Regulatory Impact Analysis: Renewable Fuel Standard Program

Chapter 8
Agricultural Sector Impacts

Assessment and Standards Division
Office of Transportation and Air Quality
U.S. Environmental Protection Agency

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EPA United States Environmental Protection Agency

EPA420-R-07-004
April 2007

Chapter 8: Agricultural Sector Impacts

As described in the Preamble, we used the Forest and Agricultural Sector Optimization Model (FASOM) to estimate the U.S. agricultural impacts of increasing renewable fuel volumes to 7.5 billion gallons per year (BGY) by 2012, as required by the Renewable Fuels Standard (RFS) and to 9.9 BGY, the volume of renewable fuel the Energy Information Administration (EIA) predicts for the year 2012 in the Annual Energy Outlook 2006.[104] Although these renewable fuel volumes are lower than current market predictions, these assumptions were established during the NPRM and are used throughout this FRM.

FASOM is a long term economic model of the U.S. agriculture sector that maximizes total revenues for producers while meeting the demands of consumers. Using a number of inputs, FASOM determines which crops, livestock, and processed agricultural products will be produced in the U.S. In each model simulation, crops compete for price sensitive inputs such as land and labor at the regional level. The cost of these and other inputs are used to determine the price and level of production of primary commodities (e.g., field crops, livestock, and biofuel products). FASOM also estimates prices using costs associated with the processing of primary commodities into secondary products (e.g., converting livestock to meat and dairy, crushing soybeans to soybean meal and oil). FASOM does not capture short-term fluctuations (i.e., month-to-month, annual) in prices and production, however, as it is designed to identify long term trends.[105]

FASOM uses supply and demand curves for the 11 major U.S. domestic regions,[106] which are calibrated to historic price and production data. FASOM also includes detailed supply and demand data for corn, wheat, soybeans, rice and sorghum across 37 foreign regions.[107] FASOM maintains transportation costs to all regions and then uses all of this information to determine U.S. exports to the point where prices are then equated in all markets.[108]

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[104] We analyzed the U.S. agricultural impacts of producing renewable fuels domestically after adjusting for equivalence values of cellulosic ethanol and biodiesel and projected U.S. imports. For the RFS Case, we assumed 440 million gallons of corn based ethanol will be imported, while we assumed 630 million gallons of corn based ethanol will be imported for the EIA Case. For both cases, we assume 250 million gallons of cellulosic ethanol will be produced (with a 2.5 equivalence value), and 300 million gallons of biodiesel will be produced (with a 1.5 equivalence value).

[105] FASOM calculates output in five year increments. For this analysis, 2010 and 2015 data were interpolated to estimate 2012 values.

[106] U.S. regions consist of the Pacific Northwest (West and East), Pacific Southwest, Rocky Mountains, Great Plains, Southwest, South Central, Corn Belt, Lake States, Southeast, and the Northeast.

[107] FASOM Foreign Regions include: the European Economic Community, North Central Europe, Southwest Europe, Eastern Europe, Adriatic, Eastern Mediterranean, Former Soviet Union, North Africa, East Africa, West Africa, South Africa, Red Sea, Iran, India, Taiwan, Japan, South Korea, North Korea, China, Bangladesh, Indonesia, Myanmar, Pakistan, Philippines, Thailand, Vietnam, West Asia, Southeast Asia, Australia, Caribbean, Eastern Mexico, Eastern South America, Western South America, Argentina, Brazil, Canada, Other.

8.1 Commodity Prices

8.1.1 Corn and DDGS Prices

FASOM predicts that as renewable fuel volumes increase, agricultural prices over a range of products (not just corn and soybean renewable fuel feedstocks) will increase as well. Since the principal feedstock for ethanol is corn, corn prices are anticipated to rise. For consistency, all of the dollar estimates are presented in 2004 dollars. In the RFS Case, corn prices increase to $2.50/bushel by 2012 (compared to a Reference Case price of $2.32/bushel in 2012). With the higher renewable fuels volumes in the EIA Case, corn prices rise to $2.71/bushel (2004$) by 2012. (See Table 8.1-1) To place this difference in perspective, in 2012, corn prices are about 8 percent higher in the RFS Case and 17 percent higher in the EIA Case relative to the Reference Case.[109]

Table 8.1-1. Corn and DDGS Prices in 2012

	Reference Case	RFS Case	EIA Case
Corn Price	$2.32/bushel	$2.50/bushel	$2.71/bushel
Distillers Dried Grains with Solubles (DDGS) Price	$85.55/ton	$83.35/ton	$86.15/ton

The cost of producing ethanol is dependent upon, among other factors, the price of corn and the price of related byproducts. As part of the analytical approach described in the NPRM, we used FASOM to estimate the future prices of the major ethanol production byproduct: distillers dried grains with solubles (DDGS). FASOM estimates that the price of DDGS will remain relatively constant with the renewable volume scenarios that we are examining in this rulemaking. An increase in DDGS supply is anticipated to be offset by an increase in DDGS demand as technology improves to pelletize and distribute DDGS to a wider market. DDGS prices in the U.S. in 2012 are predicted to be $83.35/ton in the RFS Case and $86.15/ton in the EIA Case. (See Table 8.1-1) Hence, the overall price of DDGS remains within 3 percent of the DDGS Reference Case price.

Note that the DDGS price given here is the price an ethanol producer would expect to receive at the plant gate. FASOM predicts a higher value for the DDGS at the place of end use,

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[108] For additional details on the FASOM model, see the report by Professor Bruce McCarl, Texas A&M University, "The Impacts of the Renewable Fuel Standard Program on the U.S. Agricultural Sector," February 2007, included in the docket.

[109] The current price of corn in the U.S. is approximately $3.50 per bushel (2004$), which is considerably higher than the FASOM prediction and is a likely a result of the fact that recent demand for corn for ethanol is higher than the currently available stocks. The model results for 2012 reflects medium-term spatial equilibrium prices, where rising demand for corn is met by rising supply -- due to increased acres planted to corn and to increased corn yields per acre. Note that while the model assumes that markets for corn and related agricultural commodities will settle at a price of $2.50 per bushel (in the RFS case) by 2012, that this may be a conservative estimate to the extent that the agricultural sector is able to adjust to the increased use of corn in ethanol production by 2012.

based on its nutritional ability to be substituted as half soy meal and half corn in animal feed. The difference between its feed value and the ethanol plant gate price is made up of the cost of handling and shipping, which may include pelletizing or other measures required to support a national commodity market for DDGS.

8.1.2 Soybean and Soybean Byproducts

FASOM predicts relatively modest changes in soybean prices as a result of the increases in the renewable fuel volumes examined in this rulemaking. In the RFS Case, soybean prices rise to $5.44/bushel (2004$) by 2012 (compared to a Reference Case price of $5.26/bushel in 2012). In the EIA Case, soybean prices rise to $5.47/bushel (2004$) by 2012. (See Table 8.1-2) Soybeans prices are expected to increase by about 3 percent (RFS Case) and 4 percent (EIA Case) relative to the Reference Case by 2012. The slightly higher prices of soybeans reflect the consequences of the higher demand for soybeans for renewable fuels as well as the slightly higher input costs (e.g., land prices). It is also expected that in medium-term the acres planted to soybeans will fall, due to increased corn plantings, which will also increase soybean prices.

Table 8.1-2. Soybean and Soybean Meal Prices in 2012

	Reference Case	RFS Case	EIA Case
Soybean Price	$5.26/bushel	$5.44/bushel	$5.47/bushel
Soybean Meal Price	$176.70/ton	$171.73/ton	$170.05/ton

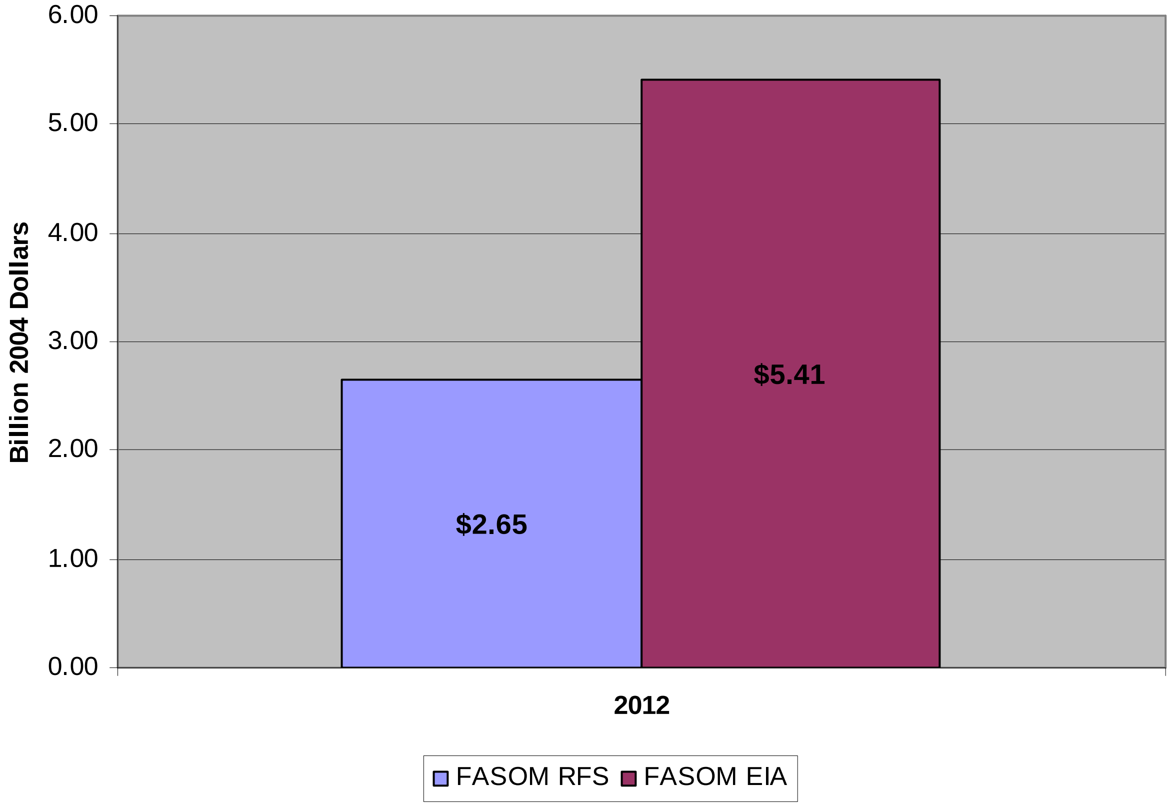
Soybean meal is produced when crushing soybeans and extracting soybean oil, the primary feedstock of biodiesel in the U.S. Under the RFS scenario, FASOM estimates the price of soybean meal will decrease by about 3 percent in 2012, relative to the Reference Case.[110] (See Table 8.1-2) This decrease is slightly larger under the EIA scenario, with the price of soybean meal dropping by about 4 percent. Several factors influence the small change in soybean meal prices. First, more acres of soybeans are being planted to rotate with increased planting of corn, and this leads to increased soybean supplies. Second, increased DDGS supplies can substitute for soybean meal as a feed ingredient by reducing the soybean meal needed in feed rations using higher levels of DDGS. Third, the size of the livestock herd is smaller due to higher meat prices, reducing the demand for animal feeds overall.

[110] The current price of soybeans in the U.S. is considerably higher than the FASOM prediction and is a likely a result of the fact that the market expects acres planted to soybeans in the short term are likely to decline due to increased corn plantings. As with the corn results,.the model reflects medium-term spatial equilibrium prices, where rising demand for corn is met by rising supply -- due to increased acres planted to corn and to increased corn yields per acre by 2012. Similarly, over time, farmers will begin to plant more soybeans in response to relatively higher short-term prices. The model expects soybean prices to reach an equilibrium price of $5.44 per bushel (in the RFS case) by 2012.

8.2 Impact on U.S. Farm Income

The increase in renewable fuel production provides a significant increase in farm income to the U.S. agricultural sector. FASOM predicts that in 2012, U.S. farm income from the sale of agricultural commodities will increase by $2.65 billion dollars in the RFS Case and $5.41 billion in the EIA Case. (See Figure 8.2-1) The RFS and EIA farm income changes represent roughly a 5 and 10 percent increase, respectively, in U.S. farm income from the sale of farm commodities over the Reference Case of roughly $53 billion[111]. Most of the increase in net income is likely to be concentrated in rural areas, and may contribute to rural wealth creation.

Figure 8.2-1. Change in Net Farm Income Relative to Reference Case in 2012



8.3 Impact on Employment

Agricultural employment was not directly modeled but is likely to be very small since modern farm practices are not labor intensive and increases in production as modeled here will have negligible impact on direct farm employment. Some additional employment will result

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[111] While U.S. government farm payments are currently part of the U.S. farm income, what programs will be in place in 2012 and their impact on farm income is unclear. For our modeling, we assumed the support programs were in place in 2010 but none were in place in 2015; interpolation between 2010 and 2015 provided the assumed impact in 2012.

from ethanol plant construction and operation. 30 to 50 people per ethanol production facility seems typical.

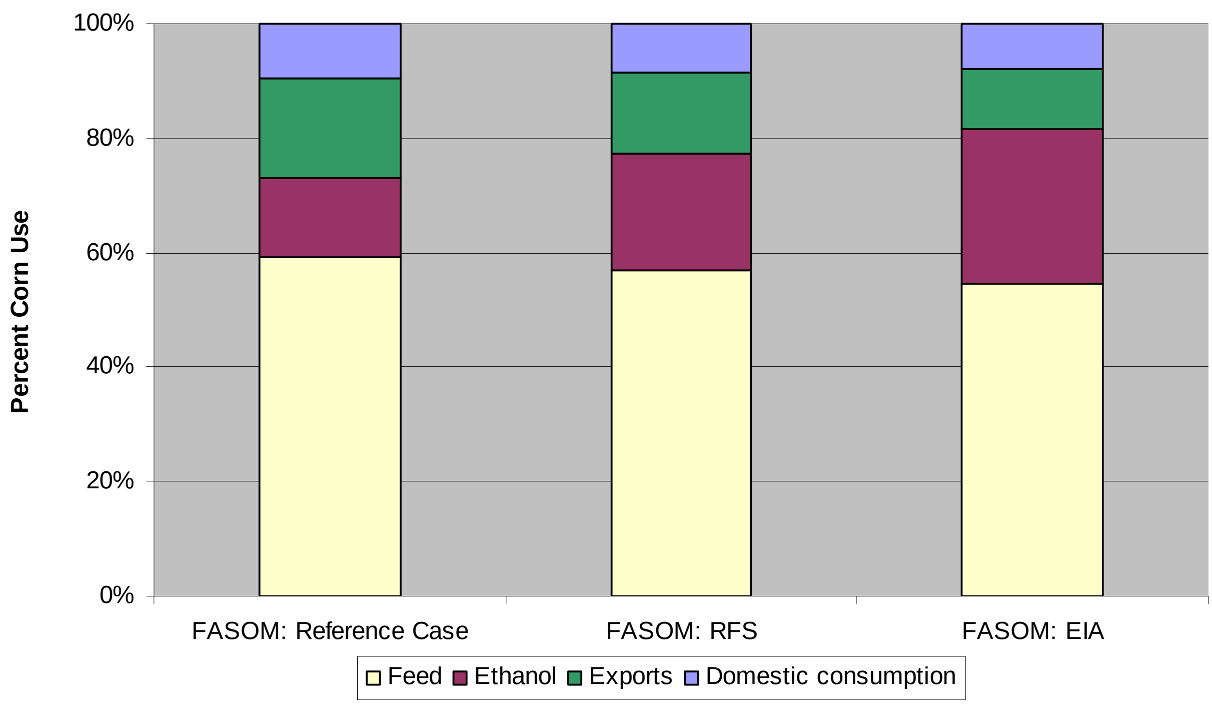
8.4 Commodity Use Change

8.4.1 Corn and Ethanol Byproducts

For this analysis, U.S. corn uses are broken down into four categories: domestic (i.e., household) consumption, ethanol production, livestock feed, and U.S. corn exports. (See Figure 8. 4-1) As the demand for corn increases to produce more renewable fuel, U.S. corn utilization patterns are expected to be altered. In 2005, approximately 13 percent of all corn produced in the U.S. was used for ethanol production. With the two renewable fuel volumes that we are examining, the percentage of corn feedstock used for renewable fuels increases significantly. By 2012, in the RFS Case, 20 percent of all corn produced in the U.S. is used to produce ethanol. In 2012, in the EIA Case, 26 percent of all corn is used to produce fuel ethanol. These estimates are similar to the percentages included in the NPRM.

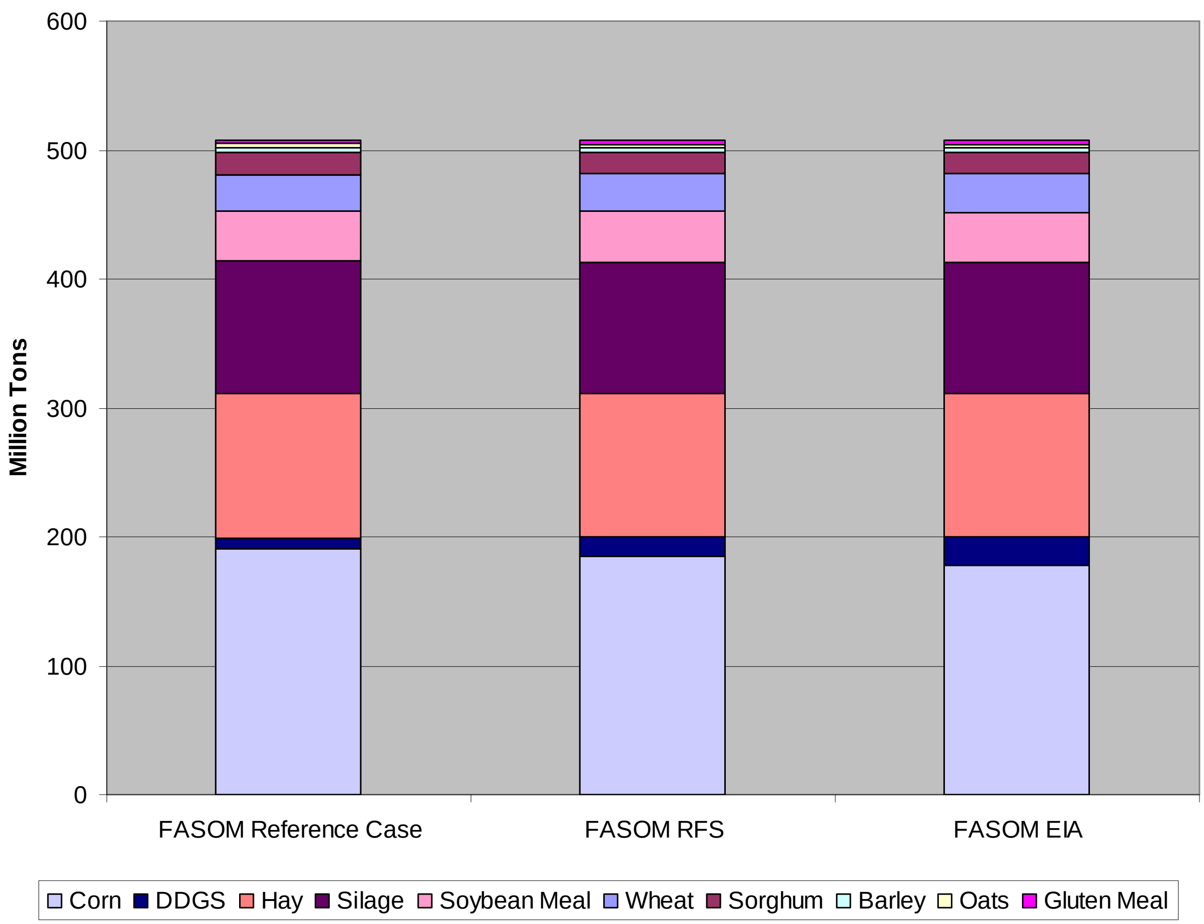
The increasing use of corn for ethanol raises the price of corn which has a direct impact on the other uses of corn. FASOM predicts higher U.S. corn prices leads to lower U.S. exports of corn. U.S. corn exports drop from about 2 billion bushels in the Reference Case to 1.6 billion bushels in the RFS Case and 1.3 billion bushels in the EIA Case by 2012. In value terms, U.S. exports of corn fall by $573 million in the RFS Case and by $1.29 billion in the EIA Case in 2012.

Figure 8.4-1. Corn Uses in 2012



Higher U.S. prices for corn due to increased demand for ethanol production results in decreased use of corn for U.S. livestock feed. The amount of corn used for livestock feeding decreases by about 320 million bushels in the RFS Case and by about 690 million bushels in the EIA Case relative to the Reference Case. Substitutes are available for corn as a feedstock, and this market is highly price sensitive. One alternate feedstock is DDGS because feed ration using increased levels of DDGS would need less corn. The relatively flat prices for DDGS predicted across all ethanol volume scenarios results from the significant increase in the demand for DDGS as a feed ingredient parallels the increase in supply of DDGS. FASOM estimates that DDGS use for livestock feeding for the RFS Case will almost double by 2012, increasing from 8.5 million tons to 15.2 million tons. Under the EIA Case, FASOM predicts that DDGS will increase to 22.2 million tons by 2012. (See Figure 8.4-2) Domestic (i.e., household) consumption of corn for food use declines slightly with the different renewable fuel volumes analyzed in this rulemaking.

Figure 8.4-2. Livestock Feed Sources in 2012



8.4.2 Soybean and Soybean Byproducts

As described previously, only a modest increase in the demand for soybeans are expected to be used to produce biodiesel in the renewable fuel scenarios analyzed in this rulemaking. Although changes in soybean uses in this analysis are limited, U.S. exports are expected to drop by 41.8 million bushels (RFS Case) and 35.6 million bushels (EIA Case). In terms of export earnings, U.S. exports of soybeans fall by $220 million in the RFS Case and by $194 million in the EIA Case in 2012.

8.5 U.S. Land Use Patterns and Land Prices

8.5.1 Corn Acreage

FASOM predicts that total production of corn in the U.S. in 2012 will be 11.9 billion bushels under the RFS Scenario and 12.1 billion bushels under the EIA Scenario (compared to 11.7 billion bushels in the Reference Case)[112]. (See Table 8.5-1) With higher renewable fuel volumes, more corn will be produced in the U.S. Increased U.S. corn production can result from two sources: greater productivity on existing acres of land devoted to corn or from "new" acres that are brought into the corn production. Much of the high quality, suitable land in the U.S. is already being used to produce corn. Improvement in the productivity of growing corn on existing U.S. land is projected to grow by roughly 1 percent annually through 2012. As a result, most of the increased demand for corn from increased use of renewable fuels will be met from increased productivity on existing acres of corn relative to the 2005 baseline year. However, corn production from new acres plays an important role in corn supply. FASOM estimates an increase in land devoted to corn production of 1.6 million acres (RFS Case) and 2.6 million acres (EIA Case) in 2012 compared to the Reference Case.

Table 8.5-1.
U.S. Corn Acres Harvested, Corn Production, and Agricultural Land Prices in 2012

	Reference Case	RFS Case	EIA Case
Corn Acres Harvested (million acres)	78.5	80.1	81.1
Total Corn Production (billion bushels)	11.7	11.9	12.1
Land Prices (percent increase relative to Reference Case)	N/A	8.4%	16.8%

[112] FASOM includes corn equivalent feeding of by products.in the estimate for total corn production.

Higher renewable fuel volumes will have a direct impact on the value of U.S. agricultural land. As demand for corn and other farm products increases, the price of U.S. farm land will also increase. The FASOM analysis shows that in 2012, higher renewable fuel volumes increase average agricultural land prices in the U.S. by about 8 percent (RFS Case) and 17 percent (EIA Case).

8.5.2 Soybean Acreage

Increasing use of biodiesel fuel in the renewable fuel scenarios does not cause a significant change in U.S. soybean production. Soybean production stays relatively flat at 3.3 billion bushels in all three scenarios analyzed. (See Table 8.5-2) Soybean acreage increases modestly as well in the renewable fuel scenarios examined. In the RFS Case, total soybean acres are 74.6 million. For the EIA Case, total soybean acres are 74.4 million acres, compared to 73.4 million acres of soybeans in the Reference Case.

Table 8.5-2. U.S. Soybean Acres Harvested and Soybean Production in 2012

	Reference Case	RFS Case	EIA Case
Soybean Acres Harvested (million acres)	73.4	74.6	74.4
Total Soybean Production (billion bushels)	3.3	3.3	3.3

8.5.3 CRP Acreage

Current lands in the Conservation Reserve Program (CRP) total approximately 40 million acres. To qualify for inclusion in the CRP, the acres must have been at one time in active agricultural use. Farmers are paid to take these lands out of production and place them in CRP to provide environmental benefits, including limiting erosion and providing wildlife habitat. Farmers put land into the CRP voluntarily, considering among other factors the value of the land if it were to remain in agricultural production versus the amount paid under the CRP contract. The amount of government payments can change over time.

For this analysis, we have assumed current per-acre payment levels to landowners are maintained through 2012. However higher commodity prices and higher land rents associated with higher renewable fuel volumes would likely require higher CRP payments to maintain the same level of CRP enrollments. The RFS and EIA renewable fuel volumes are estimated to result in CRP withdrawals of 2.3 million and 2.5 million acres, respectively, relative to the Reference Case. Most of the CRP lands are not likely to go into corn or soybean production since much of the CRP lands tend to be marginal lands due to their location and productivity. For example, only a relatively small portion of CRP lands are in the Corn Belt. Instead, additional corn or soybeans acres will probably be planted on lands that were previously used for other crops or pasture, for example, wheat, grain, sorghum or planted forage crops. It is expected that some of the land removed from CRP will be used for these other agricultural purposes. Table 8.5-3 depicts the estimate of CRP impacts.

Table 8.5-3. CRP Acreage Changes Relative to Reference Case

	RFS Case	EIA Case
Reduction in CRP Acreage (million acres)	2.3	2.5

8.6 Fertilizer Use

Under the RFS scenario, the total amount of nitrogen applied on all farms increases by 1.2 percent, or 480,000 pounds, relative to the Reference Case in 2012. Under the EIA scenario, the total amount of nitrogen applied on all farms increases by 2 percent, or 790,000 pounds, relative to the Reference Case in 2012. (See Table 8.6-1) We note that this percent increase in fertilizer is largely accounted for by the 2 percent increase in land used for corn production and 1 percent increase in land for soybean production. The fact that the amount of nitrogen used increases at a smaller percent than the amount of land increase for corn production suggest that much of the corn production land is already in agricultural use (with fertilizer applied) and is not likely to be land newly released from CRP.

Table 8.6-1. Nitrogen and Phosphorous Use in 2012

	Reference Case	RFS Case	EIA Case
Total Nitrogen Applied (million pounds)	40.28	40.76	41.07
Total Phosphorous Applied (million pounds)	4.24	4.27	4.29

Under the RFS scenario, the total amount of phosphorous applied on all farms increases by 0.7 percent, or 30,000 pounds, relative to the Reference Case in 2012. Under the EIA scenario, the total amount of phosphorous applied on all farms increases by 1.2 percent, or 50,000 pounds, relative to the Reference Case in 2012. See Table 8.6-1.

8.7 Environmental Analysis

Although this analysis does not include a comprehensive and integrated environmental assessment of the impacts in the agricultural sector of higher renewable fuel volumes from this rulemaking, we looked at two factors directly impacted by the production of agricultural crops that may relate to environmental impacts. FASOM does estimate the amount of fertilizer used and changes in CRP land, two indicators that could be associated with water pollution.[113]

Marathon commented that it believes that EPA's assessment of environmental impacts does not consider all environmental impacts and is therefore incomplete, especially with respect to water quality impacts. As described above, our analysis predicts a modest increase in fertilizer use and modest withdrawals of CRP lands due to the higher renewable fuel volumes. While increased agricultural development would likely increase pressure on environmentally sensitive areas such as wetlands and prairie lands and rural ecosystems in general, FASOM does not represent this level of land detail in the national model and therefore cannot quantify any potential impacts on these subsets of land types. To the extent that CRP withdrawals are managed in an environmentally sustainable way, however, water pollution impacts would be minimized.

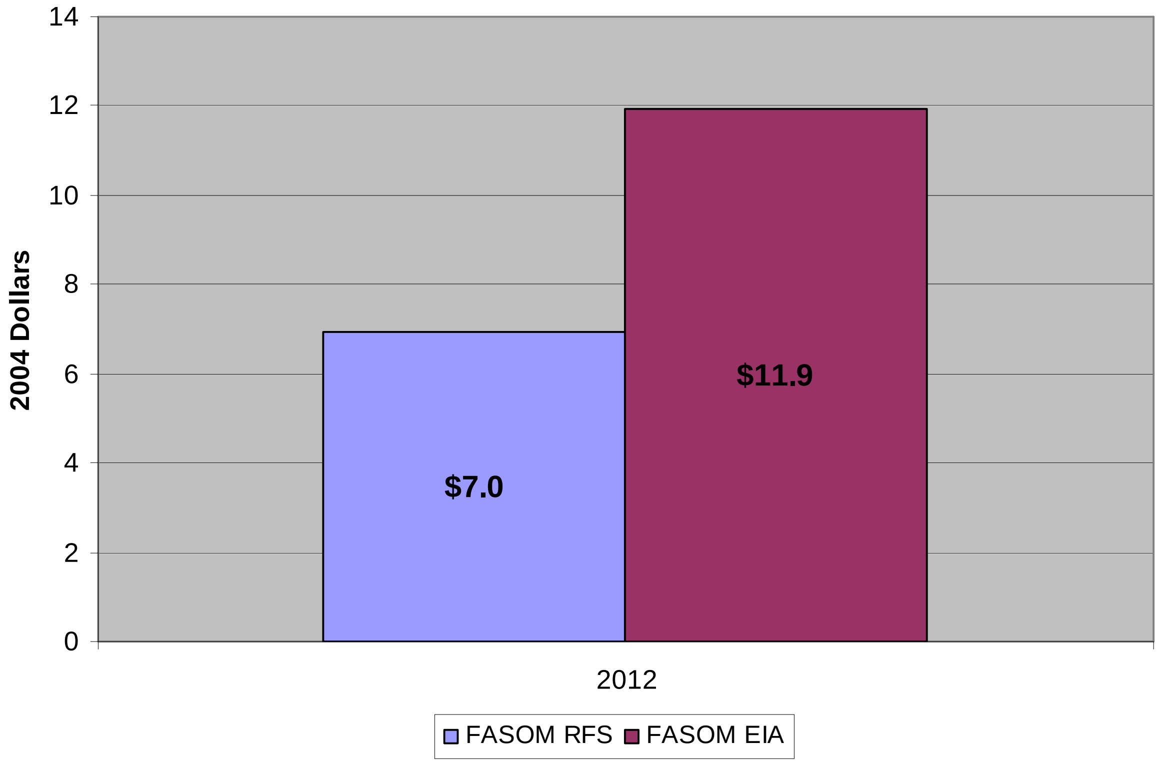
Increasing worldwide demand for biofuels and decreasing U.S. exports of feedstocks used in producing renewable fuels will likely lead to increased prices, production, and different trade patterns for renewable fuel feedstocks (i.e., corn and soybeans) in parts of the world outside of the U.S. FASOM includes the export effect as it contains supply curves for rest of world production of key agricultural products, but it does not contain a mechanism for appraising world environmental implications since FASOM is a domestic model of the U.S. agricultural sector. Therefore, this analysis focuses only on impacts of the higher renewable fuels volumes in the U.S.

8.8 U.S. Food Prices

Despite the wider use of U.S. agricultural feedstocks, principally corn, for renewable fuels, FASOM estimates only a modest increase in U.S. household food costs. Annual wholesale U.S. food costs are estimated to increase by approximately $7 per person with the RFS renewable volumes and by about $12 per person annually with the EIA renewable volumes by 2012. (See Figure 8.8-1) Agricultural costs are only a portion of ultimate household food costs so significant increases in corn prices and, to a lesser degree, soybean prices results in a much smaller relative increase in household food costs.

[113] The FASOM model can describe the proportion of fertilizer that potentially will affect groundwater quality and surface water quality. FASOM also details the extent to which shifts in agricultural production may affect soil erosion and carbon sequestration. In the short timeframe available, we were not able to devote significant efforts to this type of analysis, but this area of inquiry could be investigated more extensively in the future. We do note that we capture the sequestration impacts in the GREET analysis.

Figure 8.8-1. Increase in Annual Food Costs Per Person Relative to Reference Case in 2012



FASOM estimates a relatively modest increase in U.S. prices for meat and agricultural products associated with the higher renewable fuel volumes. When evaluating changes in overall U.S. food prices, FASOM uses the All Farm Products Price Index, which is a weighted average of prices received by farmers at the "farm gate" for crop and livestock products relative to the Reference Case.[114] FASOM estimates a 4 percent increase in the RFS Scenario and a 7 percent increase in the EIA Scenario in the weighted price of all farm products. (See Table 8.8-1)

To evaluate changes in U.S. meat prices, FASOM uses the All Meat Products Price Index which is a weighted average of the prices that farmers receive for meat products at the farm gate. This index is based upon changes in the weighted average of beef, pork, chicken, and turkey prices. U.S. meat prices that farmers receive in 2012 are estimated to increase by 0.3% in the RFS Case and by 1.3% in the EIA Case compared to the Reference Case.

[114] The All Farm Products Price Index includes: cotton, corn, soybeans, wheat, sorghum, rice, oats, barley, silage, hay, sugarcane, sugar beet, potatoes, tomatoes, oranges, grapefruit, switch grass, hybrid poplar, willow, beef, cows, milk, pigs, lamb, wool, horses and mules, eggs, chicken, and turkey.

Table 8.8-1. Increase in the All Farm Products Price Index and the All Meat Products Price Index Relative to the Reference Case in 2012

	RFS Case	EIA Case
All Farm Products Price	3.8% increase	6.9% increase
All Meat Products Price	0.3% increase	1.3% increase

Because corn is a major component of the All Crop Price Index, a significant change in corn prices will result in a pronounced change in this index. The impact of corn price changes on the Meat Price Index will be less pronounced for two reasons. First, as corn prices rise, meat producers will modify feed rations and production systems to reduce their corn usage. Second, there will also be substitution among meats leading to higher consumption of meat from animals using less of the higher priced corn (e.g., increased production of poultry products relative to beef products).