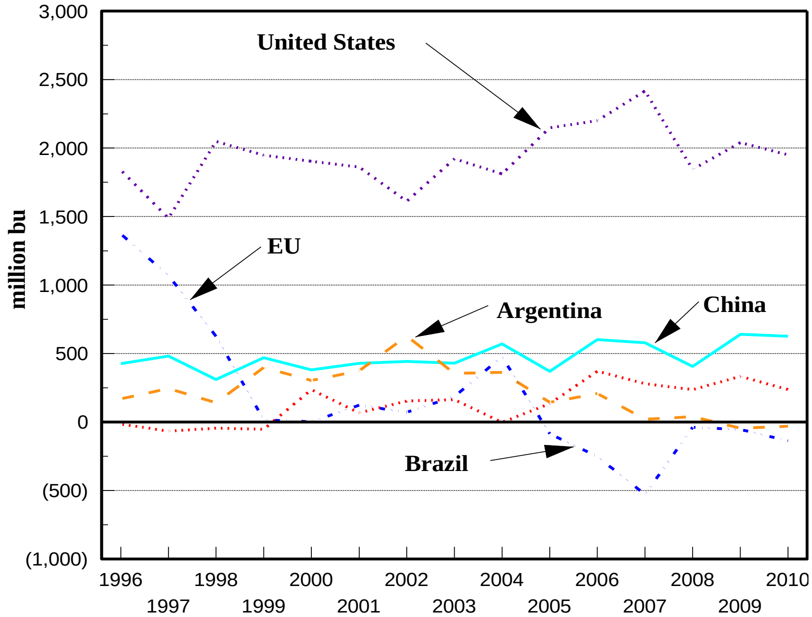


Figure 3. World Corn Consumption, 1996-2010

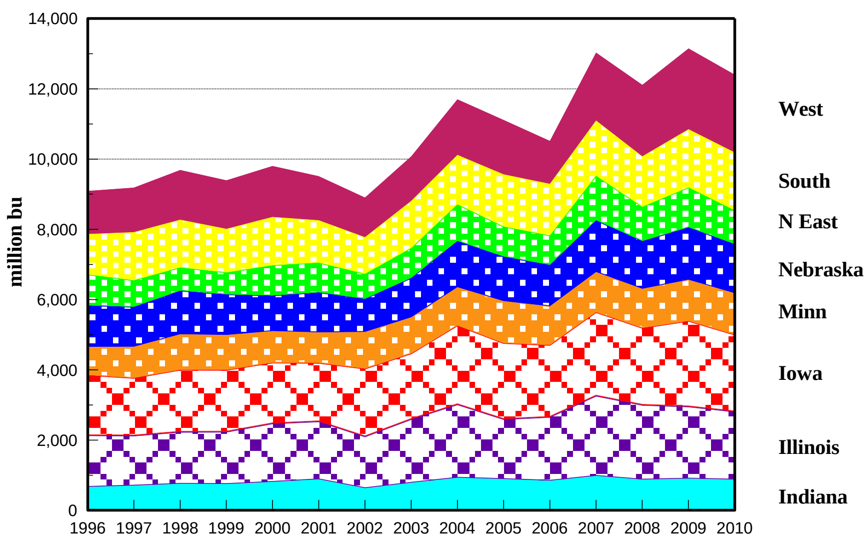
World corn consumption increased by 52% between 1996 and 2010 (Figure 3). The countries with the largest growth in corn consumption have been EU, the U.S. and China. China's consumption growth is due mainly to growth in the livestock sector and growth in the United States is a result of corn based ethanol production. Corn consumption in China increased by 54% between 1996 and 2010, while that in the U.S. increased by 65% during the same time period. Corn consumption in the European Union increased by 62% and the Rest of world (ROW) region increased by 34% during the same time period.



Source:FAS-PS&D

Figure 4. World Corn Exports, 1996-2010

The U.S. is the main exporter of corn for the 1996-2010 period, 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 1996 to 2.5 billion bushels in 2010.



Source:FAS-PS&D

Figure 5. US Corn Production by Region/State, 1996-2010

Corn Production in the U.S.

The five largest corn producing states in the U.S. are Iowa (2.2 billion bushels), Illinois (1.9 billion bushels), Nebraska (1.4 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 by 28% between 1996 and 2010, while Illinois and Indiana increased corn production by 32% and 31%, respectively, during the same time period. Minnesota and Nebraska increased corn production by 46% and 19%, respectively. The other regions of the country also increased corn production. The North East, South and West increased corn production by 43%, 9%, and 81%, respectively.

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 1996 and 2010. Corn acres increased by 35% in the West region because of profit incentive and the 1996 Farm Bill which did not require planting wheat and barley program acres. Illinois and Iowa increased corn acres by 14% and 7%, respectively, while Nebraska and Indiana increased corn acres by 2% and 3%. The South region and the North East region reduced corn acres by 16% and 12%, 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 the 2008-2010 time period, Iowa had the highest average corn yield at 173 bushels per acre compared to Minnesota at 172 bushels per acre. The fastest growth in yields was in the South region, 56%, followed by the North East, 51%, and Illinois, 42%. The slowest yield growth rate was in Nebraska and Iowa.

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

	1995-98	2008-10	% Change
	----------bushels per acre----------		
Indiana	119.3	161.0	34.9
Illinois	126.0	170.0	34.9
Iowa	133.0	172.7	29.8
Minnesota	125.3	171.7	37.0
Nebraska	128.7	169.0	31.3
South	84.8	131.9	55.6
North East	97.4	146.7	50.6
West	97.4	137.9	41.5

Figure 6 shows the U.S. utilization of corn for the years 1996 through 2010. The largest increase was for corn used for ethanol production, an increase of 1054%, from 429 million bushels in 1996 to 5.0 billion bushels for 2010. Feed use decreased by 1%, other industrial uses increased by 9% and exports increased by 6%. Total utilization increased by 65% during the time period.

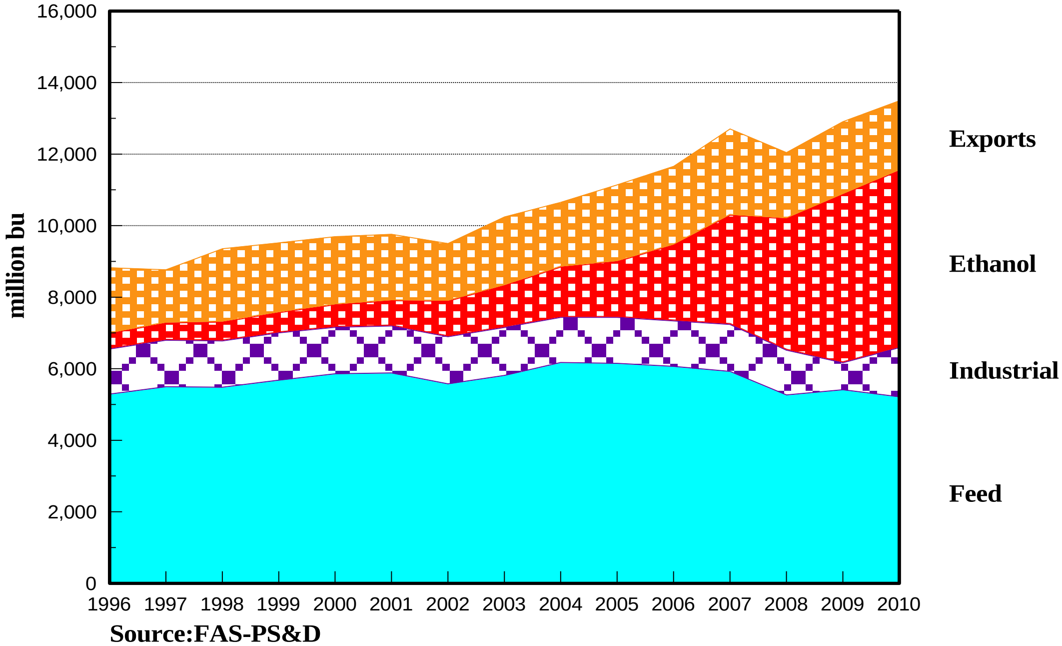


Figure 6. US Corn Utilization, 1996-2010

WORLD SOYBEAN INDUSTRY

Figure 7 shows the world soybean production by country/region. World soybean production has increased by 106% from 4.5 billion bushels in 1996 to 9.3 billion bushels in 2010. Argentina and Brazil increased soybean production by 351% and 147%, respectively, during the same time period. The U.S. increased soybean production by 40% between 1996 and 2010. Soybean production increased by 98% in the ROW region. Most of that increase took place in other South American countries.

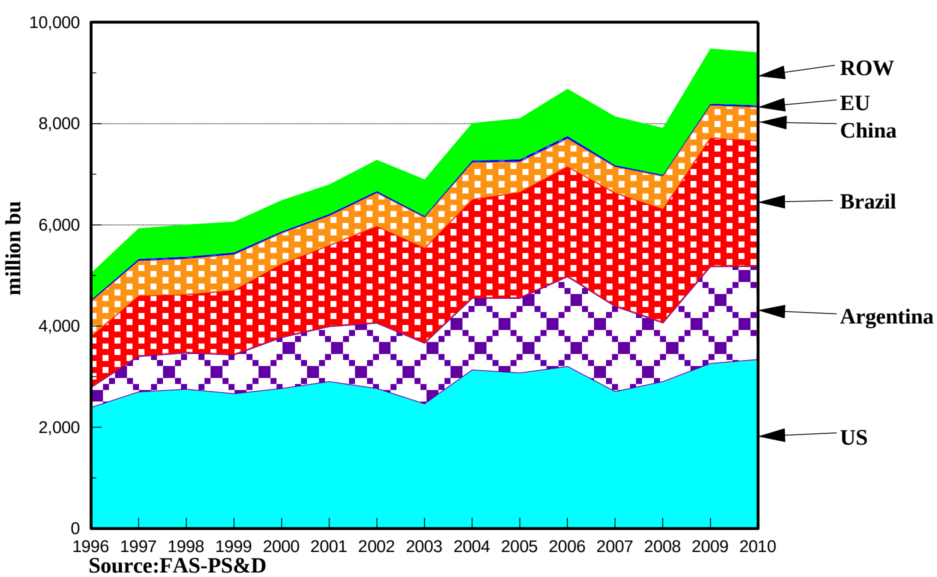


Figure 7. World Soybean Production, 1996-2010

World soybean yields have increased by 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 1996 they ranged between 27 bushels per acre and 38 bushels, increasing to between 41 bushels and 46 bushels per acre in 2010. Soybean yields in China have remained at about 25 bushels per acre and ROW soybean yield increased from 19 bushels per acre to 23 bushels per acre.

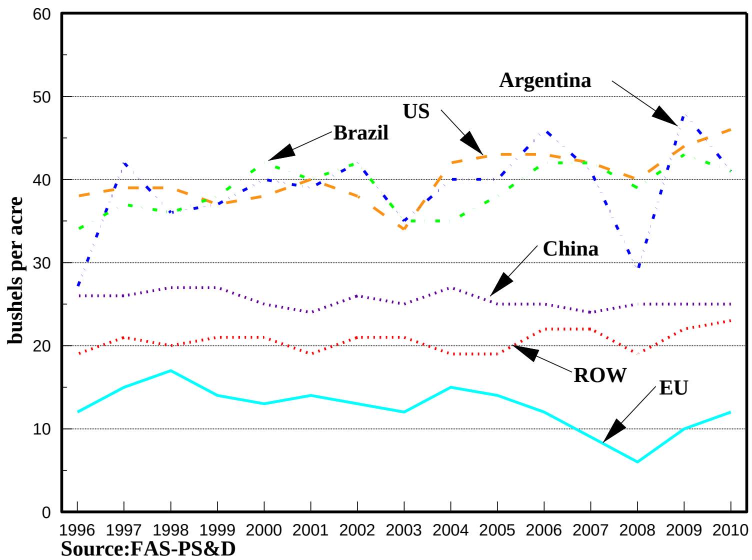
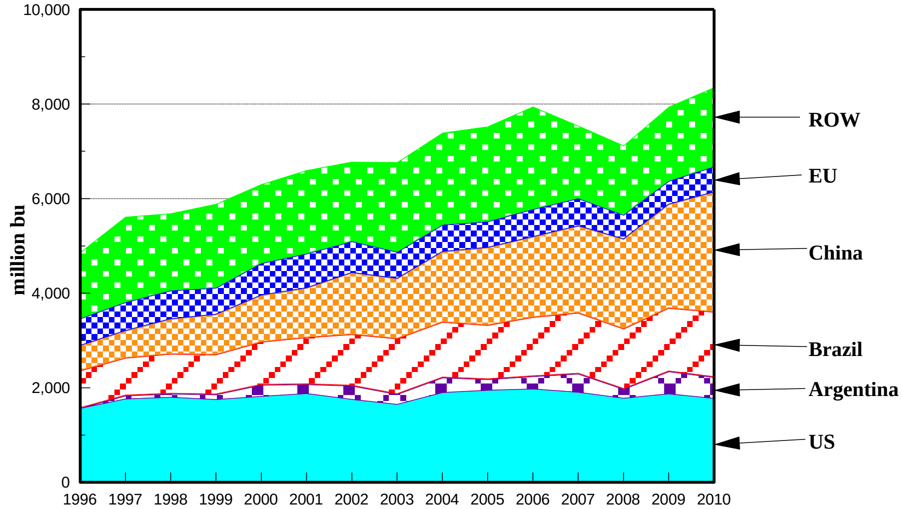


Figure 8. World Soybean Yields, 1996-2010

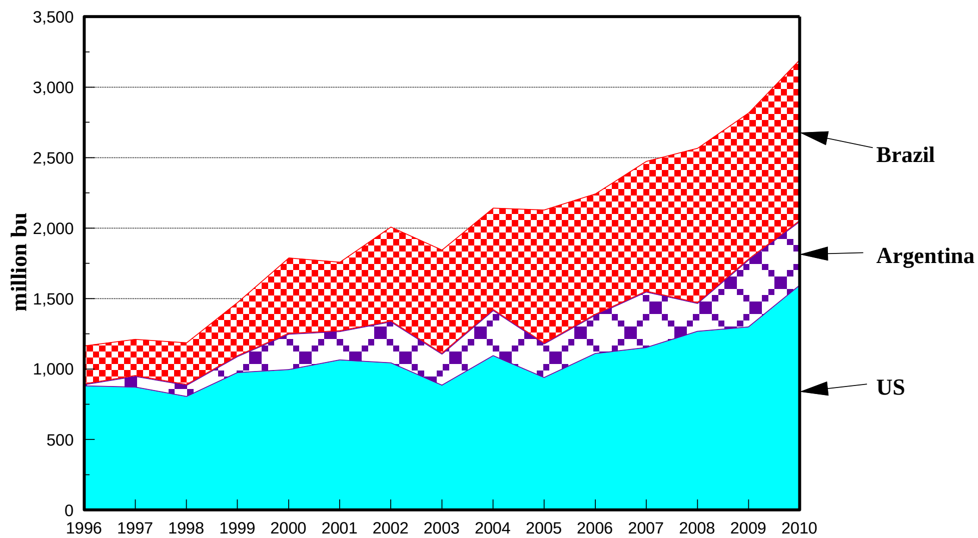
World soybean consumption increased by 79% between 1996 and 2010 (Figure 9). Soybean consumption in China increased from 526 million bushels in 1996 to 2.5 billion bushels in 2010. In 2008 China became the largest soybean consumer in the world, passing the United States. Soybean consumption increased by 73% in Brazil and 250% in Argentina for the 1996-2010 period. U.S. consumption increased by 14% from 1.6 million bushels in 1996 to 1.8 million bushels in 2010.



Source:FAS-PS&D

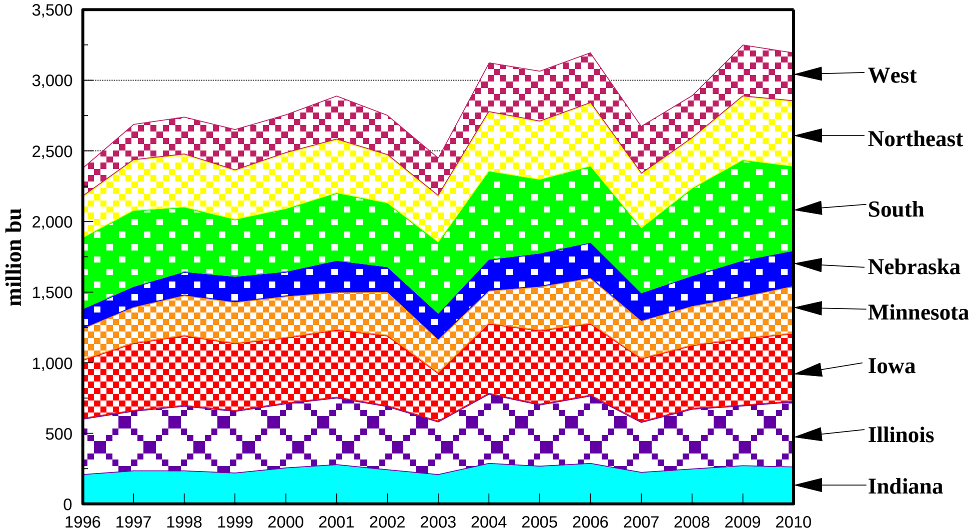
Figure 9. World Soybean Consumption, 1996-2010

The U.S., Brazil and Argentina export over 90% of the soybeans trade in the world market (Figure 10). China imports about 65% 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.



Source:FAS-PS&D

Figure 10. World Soybean Exports, 1996-2010



Source:FAS-PS&D

Figure 11. US Soybean Production, by Region/State, 1996-2010

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 (466 million bushels), and Minnesota (335 million bushels). The fastest growth has been in Nebraska (84%), followed by the West (69%) and South (58%) regions.

Much of the production growth has been in harvested acre since yield growth has been moderate (Table 3). Highest soybean yields are in Nebraska, followed by Iowa and Illinois. The yield growth is fastest in Nebraska (29.5%), followed by the South region (21.4%), and Illinois (18.0%).

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

	1995-98	2008-10	% Change
	------------bushels per acre--------------		
Indiana	40.3	47.5	17.8
Illinois	40.8	48.2	18.0
Iowa	44.7	49.5	10.8
Minnesota	39.2	41.0	4.7
Nebraska	39.5	51.2	29.5
South	30.9	37.5	21.4
North East	36.7	41.6	13.3
West	31.7	35.0	10.5

In spite of the increased production of soybeans in Argentina and Brazil, US exports of soybeans have increased by 81% between 1996 and 2010, compared to a 6% increase 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 by 15% and feed, seed, and waste have decreased by 6% between 1996 and 2010.

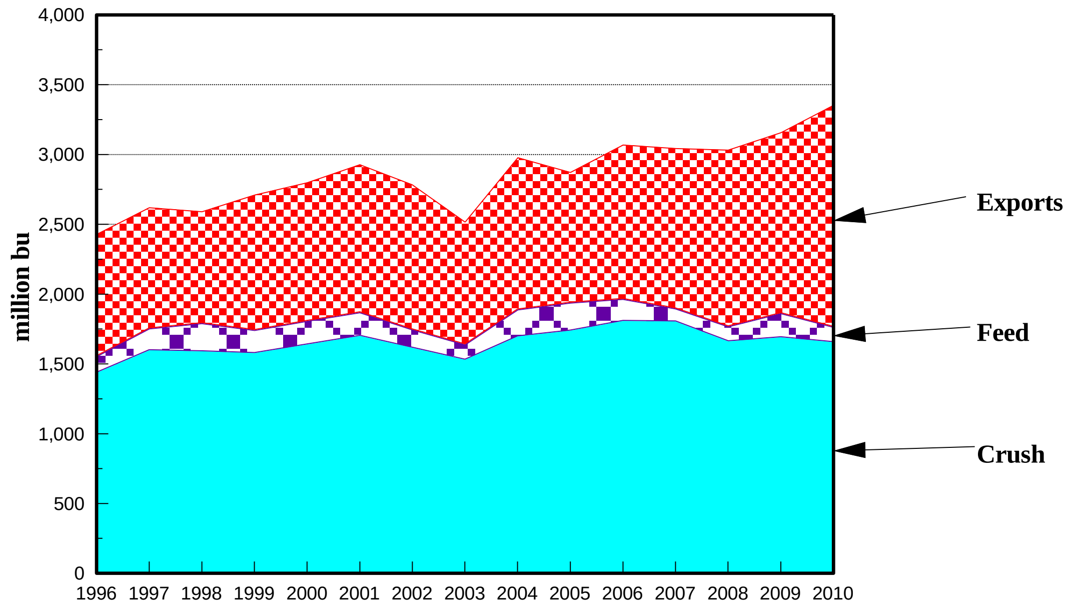


Figure 12. US Soybean Utilization, 1996-2010

AN ECONOMETRIC SIMULATION MODEL FOR CORN AND SOYBEANS

The empirical model for this study is a global corn and soybean econometric policy simulation model. 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.

Supply of Corn and Soybeans

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 harvested area of 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:

$$HA^n_t = f(HA_{t-1}, P^n_{t-1}, P^w_{t-1}) \text{ n= 1, 2.} \quad (1)$$

Where n is index for crop; n = 1 for corn and n = 2 for soybeans. HA^n_t = harvested area of crop n in time t, P^n_{t-1} = real prices of crop n 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:

$$Y^n_t = f(P^n_t, T_t) \quad (2)$$

where Y^n_t = yield of crop n in time t, P^n_t = price of crop n in time t, and T_t = trend.

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

$$Pd^n_t = \mathrm{HA}^n_t * Y^n_t \quad (3)$$

where Pd^n_t = U.S. production of crop n 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 for Feed

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

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

$$FD^l_t = f(\mathrm{P}^c_t, \mathrm{P}^l_t, T_t)\text{, l= 1,2,….5.} \quad (4)$$

where FD^l_t = the quantity of corn used to feed livestock l in time t, P^c_t = real price of corn in time t,

P^l_t = real price of livestock l in time t and T_t = trend variable. l= 1 for beef, 2 for pork, 3 for poultry, 4 for turkey and 5 for dairy.

It is expected that all feed use will have a negative relationship with corn price and a positive relationship with livestock price. The total feed use is:

$$FD_t = \sum_{l=1}^{n} FD_t^l \tag{5}$$

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

$$NFD_t = FD_t - BP_t\ . \tag{6}$$

where NFD_t is net consumption of corn for feed use. $BP_t = a(b^*E_t)$ 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).

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 represent 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:

$$E_t = \text{f}(P^c{}_t, P^g{}_t, E_{t-1}, G^c{}_t, D^{mtbe}) \tag{8}$$

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, $G^c{}_t$ = government subsidy, and D^{mtbe} is a dummy variable for removal of MTBE in California. 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 average price of these industrial goods will have a positive impact on the industrial use of corn. The demand model for other industrial use is specified as:

$$I^c_t = \mathrm{f}(P^c_t, P^o_t) \tag{9}$$

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^o_t = real average price of other industrial goods.

Demand for Soybeans for Industrial and Other Uses

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

$$CD^s_t = \mathrm{f}(\mathrm{P}^s_t, T_t) \tag{10}$$

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_t = trend variable.

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:

$$OD^s_t = \mathrm{f}(\mathrm{P}^s_t, T_t) \tag{11}$$

where $\mathrm{O}D^s_t$ = the quantity of soybeans used for other uses in time t, P^s_t = real price of soybean in time t, and T_t = trend variable.

The total demand for industrial and other uses are:

$$\mathrm{I}^s_t,=CD^s_t + OD^s_t \tag{12}$$

Carry-over Stocks for Corn and Soybeans

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:

$$CS^n_t = \mathrm{f}(P^n_t, CS^n_{t-1}) \tag{13}$$

where CS^n_t = carry-over stocks of crop n.

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. In addition, consumer income has a positive relation with demand for crop n. The import demand model for the ROW is specified as:

$$ED^{Wn}{}_t = \mathrm{f}(P^n{}_t, Y_t) \tag{14}$$

where $ED^{Wn}{}_t$ = ROW import demand for crop n in time t, $P^n{}_t$ = real world price of crop n in time t, and Y_t = weighted average real per capita income in t.

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:

$$ES^{Wn}{}_t = f(P^n{}_t, T_t) \tag{15}$$

where $ES^{Wn}{}_t$ = ROW excess supply in time t, $P^n{}_t$ = real price of crop n in time t, and T_t= trend variable. It is expected that the export price of each crop and trend variable will have a positive impact on excess supply of individual crop.

<u>Corn to Soybean Price Ratio</u>

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.

<u>Equilibrium Condition</u>

The equilibrium conditions for crop n are established in such a way that the aggregated excess supply of crop n equals the aggregated demand for the crop. Excess supply of crop n ($XS^n{}_t$) equals beginning stocks ($CS^n{}_{t-1}$) plus production ($Pd^n{}_t$) minus domestic use for feed ($NFd^n{}_t$), domestic use for bio-energy production ($\mathrm{EN}^n{}_t$), other industrial use ($\mathrm{I}^n{}_t$), and carry-over stocks CS^n of the corresponding crop in country/region as follows:

$$XS^n{}_t = \mathrm{C}S^n{}_{t-1} + Pd^n{}_t - NFd^n{}_t - \mathrm{I}^n{}_t - \mathrm{C}S^n{}_{t-1} \tag{16}$$

where $XS^n{}_t$ = export supply of crop n in time t.

The aggregated excess supply of each crop for all countries/regions (m) and ROW should be equal to zero under the equilibrium condition, as follows:

$$\sum_{m=1} XS^{nm}{}_t + (ES^{Wn}{}_t - ED^{Wn}{}_t) = 0.0, \mathrm{n{=}1,2.} \tag{17}$$

Equation 17 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 2010, the simulation is continued for 10 years until 2020. The simulation results in 2020 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 2010. 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 by 13% between 2010 and 2020 (Table 4). U.S. exports are expected to fall from 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 a large importer of corn by 2020.

World soybean trade will increase by 66% between 2010 and 2020. China is expected to increase imports by 43% in 2020 from the 2009-2010 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

	2009-2010	2010	2020	Change
Corn	----------------million bu------------			%
US	1,995	2,040	1,833	-8.1
Arg	633	640	864	36.5
Brazil	285	332	554	94.6
China	-38	-45	-1,090	2769.1
EU	-97	-55	308	NA
ROW	-2612	-2,663	-2,551	-2.3
Soybeans				
US	1,443	1,295	1,463	1.4
Arg	470	481	984	109.3
Brazil	1,096	1,044	1,668	52.2
China	-1,960	-1,843	-2,809	43.3
EU	-488	-462	-513	5.3
ROW	-560	-515	-764	36.5

Figure 13 shows the projected corn exports for the U.S., Brazil and Argentina. U.S. exports are expected to increase through 2016 before decreasing 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 2018. 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.

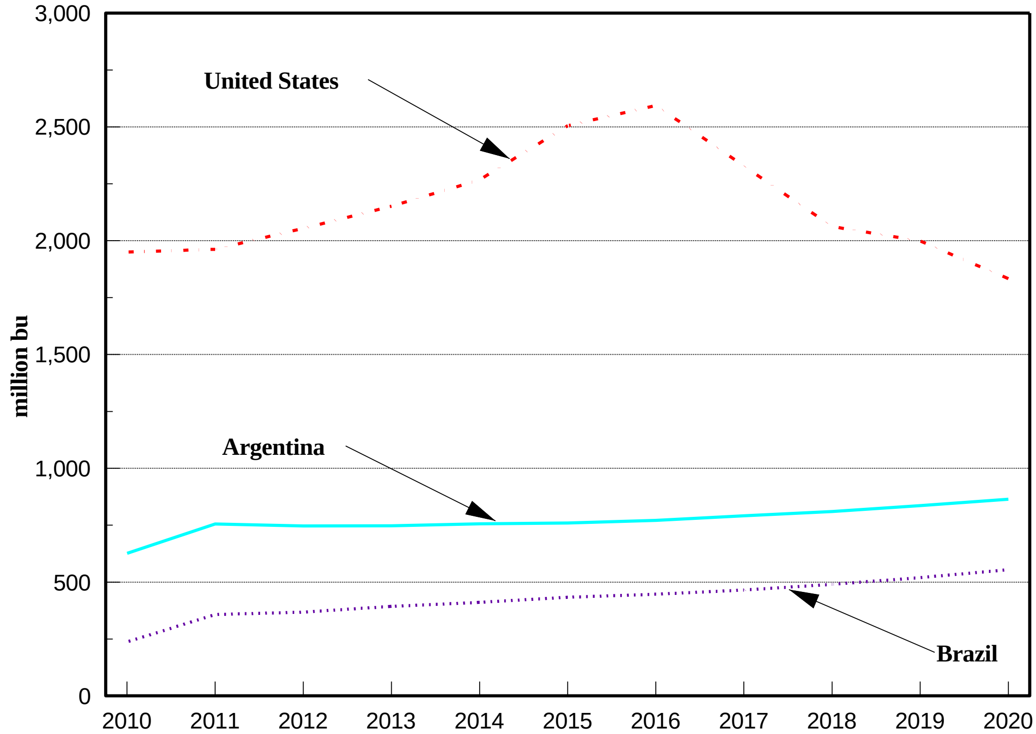


Figure 13. Projected Corn Exports by Major Exporters

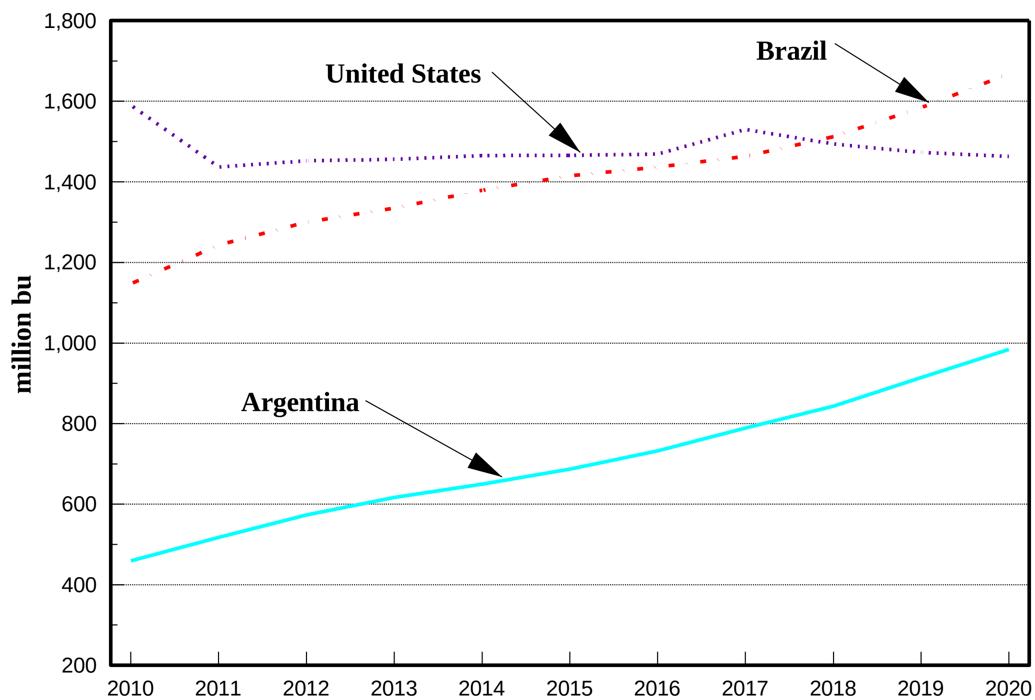


Figure 14. Projected Soybean Exports by Major Exporter

World Production of Corn and Soybeans

World corn production is expected to increase by 23%, from 31 billion bushels in 2009-2010 average to 38 billion bushels in 2020. The U.S. will increase corn production by 18% while Argentina will increase corn production by 25% (Table 5). Brazil's production in 2020 is expected to be larger than the 2008-2009 average. Historically, Brazil has produced about 2 billion bushels of corn per year. Chinese corn production is expected to increase by about 15% to 6.3 billion bushels by 2020 but not enough to prevent the importation of corn for domestic use. Corn production in the European Union is expected to increase from 2.4 billion bushels in 2010 to about 3.4 billion bushels in 2020 which will satisfy domestic needs. Corn production by the major producing countries is shown in Figure 14. U.S. corn production is expected to increase slightly during the forecast period. Argentine corn production has ranged between 550 million and 600 million bushels per year and it is expected to remain near that level.

Table 5. World Corn and Soybean Production

	2009-2010	2010	2020	Change
Corn	--------------million bu---------------			%
US	12,684	12,447	14,995	18.2
Arg	880	925	1,102	25.3
Brazil	2,108	2,008	2,731	29.6
China	5,489	5,637	6,285	14.5
EU	2,350	2,361	3,358	42.9
ROW	7,383	7,464	9,569	29.6
Soybeans				
US	3,290	3,329	3,660	11.2
Arg	1,892	1,855	2,414	27.6
Brazil	2,509	2,480	3,160	26.0
China	651	659	826	27.0
EU	34	38	60	74.0
ROW	1,070	1,048	1,281	19.8

The U.S. is projected to increase soybean production by about 11% in 2020. U.S. production growth is limited because of land constraints. However the U.S. is the largest producer of soybeans and will remain during the forecast period. Production is expected to increase from about 3.3 billion bushels in 2010 to about 3.7 billion bushels in 2020. Argentina and Brazil are expected to increase soybean production by 28% and 26%, respectively. Brazil's soybean production is projected to increase from 2.5 billion bushels to 3.2 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 2010 and 2020. 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.

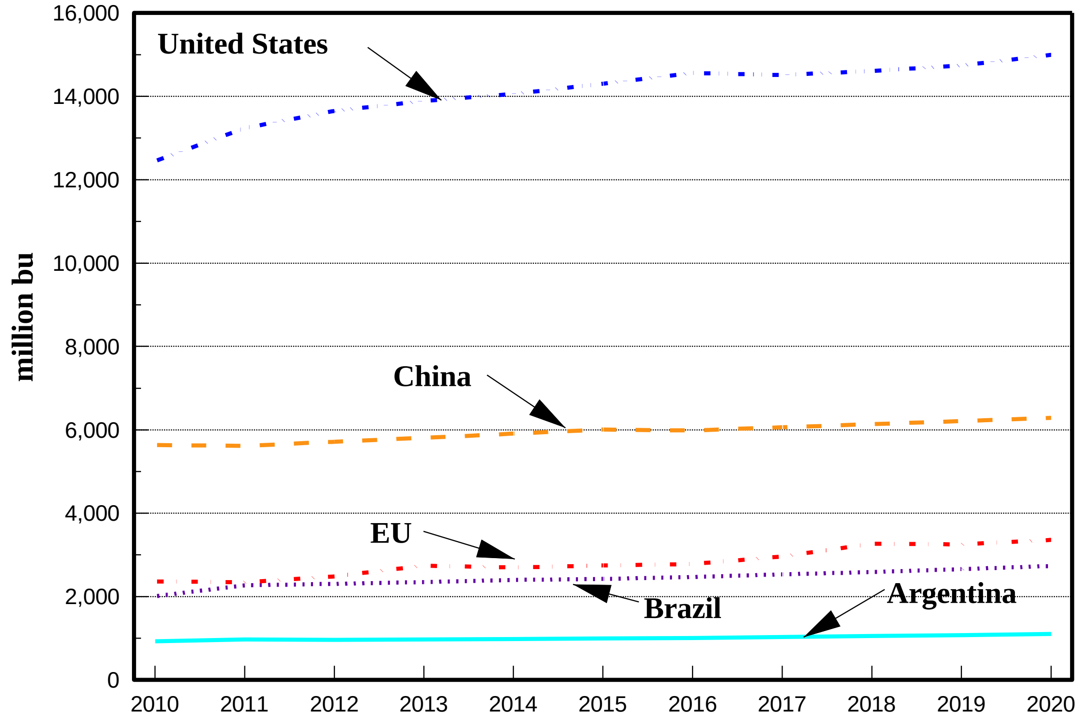


Figure 15. Projected Corn Production by Major Producers

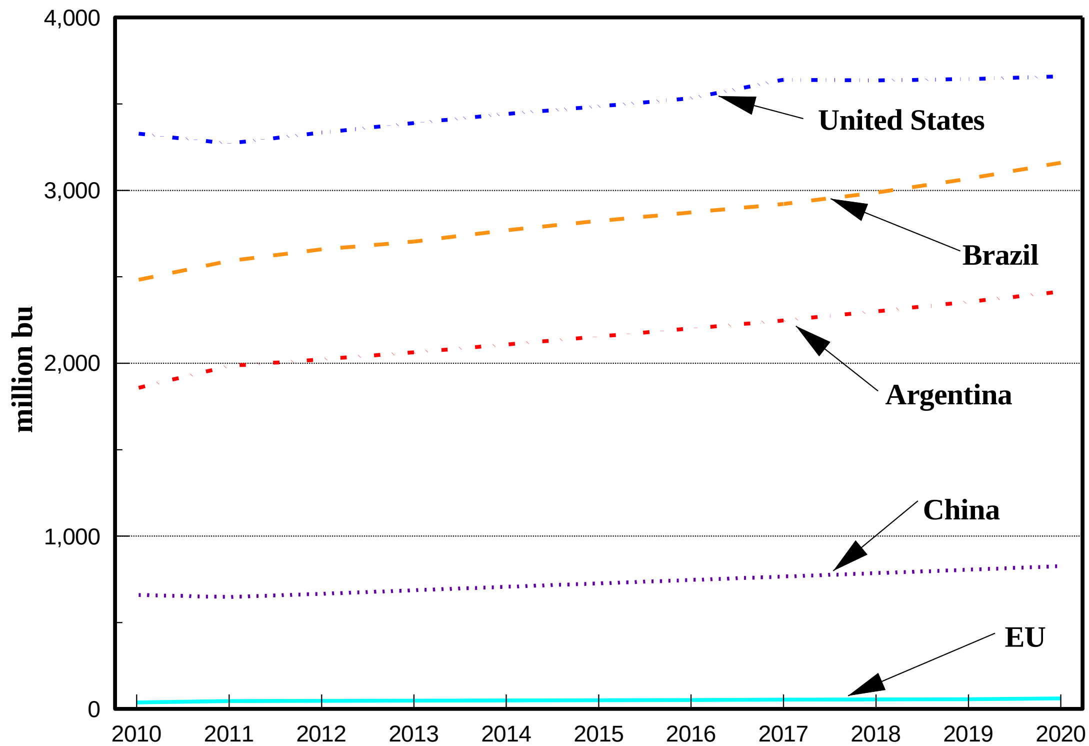


Figure 16. Projected Soybean Production by Major Producers

Corn and Soybean Production in the U.S.

Table 6 shows the yield and harvested acres for the states/regions in the U.S. Minnesota has the highest average yield of 176 bushels per acre followed by Iowa and Nebraska. Outside of the major corn producing states, the northeast has the highest yield at 153 bushels per acre. Yields are expected to increase in all states/regions. Harvested acres in the U.S. are expected to increase from 80.8 million acres to 85.1 million acres in 2020.

Table 7 shows yields and harvested acres for U.S. soybeans. Soybean yields are expected to increase in most states/regions in the United States. Yields for West and the South are projected to be 1.2% and 6.2% lower in 2020 than in 2009-2010. The main reason is that both areas had abnormally high soybean yields in 2008. 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 73.7 million acres of soybeans in 2010 and harvested acres are expected to increase to 76.1 million acres by 2020.

Figure 17 shows the production of corn by state/region for the U.S. Iowa is the largest corn producing state in 2010 (2.2 million bushels), followed by the west region and Illinois. Total U.S. corn production in 2010 was 12.4 billion bushels and is expected to increase by 21% to 15.0 billion bushels by 2020. The fastest growth is expected to be in Indiana (27%), followed by Nebraska (28%), and Illinois (18%). Production increase for 2020 from the 2009-2010 average is almost 21%.

In Figure 18 shows the production of soybeans by state/region. The south region was the largest soybean producing region in 2010 with 596 million bushels, followed by Iowa, Illinois and the northeast region. However, the south region had an unusually large crop in 2010. The fastest increase in soybean production is projected to be in the West region (45%), followed by Nebraska and Iowa.

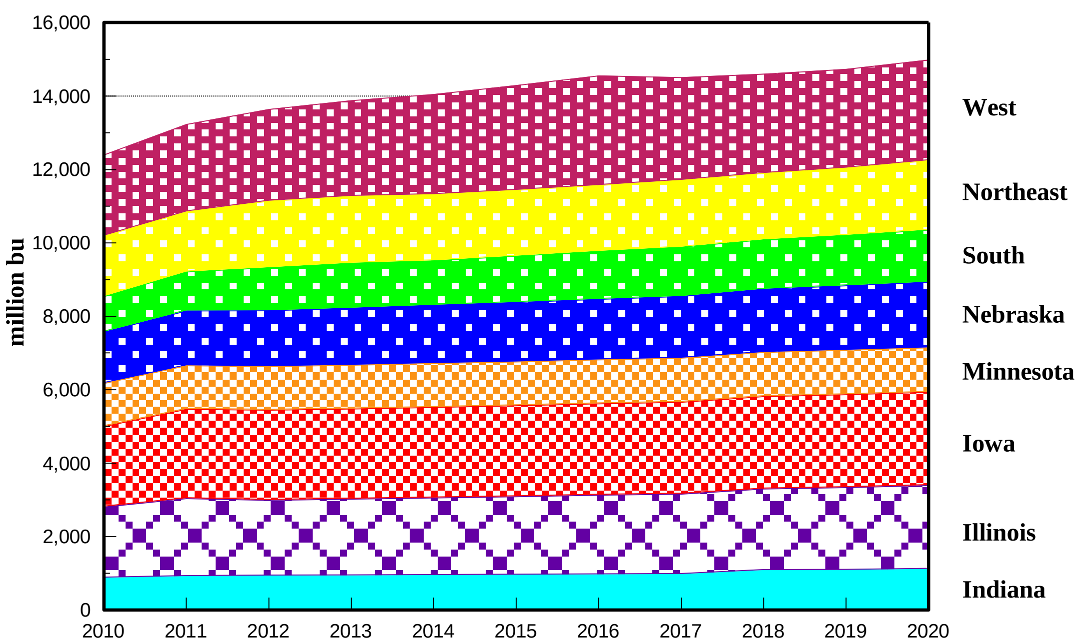


Figure 17. Projected US Corn Production by State/Region

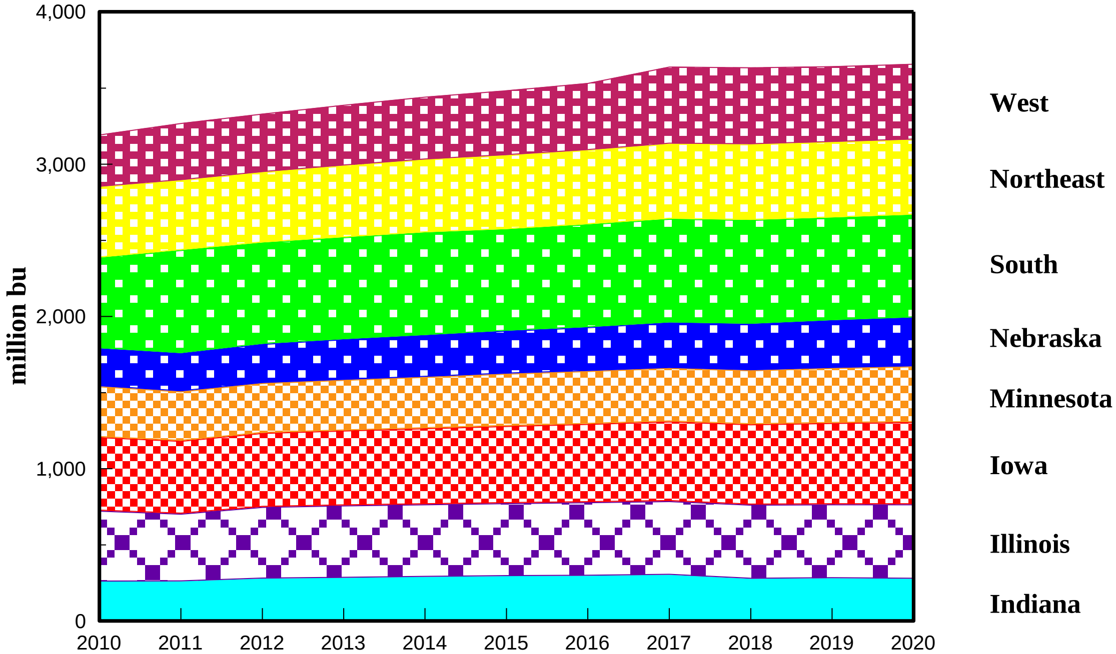


Figure 18. Projected US Soybean Production by State/Region

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

Yields	2009-2010	2010	2020	change
	---------bushels per acre--------			%
Indiana	162	157	188	16.7
Illinois	166	157	187	13.2
Iowa	174	165	195	12.3
Minnesota	176	177	189	7.8
Nebraska	172	166	192	12.0
South	122	122	150	22.8
Northeast	153	151	167	9.3
West	141	136	157	11.9
Harvested acres				
	------------million acres------------			
Indiana	5,519	5,593	5,930	6.9
Illinois	12,065	12,330	12,165	0.8
Iowa	13,331	13,271	13,053	-2.1
Minnesota	6,691	6,652	6,407	-4.4
Nebraska	8,417	8,441	9,291	9.4
South	7,884	7,865	9,477	16.8
Northeast	10,838	10,983	11,330	4.3
West	16,028	16,211	17,424	8.0

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

Yields	2009-2010	2010	2020	change
	--------bushels per acre---------			%
Indiana	49	49	53	8.5
Illinois	49	52	52	7.0
Iowa	50	51	56	10.7
Minnesota	47	45	47	1.5
Nebraska	48	53	59	19.0
South	46	36	43	-6.2
Northeast	41	45	46	11.1
West	40	34	40	-1.2
Harvested acres				
	-----------million acres-------------			
Indiana	5,385	5,330	5,216	-3.2
Illinois	9,200	9,050	9,335	1.4
Iowa	9,389	9,449	9,667	2.9
Minnesota	7,409	7,448	7,693	3.7
Nebraska	4,707	4,755	5,430	13.3
South	17,181	16,653	15,645	-9.8
Northeast	10,248	10,323	10,630	3.6
West	9,795	9,994	12,446	21.3

Prices of Corn and Soybeans in the U.S.

Figure 19 shows the projected corn and soybean prices for 2010 through 2020. Corn price is expected to decrease slightly to $4.68 per bushel in 2015 and then increase to $5.35 by 2020. Soybean price is expected to be $11.01 per bushel in 2011 before falling to $9.82 in 2020.

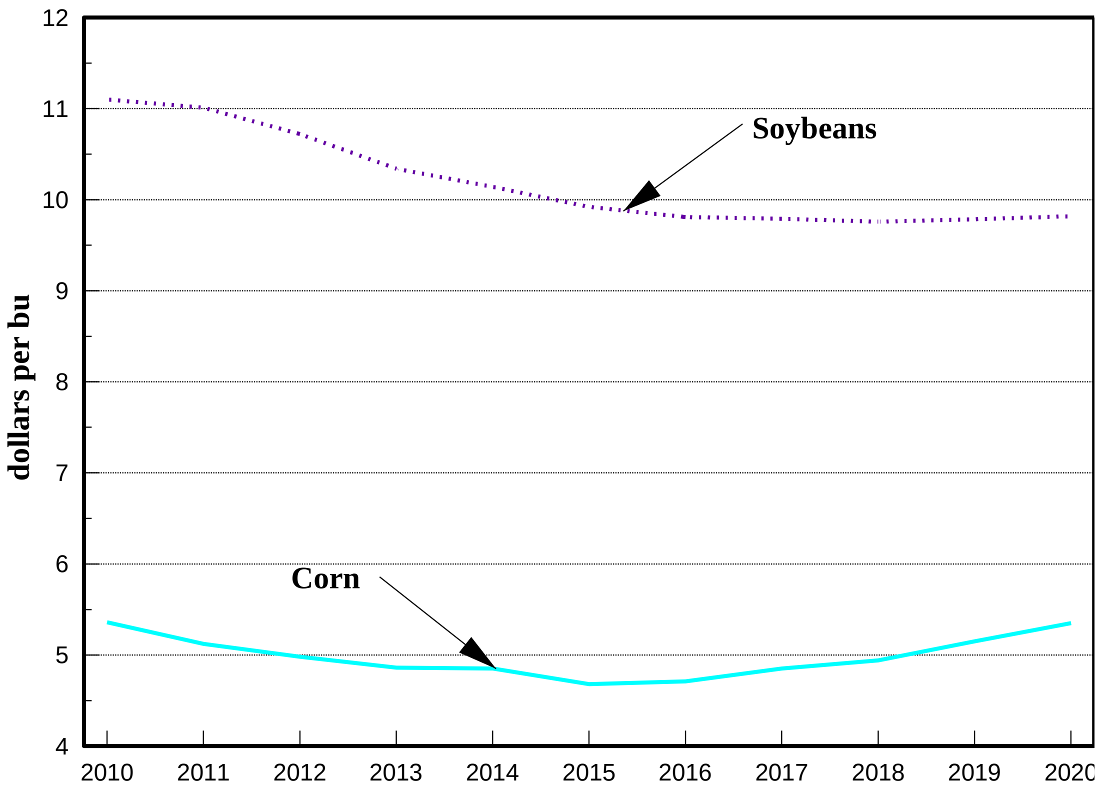


Figure 19. Projected Corn and Soybean Prices

U.S. Export and Utilization of Corn and Soybeans

Figure 20 shows the projected utilization for U.S. corn. Exports are expected to increase from 2.0 billion bushels in 2010 to 2.6 billion bushels in 2016 before decreasing to 1.8 billion bushels in 2020. The feed use of corn is projected to increase by 13% from 5.4 billion bushels in 2010 to about 6 billion bushels in 2020. Ethanol use of corn is expected to increase by 15% from 5.2 billion bushels in 2010 to 5.9 billion bushels in 2020. Other industrial uses are projected to decrease by 6% between 2010 and 2020. Total U.S. consumption of corn is expected to increase by 14% during the forecast period.

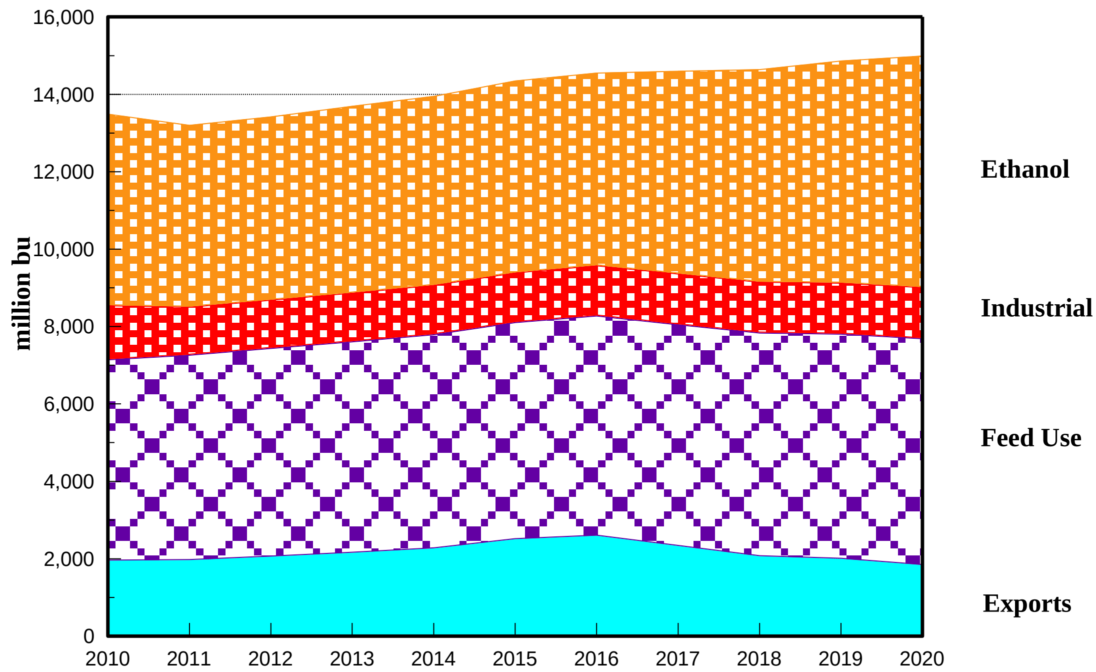


Figure 20. Projected US Corn Utilization

U.S. exports of soybeans are expected to remain flat during the forecast period between 1.4 billion bushels and 1.5 billion bushels (Figure 21). U.S. domestic processing is projected to increase by 21% from 1.7 billion bushels in 2010 to about 2.0 billion bushels in 2020. Feed and other uses are expected to increase by about 16%. Total domestic consumption is expected to increase by about 24% during the forecast period.

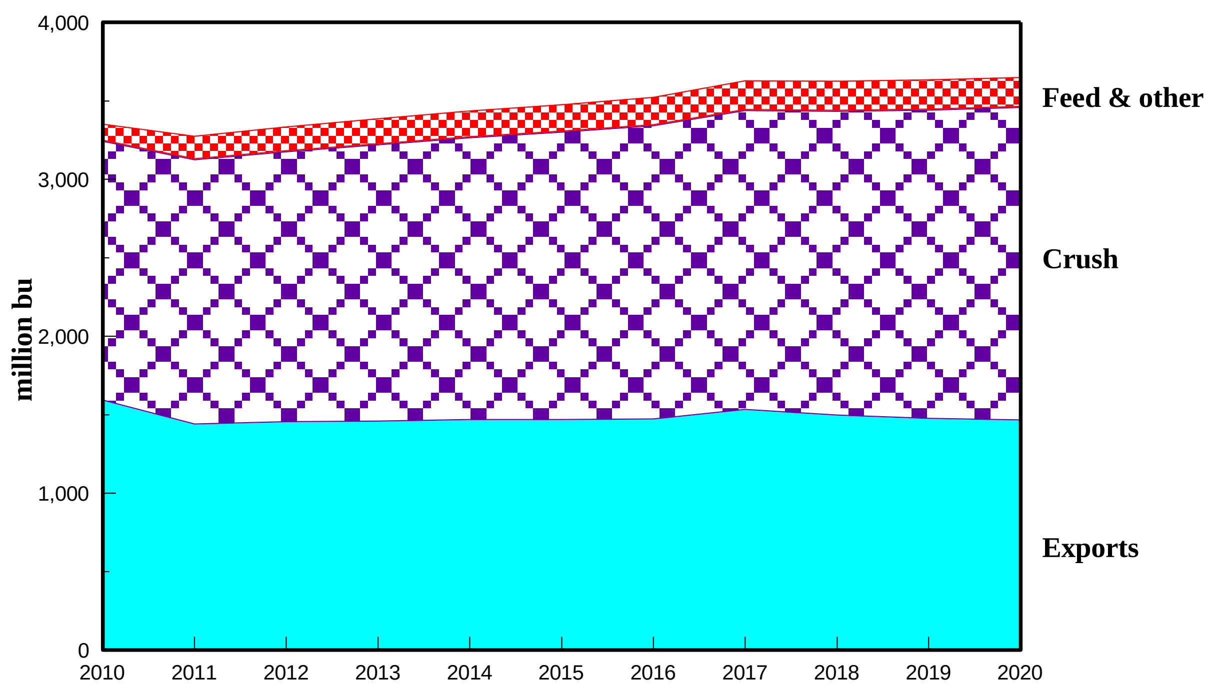


Figure 21. Projected US Soybean Utilization

CONCLUSIONS

Recently, 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 reached levels near historical levels. Prices again increase for most commodities in late 2010 and early 2011.

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 will remain near current levels. Increases in corn production 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 for food use 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 processing capacity of corn-based ethanol will not continue to increase since profit margins have narrowed in the past 2 or 3 years. The Energy Independence and Security Act of 2007 requires 36 billion gallons of ethanol to be blended with the U.S. gasoline supply with about 11 billion gallons from corn-based ethanol and 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 consumer income continue to change dietary patterns in the country. In 2010, China imported 2.1 billion bushels of soybeans. By 2020, it is projected to import about 2.8 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 price of corn is expected to slowly fall from the current price of $5.36 to $4.68 in 2015 before increasing to $5.35 by 2020. Soybean price is expected slowly fall throughout the forecast period. By 2020 soybean price is expected to be $9.22 per bushel. The U.S. ethanol industry is expected to continue to grow but at a slower rate than in the past. In 2010, 5.0 billion bushels of corn was used for ethanol production and by 2020 it is projected that 6.0 billion bushels of corn will be used for the production of ethanol.

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