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Impacts of Climate Change Legislation on US Agricultural Markets: Sources of Uncertainty

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While input from USDA-OCE was very valuable in identifying issues of interest and in reviewing preliminary results, all results and conclusions are the responsibility of the Food and Agricultural Policy Research Institute (FAPRI) at the University of Missouri (MU).

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Summary

Climate change legislation could have important effects on US agriculture. The impacts depend on the particular features of any final legislation, how it is implemented and how individuals and firms respond.

The American Clean Energy and Security (ACES) Act, approved by the US House of Representatives in 2009, would establish a regulatory framework intended to reduce greenhouse gas (GHG) emissions. To evaluate the bill's impacts on the US agricultural sector, the Food and Agricultural Policy Research Institute at the University of Missouri (FAPRI-MU) used an extended version of its modeling system to evaluate a wide range of possible scenarios over the 2010-2030 period. The analysis shows that altering a few key assumptions can lead to qualitatively different estimates of the bill's impact.

1. **Production cost impacts.** Energy analysts have developed widely varied estimates of how climate change legislation would affect costs faced by users of fossil fuels. Farm production expenses for fuel, fertilizer and other energy-intensive inputs are likely to increase, but the magnitude of any increase remains uncertain. Key issues are the value of a ton of GHG emissions, how provisions to protect energy-intensive, trade-exposed (EITE) industries work, and how producers respond to changes in input costs. Under some scenarios, annual farm production expenses increase by several billion dollars.
2. **Biofuel sector impacts.** By increasing the consumer price of gasoline and diesel fuel, the legislation could provide an additional incentive for biofuel production. The size of any impact on the biofuel sector depends on petroleum prices, biofuel policies and how climate change policies might apply to the biofuel sector. Under some scenarios, the impacts are quite large, increasing crop receipts and feed costs by billions of dollars.
3. **Land use impacts**. Researchers at Texas A&M and at the University of Tennessee have estimated that climate change legislation could cause significant shifts in land use patterns, as farmers plant more trees or energy crops to sequester carbon and earn offset income. More land diverted to these uses means less land remains available for traditional crop and forage production, resulting in higher crop prices, higher feed costs and increased land rental costs.

For the US farm sector as a whole, the effect on net farm income depends on the magnitude of these various impacts. Higher production expenses reduce aggregate net farm income, but biofuel effects, land use shifts and income from the sale of offsets push farm income higher.

Consumers are likely to face higher food prices, both because of higher farm commodity prices, and because costs of processing and transporting food also increase when energy costs rise.

Background

Various studies have examined the economic effects of climate change legislation on US agriculture.[1] These studies have come to different conclusions, in part because they have made different assumptions about the form of legislation, how it would be implemented, and how individuals and firms would respond to a new regulatory environment. The USDA Office of the Chief Economist (USDA-OCE) asked FAPRI-MU to use its modeling system to estimate possible impacts on the agricultural sector and to evaluate the sensitivity of the results.

The list of possible sources of uncertainty in determining the effects of climate change legislation on the farm sector is very long. This report focuses on three particular issues:

1) How would climate change legislation affect farm production costs?
2) How would it affect biofuel production?
3) How would it affect land use decisions?

To investigate these and related questions, an extended version of the FAPRI-MU modeling system is used to develop 14 scenarios that utilize different combinations of assumptions regarding these and other related issues. The intention is to identify at least some of the critical issues in evaluating the possible impacts of climate change legislation on the farm sector. The analysis examines H.R 2454, the American Clean Energy and Security (ACES) Act,[2] approved by the US House of Representatives in 2009, but the framework created can be used to evaluate other legislation as well.

The extended FAPRI-MU baseline

Climate change legislation could have important effects on US agriculture for decades to come, and the magnitude of impacts could grow over time. In its analysis of the House-passed legislation, the Energy Information Administration (EIA)[3] developed estimates of energy market impacts for a 20-year period ending in 2030. To take advantage of these EIA estimates, FAPRI-MU has extended its traditional ten-year baseline through 2030.

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[1] For example, in December 2009, the USDA Office of the Chief Economist issued a report, "The Impacts of the American Clean Energy and Security Act of 2009 on U.S. Agriculture." In September 2009, Justin Baker, Bruce McCarl and colleagues released a working paper, "The Effects of Low-Carbon Policies on Net Farm Income" (http://nicholas.duke.edu/institute/ni.wp.09.04.pdf), based on work done with the FASOM model maintained at Texas A&M University. In November 2009, Daniel de la Torre Ugarte and colleagues at the University of Tennessee released a report, "Analysis of the Implications of Climate Change and Energy Legislation to the Agricultural Sector" (http://beag.ag.utk.edu/pp/UT_Climate_energy%20report_25x'25Nov30.pdf), based on work done with the POLYSIS model.

[2] H.R. 2454 is also commonly referred to as "Waxman-Markey" after its lead sponsors in the House.

[3] The EIA analysis, "Energy Market and Economic Impacts of H.R. 2454, the American Clean Energy and Security Act of 2009," can be found at www.eia.doe.gov/oiaf/servicerpt/hr2454/index.html.

The starting point for the extended FAPRI-MU baseline is the FAPRI baseline developed in January 2010 in conjunction with analysts at Iowa State University and other cooperating institutions.[4] Three types of adjustments are made to that baseline:

1) US models are extended to 2030, maintaining the same basic structure used to develop the global FAPRI baseline. Because no estimates were prepared for countries outside the United States, future trade paths depend on a continuation of patterns observed during the 2009-2019 period in the global FAPRI baseline.
2) Energy prices are assumed to evolve as projected by the Energy Information Administration in its Annual Energy Outlook 2010.[5] The EIA reference projections indicate the nominal price of imported crude oil could increase from $69 per barrel in 2010 to $168 per barrel by 2030 (Figure 1).[6]
3) Minor model adjustments are made to improve some nearby market projections and to adjust certain model behavior to be appropriate for the longer baseline period.

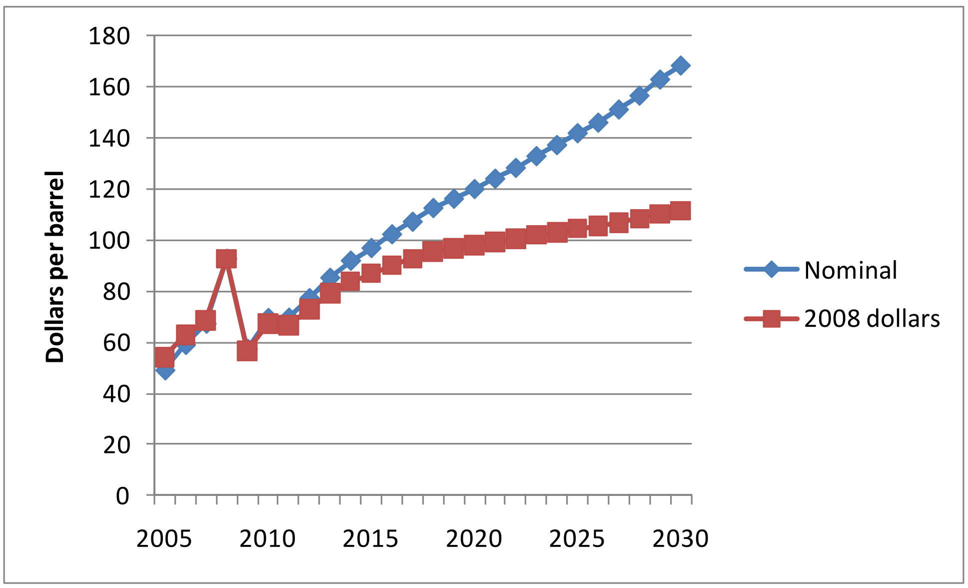

Figure 1. Price of imported crude oil. Source: Reference scenario, EIA Annual Energy Outlook 2010

The extended baseline utilizes the same policy assumptions as the 2010 FAPRI baseline. In general, policies are assumed to continue indefinitely, even when they are currently scheduled to expire at some point. For example, it is assumed that 2008 farm bill provisions are maintained

[4] The 2010 global FAPRI baseline can be found at www.fapri.iastate.edu/outlook/2010/. This baseline is developed using deterministic models maintained at FAPRI-MU, Iowa State's Center for Agricultural and Rural Development (CARD), and other cooperating institutions.
[5] See EIA's reference and alternative energy price scenarios at www.eia.doe.gov/oiaf/forecasting.html.
[6] Alternative scenarios that assume a lower oil price are discussed beginning on page 30.

at their 2012 levels indefinitely. The baseline also assumes that biofuel tax credits and tariffs are maintained at 2009 levels through 2030.[7]

Rising oil prices and the continuation of biofuel tax credits and tariffs have very important implications for agricultural markets (Table 1). Higher prices for oil and other energy sources contribute to significant increases in farm production expenses. Increasing motor fuel prices make biofuel use more attractive. The result is a sharp increase in biofuel production, which in turn results in higher prices for corn and other biofuel feedstocks. Higher corn prices draw more land into corn production, limiting supplies of competing crops like soybeans and wheat, and driving up their prices as well. Supportive policies help switchgrass and corn stover develop as feedstocks for cellulosic ethanol production, and switchgrass area displaces field crops, hay and pasture.

Livestock producers face higher feed prices, which slow the expansion of meat and milk production. This pushes up prices for cattle, hogs, chickens and milk, as does rising global demand for animal protein. Both crop and livestock sector sales receipts increase over time, offsetting the increase in farm production expenses. Net farm income increases as well, but the rate of increase is very modest in real terms; expressed in 2009 dollars, net farm income never recovers to the 2005 level. Consumer food price inflation averages about 2.5% per year.

In some cases, the baseline used to evaluate policy alternatives is not very important. Often, the level of baseline prices and quantities does not significantly affect estimates of the changes from baseline that occur when a policy alternative is evaluated. In the case of climate change legislation, however, baseline levels matter. As discussed later in greater detail, the estimated impacts of climate change legislation are sensitive to the point of comparison. The fact that baseline biofuel production and use far exceed the levels mandated under the Energy Independence and Security Act (EISA) proves to have important implications, so it is critical to understand how this result is obtained.

Two relationships are crucial to the baseline outlook. The first is between the price of gasoline and the price of ethanol. The lower the price of ethanol is relative to gasoline, the greater the incentives for fuel blenders to incorporate ethanol in the fuel they sell and the greater the incentives for consumers to buy more fuel blended with ethanol. If ethanol production continues to increase, the market for 10 percent ethanol blends will soon be saturated. Further industry expansion will hinge on whether higher-level ethanol blends become widely adopted.

[7] Scenarios that assume biofuel tax credits and tariffs expire on schedule are discussed beginning on page 28.

Table 1. Baseline projections with EIA reference oil prices and extended biofuel credits

Calendar or marketing year	2005	2010	2015	2020	2025	2030
Assumptions (calendar year)						
W. Texas oil price, dollars per barrel	56.64	74.94	102.88	126.46	148.76	175.77
Ethanol tax credit, dollars per gallon	0.51	0.45	0.45	0.45	0.45	0.45
Ethanol specific tariff, dollars per gallon	0.54	0.54	0.54	0.54	0.54	0.54
Crop sector results (marketing year)						
Corn production, billion bushels	11.11	13.06	14.26	15.43	17.04	18.88
Corn ethanol use, billion bushels	1.60	4.58	5.36	6.43	8.22	10.30
Corn area planted, million acres	81.78	89.04	90.94	92.47	96.26	100.68
Soybean area planted, million acres	72.03	76.84	77.13	77.37	75.73	73.37
Wheat area planted, million acres	57.21	53.53	53.84	52.21	49.68	46.63
Hay area harvested, million acres	61.64	60.07	59.37	59.08	58.15	57.07
Switchgrass area, million acres	0.00	0.00	0.00	0.52	5.44	12.18
13 crops, hay, switchgrass, mil. acres	312.34	313.59	314.00	313.79	316.21	319.41
Corn price, dollars per bushel	2.00	3.70	3.95	4.14	4.57	5.12
Soybean price, dollars per bushel	5.66	8.73	9.84	10.51	11.34	12.25
Wheat price, dollars per bushel	3.42	4.58	5.02	5.29	5.77	6.35
Biofuel sector results (marketing year)						
Ethanol production, billion gallons	4.50	12.87	15.81	19.96	30.24	46.27
of which, from corn, billion gallons	4.35	12.59	15.10	18.59	24.16	30.79
Biodiesel production, billion gallons	0.20	0.79	1.29	1.59	1.67	1.73
Ethanol rack price, dollars per gallon	2.61	1.77	2.02	2.32	2.60	2.89
Livestock sector results (calendar year)						
Beef production, billion pounds	24.79	25.59	25.50	27.34	28.09	28.87
Pork production, billion pounds	20.71	22.70	24.79	25.94	27.75	29.71
Chicken production, billion pounds	34.99	35.66	39.27	43.22	46.86	50.37
Milk production, billion pounds	176.93	188.40	199.04	208.53	216.39	223.55
Steer price, dollars per cwt.	87.28	87.80	102.41	102.99	111.81	121.33
Barrow & gilt price, dollars per cwt.	50.05	47.89	50.75	56.14	60.62	65.97
Wholesale chicken price, cents per lb.	70.83	77.88	87.03	93.86	100.57	108.34
All milk price, dollars per cwt.	15.19	16.49	18.19	19.80	21.70	24.07
Farm income results (calendar year)						
Crop receipts, billion dollars	116.08	168.57	189.94	215.13	249.94	295.98
Livestock receipts, billion dollars	124.94	130.91	154.56	172.39	195.24	221.73
Production expenses, billion dollars	219.67	287.39	330.38	367.56	415.42	478.02
Net farm income, billion dollars	78.69	64.30	74.71	85.13	101.27	119.37
Net farm income, billion 2009 dollars	86.36	63.63	67.88	70.65	76.89	82.92
Food price inflation (calendar year)	2.4%	2.7%	2.7%	2.4%	2.4%	2.5%

In the baseline, it is assumed that the only alternative to 10% ethanol blends is E-85, a blend containing up to 85% ethanol.[8] Currently, the infrastructure does not exist to allow widespread use of E-85. Only a small proportion of vehicles can use E-85, and relatively few service stations sell the product. The analysis assumes that the price of ethanol must drop low enough to provide economic incentives to build and buy vehicles that can use E-85, to install E-85 pumps at service stations, and to encourage consumers to purchase the fuel. The difficult question is how low ethanol prices must drop and for how long they must remain low to provide the necessary incentives.

In the baseline, the retail-equivalent of the ethanol wholesale price drops to less than 60% of the retail gasoline price on a per-gallon basis (Figure 2). This is a lower ratio than implied by ethanol's energy content, which is approximately two-thirds that of gasoline per gallon. For any given gasoline price, ethanol prices could be higher if the expansion in use of higher-level blends proceeds smoothly or lower if it proves more difficult to build the infrastructure and convince consumers to buy the product. In the model, ethanol use is sensitive to the ratio of ethanol and gasoline prices, but it is not so sensitive that ethanol prices are always a fixed percentage of gasoline prices.

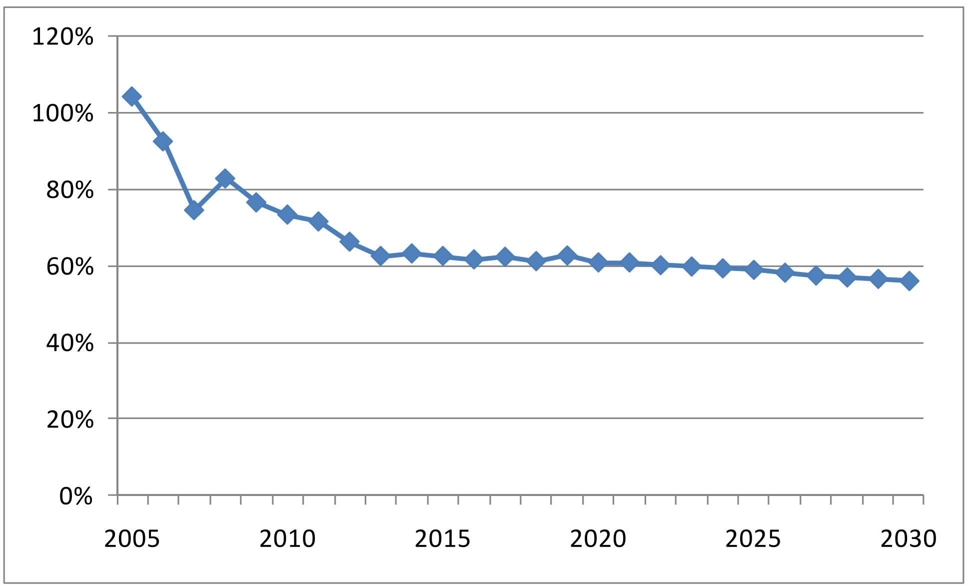

Figure 2. Ethanol-gasoline price ratio, retail-equivalent, marketing year basis, in the baseline with EIA reference oil prices and continued biofuel tax credits and tariffs

[8] A request is pending to allow 15% ethanol blends, but the analysis does not assume the request will be granted. If 15% blends were allowed, they would facilitate use of greater quantities of ethanol, but to achieve the levels of use projected in the baseline still would require greatly expanded use of E-85 or other blends containing more than 15% ethanol.

The second key relationship is between the price of ethanol and the price of corn and other feedstocks. If the price of ethanol is high relative to the price of feedstocks, then ethanol production is very profitable and there is an incentive to expand ethanol plant capacity and production. If the price of ethanol is sufficiently low relative to the price of feedstocks, new investment stops and some plants may shut down if they cannot cover their operating costs.

Ethanol plant margins have been much lower since 2008 than they were from 2005-2007. In the baseline, plant margins eventually recover enough to encourage renewed investment in new plant capacity (Figure 3). In the model, plant capacity and capacity utilization are sensitive to ethanol plant margins, but not so sensitive that the margin is fixed at a particular level. If it were more difficult to encourage further investment, corn prices would be lower relative to ethanol prices; if investors were even more responsive to profit opportunities, corn prices would be higher relative to ethanol prices.

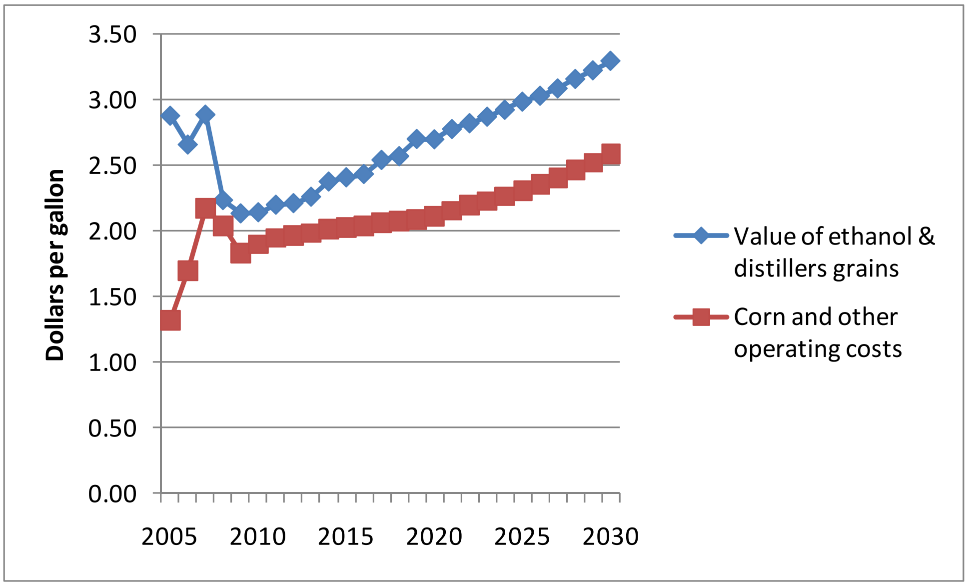

Figure 3. Dry mill ethanol plant returns and operating costs, marketing year basis, in the baseline with EIA reference oil prices and continued biofuel tax credits and tariffs

In summary, the price of gasoline can strongly affect the price of corn and other crops. If gasoline prices are high enough, ethanol production and use is likely to exceed the levels required under EISA biofuel mandates. If anything, the model assumptions could be judged conservative; if fuel consumers and ethanol producers are more sensitive to relative price changes than assumed here, baseline corn prices in 2030 would be even higher. As discussed in a later section, removing biofuel tax credits would reduce corn prices relative to gasoline prices, but the two would continue to be correlated so long as biofuel use exceeds mandated levels.

Impacts on energy costs and farm production expenses

The 2009 House-passed climate change bill would put a price on many types of GHG emissions. Even though farm-level emissions would be explicitly exempted from regulation, crop and livestock producers could face higher prices for fuel, fertilizer and other energy-intensive inputs.

Just how much energy-related costs might change is uncertain. One source of uncertainty is the value of an emission allowance. Under the House bill, a cap is placed on GHG emissions from covered entities and the cap is reduced over time. Utilities and other regulated firms can either reduce emissions by the required amounts, purchase allowances from other capped firms that have made greater cuts than required, or purchase offsets from uncapped firms that voluntarily reduce emissions or sequester carbon. The value of an allowance will depend on how easy it is for capped firms to reduce emissions or for uncapped firms to generate offsets.

In its analysis of the House bill, the Environmental Protection Agency (EPA) estimated the value of an emissions allowance in 2030 would be $26.54 per ton of carbon dioxide equivalent, measured in 2005 dollars. In contrast, the Energy Information Administration (EIA) estimated the 2030 allowance value to be $61.16 per ton, also measured in 2005 dollars, in its "basic" analysis of the House bill.[9]

EIA also examined a range of other scenarios. For example, in its "high offset" scenario, the cost of generating offsets is assumed to be much lower, which holds down allowance values. In its "high cost" scenario, a slower expansion of nuclear power and other factors result in higher allowance values. An even more extreme scenario assumes no ability to utilize international offsets that are generated when other countries reduce emissions or sequester carbon; the sharp reduction in available offsets results in dramatically higher allowance prices.

Table 2 provides selected results from EIA's basic, high offset, and high cost scenarios. Nominal prices for diesel fuel, electricity, and natural gas all increase, with much larger increases in 2030 than in 2020, reflecting rising allowance prices over time. Note the major differences across scenarios. Diesel fuel costs including allowance values increase twice as much in 2030 in the high cost scenario as in the high offset scenario. In the case of electricity, the 2030 difference is even larger, and in the case of industrial natural gas, the increase in the high cost scenario is almost four times as large as in the high offset scenario.

Translating these estimated increases in energy costs to changes in farm production expenses is not straightforward. While it may be fairly clear how diesel fuel prices might affect farm-level

[9] As reported in the December 2009 USDA-OCE report, "The Impacts of the American Clean Energy and Security Act of 2009 on U.S. Agriculture," page 21.

Table 2. Estimates of changes in energy costs and farm operating costs resulting from H.R. 2454, the House-passed climate change bill

	EIA basic scenario	EIA high offset scenario	EIA high cost scenario
Nominal energy cost impacts*			
Diesel fuel			
2020	8.3%	4.6%	9.0%
2030	15.0%	8.0%	17.5%
Electricity			
2020	3.8%	3.6%	5.4%
2030	22.3%	11.8%	32.7%
Industrial natural gas			
2020	14.4%	8.3%	20.2%
2030	25.9%	10.2%	39.9%
Crop operating cost impacts			
Corn			
2020	1.9%	1.0%	2.7%
2030	5.9%	2.5%	8.4%
Soybeans			
2020	2.3%	1.3%	2.7%
2030	5.1%	2.6%	6.5%
Wheat			
2020	2.2%	1.2%	3.0%
2030	6.5%	2.8%	9.1%
Upland cotton			
2020	2.3%	1.4%	2.9%
2030	6.6%	3.2%	9.1%

*Calculations based on EIA reported nominal energy cost data. Note that inflation-corrected real price changes generally would be slightly smaller, as EIA estimates that the scenarios would result in slightly higher rates of overall price inflation in the economy.

The EIA scenarios are briefly described in the text. The full EIA analysis is available at http://www.eia.doe.gov/oiaf/servicerpt/hr2454/index.html fuel costs, it is far less clear how a change in natural gas costs will affect the price of nitrogen fertilizer. A high allowance value could increase the cost of domestic production of nitrogen fertilizer. However, the United States is a major importer of nitrogen fertilizer, and if foreign producers do not experience higher feedstock costs, they might increase their share of the domestic market, holding down any increase in nitrogen costs. In addition, provisions in the House bill would provide free allowances to energy-intensive, trade-exposed (EITE) industries, at least until they are phased out over the 2025-2035 period. This could moderate any increase in domestic nitrogen production costs. The figures reported in Table 2 assume the EITE provisions do hold down nitrogen fertilizer costs; an alternative scenario is discussed on page 26.

Finally, if climate change legislation increases the cost of certain inputs, producers are likely to make some adjustments in their production practices. Where it is economical to do so, producers may reduce use of higher-cost inputs, or shift the mix of commodities they produce away from those that experience the greatest increases in production expenses. Changes in output and input prices could also affect long-run investments in yield-enhancing technology.

The estimates reported in Table 2 attempt to take these considerations into account, but the results are clearly sensitive to a long chain of assumptions. Regardless, it should be clear that the value of a GHG emission allowance has a strong influence on farm production expenses. Given all the assumptions of the analysis, corn operating costs in 2030 could increase as little as 2.5% in the high offset scenario to as much as 8.4% in the high cost scenario. The rest of the analysis included in this report uses EIA's basic analysis of the House climate change bill as the source of estimated changes in energy costs, but it is important to recognize that alternative energy cost scenarios would generate markedly different estimates of farm production expenses.

The core scenarios

The extended baseline and three alternative scenarios help illustrate critical concerns in evaluating the impact of climate change legislation on the agricultural sector (Table 3).

1) *Baseline*. Extends biofuel tax credits and tariffs and uses EIA's reference energy prices from the 2010 Annual Energy Outlook, but does not assume any climate change legislation or any new EPA regulations to reduce GHG emissions.
2) *Basic/costs only*. Same assumptions as the *baseline*, except farm production costs change in response to changes in energy costs as reported in EIA's basic scenario analysis of the House climate change bill, H.R. 2454. Until 2025, nitrogen fertilizer producers receive free allowances under EITE provisions. These free allowances are reduced by 10% per year after 2025. To isolate effects from higher farm production expenses, biofuel producers are not allowed to respond to changes in energy prices.

3) *Basic/with biofuels*. Same assumptions as the *basic/costs only* scenario, except biofuel producers are allowed to respond to changes in gasoline and diesel fuel prices. EITE provisions are assumed to apply to ethanol producers, so they receive free allowances to cover their use of natural gas. These free allowances are reduced after 2025.
4) *Basic/with 20 million acre shift*. Same assumptions as the *basic/with biofuels* scenario, except it is assumed 1 million new acres are devoted to forestry each year, or a total shift of 20 million acres by 2030. Approximately half of the land newly devoted to forestry reflects reductions in acreage devoted to crop production.

The purpose of these various scenarios is to isolate different aspects of the question. The *basic/costs only* scenario is intended to isolate the impacts of higher production costs. Results from the *basic/with biofuels* scenario can be used to isolate the impacts of biofuel market responses. Finally, the *basic/with 20 million acre shift* scenario can be used to isolate the impacts of incentives to shift land into forestry uses to earn offset income.

Table 3. The core scenarios

	Baseline	Basic/costs only	Basic/with biofuels	Basic/with 20 mil. ac. shift
Is EIA's AEO10 reference run the starting point for energy prices?	Yes	Yes	Yes	Yes
Are energy prices adjusted based on EIA's basic scenario analysis of H.R. 2454?	No	Yes	Yes	Yes
Do biofuel tax credits and tariffs continue at 2009 levels?	Yes	Yes	Yes	Yes
Do EITE provisions apply to nitrogen and ethanol production?	n.a.	Yes	Yes	Yes
Is the biofuel sector allowed to respond to changes in energy prices relative to baseline levels?	n.a.	No	Yes	Yes
Are 1 million new acres devoted to forestry each year (20 million acres by 2030)?	No	No	No	Yes

Cost of production effects

By increasing the cost of energy-related inputs, the House climate change bill would increase farm production expenses. The reported impacts on crop variable production expenses reported in Table 4 are consistent with those reported in Table 2.[10] The three scenarios all use the same energy cost assumptions, and the model used does not allow crop variable expenses to respond to changes in output prices, so the estimated cost impacts are the same across all three scenarios.

For all four major crops, variable expenses increase by about 2% above baseline values in 2020 and by 5% or 6% in 2030. Rising allowance values and energy cost impacts are one reason for the larger impacts in 2030 than in 2020. Another reason is the assumed phase-out of EITE provisions after 2025. In earlier years, it is assumed that sufficient free allowances are available so that nitrogen fertilizer producers do not face an increased net cost for natural gas. In fact, in EIA's basic scenario, natural gas prices before incorporating allowance values actually decline relative to baseline values in most years, suggesting nitrogen production costs could actually decline. By 2030, it is assumed that free EITE allowances are available for only half of the natural gas used by domestic nitrogen producers, so nitrogen production costs significantly exceed baseline levels.

Note that the increase in soybean production costs in 2030 is proportionally less than the increase in corn, wheat and cotton production expenses. The primary reason is that soybean producers apply little or no nitrogen fertilizer, so changes in nitrogen costs affect them less than producers of nitrogen-intensive crops.

For the cow-calf and hog sectors, the reported costs include both non-feed and feed inputs. Most of the reported increases in the *basic/costs only* scenario can be attributed to changes in fuel, electricity, and other energy-intensive non-feed inputs. In the other two scenarios rising feed costs account for the larger reported increases in production costs.

Again, note that these estimates all assume that energy costs inclusive of allowances increase as projected by EIA in its basic analysis of H.R. 2454. Even assuming the FAPRI-MU model correctly captures the relationship between energy costs and farm production expenses, the estimates could be much larger or smaller if alternative estimates of energy cost impacts were utilized.

[10] The reported percentage differences from baseline are marginally different in the two tables, as Table 2 reports operating costs, which exclude hired labor expenses, while the variable expenses reported in Table 4 include hired labor. In both cases, land and other fixed expenses are excluded.

Table 4. Production expenses* in the core scenarios

	2020			2030		
	Level	Absolute change	Percent change	Level	Absolute change	Percent change
Corn, dollars per acre						
Baseline	346.65			434.46		
Basic/costs only	353.30	6.65	1.9%	459.65	25.19	5.8%
Basic/with biofuels	353.30	6.65	1.9%	459.65	25.19	5.8%
Basic/with 20 mil. shift	353.30	6.65	1.9%	459.65	25.19	5.8%
Soybeans, dollars per acre						
Baseline	166.32			205.02		
Basic/costs only	170.07	3.76	2.3%	215.32	10.29	5.0%
Basic/with biofuels	170.07	3.76	2.3%	215.32	10.29	5.0%
Basic/with 20 mil. shift	170.07	3.76	2.3%	215.32	10.29	5.0%
Wheat, dollars per acre						
Baseline	149.00			189.12		
Basic/costs only	152.25	3.25	2.2%	201.04	11.92	6.3%
Basic/with biofuels	152.25	3.25	2.2%	201.04	11.92	6.3%
Basic/with 20 mil. shift	152.25	3.25	2.2%	201.04	11.92	6.3%
Cotton, dollars per acre						
Baseline	596.02			762.13		
Basic/costs only	609.36	13.34	2.2%	810.78	48.64	6.4%
Basic/with biofuels	609.36	13.34	2.2%	810.78	48.64	6.4%
Basic/with 20 mil. shift	609.36	13.34	2.2%	810.78	48.64	6.4%
Cow-calf, dollars per cow						
Baseline	664.63			806.99		
Basic/costs only	669.60	4.97	0.7%	820.11	13.12	1.6%
Basic/with biofuels	670.69	6.06	0.9%	825.70	18.71	2.3%
Basic/with 20 mil. shift	678.79	14.16	2.1%	846.13	39.14	4.9%
Hogs, dollars per cwt						
Baseline	56.75			68.61		
Basic/costs only	57.47	0.73	1.3%	70.56	1.96	2.9%
Basic/with biofuels	57.98	1.24	2.2%	73.12	4.51	6.6%
Basic/with 20 mil. shift	58.74	1.99	3.5%	74.59	5.99	8.7%

*Variable expenses for crops, feed and nonfeed expenses for livestock, measured in nominal dollars.

Biofuel sector effects

In addition to increasing farm costs of production, higher consumer costs for fossil fuels can also have important effects on the biofuel sector (Table 5). If producers are able to get more for the ethanol they sell without facing larger net costs for the natural gas and other fossil fuels they use in the production process, they will have an incentive to expand production.

In the *basic/costs only* scenario, it is assumed that biofuel producers do not have the opportunity to benefit from higher prices for competing fuels, and they pay the same price for the fuels they use in the production process as in the baseline. In this artificial scenario, biofuel sector results are almost identical to the baseline. Higher farm production costs result in marginally higher prices for biofuel feedstocks. As a result, biofuel production is slightly less profitable, resulting in a very small decline in biofuel production and an almost imperceptible increase in biofuel prices.

In the *basic/with biofuels* scenario, it is assumed that biofuel producers are able to take advantage of higher consumer costs for gasoline and diesel fuel. In addition, it is assumed that EITE provisions of the proposed legislation would provide free allowances to biofuel producers to offset what otherwise could be a significant increase in the cost of obtaining natural gas and other fossil fuels used to operate plants. These free allowances are assumed to decline after 2025 to cover just 50% of plant fossil fuel use by 2030.

This favorable combination of assumptions results in a strong incentive to expand biofuel production. Higher consumer gasoline prices increase the price blenders and consumers are willing to pay for ethanol. By 2030, producer prices for conventional ethanol exceed baseline levels by $0.25 per gallon, or 8.5%. This results in an 8 billion gallon (17.5%) increase in ethanol production, with more than half of the increase coming from an expansion of corn starch-based ethanol. An additional 1.5 billion bushels of corn is used for ethanol production in the 2030/31 marketing year, relative to the baseline.

Effects on biodiesel production are much smaller. In the baseline and in the scenario, biodiesel is produced primarily to satisfy requirements of the advanced biofuel mandate, so the price of biodiesel is not very sensitive to fossil fuel prices, at least not in the range of prices considered in the analysis. In addition to soybean oil, other feedstocks are used in biodiesel production.

In the *basic/with 20 million acre shift* scenario, an increase in forestry acreage reduces production of conventional crops, resulting in higher prices for biofuel feedstocks. Relative to the *basic/with biofuels* scenario, this results in slightly less biofuel production and higher biofuel prices. Ethanol production continues to be far above baseline levels, however.

Table 5. Biofuel sector effects in the core scenarios

	---2020---			---2030---		
	Level	Absolute change	Percent change	Level	Absolute change	Percent change
Corn ethanol rack price, $ per gal.						
Baseline	2.32			2.89		
Basic/costs only	2.32	0.00	0.0%	2.89	0.00	0.1%
Basic/with biofuels	2.43	0.11	4.7%	3.14	0.25	8.5%
Basic/with 20 mil. shift	2.43	0.11	4.9%	3.15	0.26	8.9%
Total ethanol production, bil. gal.						
Baseline	19.96			46.27		
Basic/costs only	19.90	-0.06	-0.3%	46.15	-0.12	-0.3%
Basic/with biofuels	21.40	1.44	7.2%	54.39	8.12	17.5%
Basic/with 20 mil. shift	21.19	1.23	6.1%	53.49	7.22	15.6%
Corn ethanol production, bil. gal.						
Baseline	18.59			30.79		
Basic/costs only	18.53	-0.06	-0.3%	30.60	-0.19	-0.6%
Basic/with biofuels	19.70	1.11	6.0%	35.39	4.60	14.9%
Basic/with 20 mil. shift	19.52	0.92	5.0%	34.64	3.84	12.5%
Biodiesel production, bil. gal.						
Baseline	1.59			1.73		
Basic/costs only	1.58	0.00	-0.1%	1.73	0.00	-0.2%
Basic/with biofuels	1.60	0.01	0.7%	1.75	0.02	1.1%
Basic/with 20 mil. shift	1.58	-0.01	-0.5%	1.71	-0.02	-1.3%
Corn used for ethanol, bil. bushels						
Baseline	6.43			10.30		
Basic/costs only	6.41	-0.02	-0.3%	10.23	-0.06	-0.6%
Basic/with biofuels	6.81	0.38	6.0%	11.84	1.54	14.9%
Basic/with 20 mil. shift	6.75	0.32	5.0%	11.58	1.28	12.5%
Soyoil used for biodiesel, bil. pounds						
Baseline	6.75			7.58		
Basic/costs only	6.74	-0.01	-0.2%	7.57	-0.02	-0.2%
Basic/with biofuels	6.81	0.06	0.9%	7.67	0.08	1.1%
Basic/with 20 mil. shift	6.69	-0.07	-1.0%	7.41	-0.17	-2.3%

Land use effects

In the *basic/costs only* scenario, higher production expenses reduce producer net returns and encourage shifts in acreage away from crops like corn and cotton that experience the largest declines (Table 6). Soybean acreage, on the other hand, is essentially unchanged, as the effect of higher soybean production costs is offset by acreage shifts away from crops experiencing even larger reductions in net returns. Total acreage devoted to 13 crops, hay and switchgrass declines by about 0.4 million acres in 2020 and 1.0 million acres in 2030. Even in 2030, that represents just 0.3% of baseline area devoted to the same set of crops.

The significant increase in biofuel production in the *basic/with biofuels* scenario results in higher crop prices. For corn in particular, the increase in prices is more than enough to offset the effect of higher production expenses, so net returns over variable expenses exceed baseline levels. The result is a large shift in acreage away from other crops and into corn production. Relative to the baseline, corn acreage increases by 1.1 million acres in 2020 and by 4.7 million acres in 2030. Switchgrass area also expands to supply a larger market for cellulosic biofuels. Most of the increase in corn and switchgrass area is accounted for by a reduction in acreage for other major crops. In addition, however, more land is used for crop production, as total cropped area exceeds baseline levels by 1.6 million acres (0.5%) in 2030.

How much land might switch to new forestry uses because of climate change legislation is uncertain. In the FASOM model results reported by USDA-OCE, the net area devoted to forestry increases by 26.6 million acres by 2030, with 14.6 million acres coming from cropland.[11] The *basic/with 20 million acre shift* assumes a slightly smaller 20 million acre shift into forestry uses by 2030, of which approximately half is obtained by reducing the area devoted to major crops. Total area devoted to 13 crops, hay and switchgrass in 2030 declines by a little over 10 million acres relative to the *basic/with biofuels* scenario (8.6 million acres relative to the baseline).

The mix of crops that would be affected depends in part on the regions where forestry expands. Southeastern and Delta states account for over one-fourth of the assumed new forestry area, even though they account for just one-eighth of the nation's cropland. This results in a larger reduction in area for crops like cotton and soybeans that are produced in the region. In contrast, Plains states account for less than 20% of the new forestry area but more than 40% of cropland.

Finally, note that these results assume that conservation reserve area is maintained at 30 million acres across all the scenarios. Conservation reserve area could, of course, be allowed to adjust, which could moderate impacts on crop production and prices.

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[11] USDA-OCE report, "The Impacts of the American Clean Energy and Security Act of 2009 on U.S. Agriculture," Table 15 on page 28.

Table 6. Land use effects in the core scenarios (million acres)

	2020			2030		
	Level	Absolute change	Percent change	Level	Absolute change	Percent change
Corn area planted						
Baseline	92.47			100.68		
Basic/costs only	92.31	-0.16	-0.2%	100.12	-0.56	-0.6%
Basic/with biofuels	93.54	1.07	1.2%	105.38	4.70	4.7%
Basic/with 20 mil. shift	92.69	0.21	0.2%	103.35	2.67	2.7%
Soybean area planted						
Baseline	77.37			73.37		
Basic/costs only	77.33	-0.04	-0.1%	73.42	0.05	0.1%
Basic/with biofuels	76.64	-0.73	-0.9%	70.65	-2.72	-3.7%
Basic/with 20 mil. shift	74.90	-2.47	-3.2%	67.28	-6.09	-8.3%
Wheat area planted						
Baseline	52.21			46.63		
Basic/costs only	52.23	0.02	0.0%	46.51	-0.13	-0.3%
Basic/with biofuels	51.97	-0.24	-0.5%	45.54	-1.10	-2.4%
Basic/with 20 mil. shift	50.77	-1.43	-2.7%	43.04	-3.60	-7.7%
Upland cotton area planted						
Baseline	10.16			9.84		
Basic/costs only	10.06	-0.10	-1.0%	9.52	-0.32	-3.3%
Basic/with biofuels	10.01	-0.15	-1.5%	9.37	-0.47	-4.8%
Basic/with 20 mil. shift	9.76	-0.40	-3.9%	8.90	-0.94	-9.5%
Hay area harvested						
Baseline	59.08			57.07		
Basic/costs only	59.10	0.02	0.0%	57.10	0.03	0.1%
Basic/with biofuels	59.07	-0.02	0.0%	57.01	-0.06	-0.1%
Basic/with 20 mil. shift	58.39	-0.69	-1.2%	55.63	-1.44	-2.5%
Switchgrass area						
Baseline	0.52			12.18		
Basic/costs only	0.54	0.02	3.7%	12.50	0.32	2.6%
Basic/with biofuels	1.01	0.49	95.0%	13.82	1.64	13.4%
Basic/with 20 mil. shift	0.99	0.47	90.7%	14.20	2.01	16.5%
13 crops, hay and switchgrass*						
Baseline	313.79			319.41		
Basic/costs only	313.40	-0.39	-0.1%	318.43	-0.98	-0.3%
Basic/with biofuels	314.07	0.28	0.1%	320.98	1.57	0.5%
Basic/with 20 mil. shift	308.96	-4.83	-1.5%	310.81	-8.60	-2.7%

*Listed crops, plus sorghum, barley, oats, rice, sunflowers, peanuts, canola, sugar beets and sugarcane.

Production effects

Higher production expenses lead to a small reduction in production for most major crops in the *basic/costs only* scenario (Table 7). In addition to the acreage effects already discussed, higher prices for fuel and fertilizer result in very slight reductions in average crop yields, as some producers reduce use of more expensive inputs.

In the *basic/with biofuels* scenario, higher prices for corn and other biofuel feedstocks result in increased production of corn, but less production of most other major crops. In the *basic/with 20 million acre shift* scenario, the assumed expansion of forestry area reduces production of traditional agricultural crops. Upland cotton production declines relative to the baseline by more than 10% in 2030, and soybean and wheat production decline by more than 8%.[12]

In the *basic/costs only* scenario, livestock production is responding primarily to changes in non-feed production costs, as feed prices are very close to baseline levels. Higher prices for fuel, electricity and other inputs results in very small reductions (all less than 1% below baseline levels) in meat and milk production.

Higher feed costs in the other two scenarios contribute to larger contractions in livestock and poultry production. In the *basic/with 20 million acre shift* scenario, higher production costs contribute to a 2.9% reduction in pork production in 2030 relative to the baseline, with smaller reductions in chicken, milk and beef production.

[12] Proportional changes in production sometimes differ slightly from changes in planted acreage. In addition to adjustments in yields caused by higher production costs and output prices, regional shifts in production can affect average crop yields and the share of planted area which is harvested.

Table 7. Production effects in the core scenarios

	2020			2030		
	Level	Absolute change	Percent change	Level	Absolute change	Percent change
Corn, billion bushels						
Baseline	15.43			18.88		
Basic/costs only	15.39	-0.04	-0.3%	18.75	-0.13	-0.7%
Basic/with biofuels	15.61	0.18	1.1%	19.82	0.94	5.0%
Basic/with 20 mil. shift	15.48	0.05	0.4%	19.49	0.61	3.2%
Soybeans, billion bushels						
Baseline	3.54			3.63		
Basic/costs only	3.53	-0.01	-0.2%	3.62	0.00	-0.1%
Basic/with biofuels	3.50	-0.04	-1.1%	3.48	-0.15	-4.0%
Basic/with 20 mil. shift	3.42	-0.11	-3.2%	3.32	-0.30	-8.4%
Wheat, billion bushels						
Baseline	2.08			2.00		
Basic/costs only	2.07	0.00	-0.2%	1.98	-0.01	-0.7%
Basic/with biofuels	2.06	-0.01	-0.6%	1.94	-0.06	-2.8%
Basic/with 20 mil. shift	2.01	-0.07	-3.2%	1.82	-0.17	-8.7%
Upland cotton, million bales						
Baseline	16.82			18.01		
Basic/costs only	16.62	-0.20	-1.2%	17.33	-0.68	-3.8%
Basic/with biofuels	16.54	-0.28	-1.7%	17.03	-0.97	-5.4%
Basic/with 20 mil. shift	16.07	-0.75	-4.5%	16.10	-1.91	-10.6%
Beef, billion pounds						
Baseline	27.34			28.87		
Basic/costs only	27.31	-0.02	-0.1%	28.81	-0.06	-0.2%
Basic/with biofuels	27.31	-0.03	-0.1%	28.77	-0.10	-0.3%
Basic/with 20 mil. shift	27.28	-0.05	-0.2%	28.66	-0.21	-0.7%
Pork, billion pounds						
Baseline	25.94			29.71		
Basic/costs only	25.82	-0.12	-0.5%	29.44	-0.27	-0.9%
Basic/with biofuels	25.77	-0.18	-0.7%	29.06	-0.65	-2.2%
Basic/with 20 mil. shift	25.67	-0.27	-1.1%	28.86	-0.85	-2.9%
Chicken, billion pounds						
Baseline	43.22			50.37		
Basic/costs only	43.20	-0.01	0.0%	50.33	-0.04	-0.1%
Basic/with biofuels	43.14	-0.07	-0.2%	49.96	-0.40	-0.8%
Basic/with 20 mil. shift	43.01	-0.21	-0.5%	49.68	-0.69	-1.4%
Milk, billion pounds						
Baseline	208.53			223.55		
Basic/costs only	208.02	-0.51	-0.2%	222.52	-1.02	-0.5%
Basic/with biofuels	207.92	-0.61	-0.3%	221.90	-1.65	-0.7%
Basic/with 20 mil. shift	207.52	-1.01	-0.5%	221.02	-2.53	-1.1%

Commodity price effects

Impacts on the prices of agricultural commodities are very small in the *basic/costs only* scenario (Table 8). Higher production costs result in a slight reduction in production of major crop and livestock commodities, and this in turn results in only a small increase in commodity prices. In 2020, prices for all the major agricultural commodities increase by less than 1% over baseline levels. Even in 2030, when production cost impacts are significantly larger, farm-level commodity price impacts are 2% or less.[13]

In the *basic/with biofuels* scenario, the increase in demand for biofuel feedstocks and the reduction in production of crops that compete with those feedstocks both contribute to much larger increases in commodity prices. Corn prices exceed baseline levels by 2.9% in 2020 and by 9.4% in 2030, with smaller increases for other crops that have to compete with corn for acreage.

The increase in feed costs reduces meat and milk production, contributing to higher prices for cattle, hogs, chicken and milk. The increase in farm-level livestock, poultry and milk prices are greater in proportional terms than the decline in production. Final consumer demand for meat and dairy products is relatively inelastic with respect to farm-level prices; that is, a 1% increase in farm-level livestock and milk prices corresponds with less than a 1% reduction in meat and dairy product consumption.

In the *basic/with 20 million acre shift* scenario, the diversion of cropland to forestry uses results in less crop production and in even higher crop prices. Corn prices exceed baseline levels by 12.2% in 2030, and prices for other major crops all increase by at least 5%. Higher feed costs contribute to higher livestock sector prices as well. Hog and broiler prices increase by about 4 cents per pound above baseline levels in 2030, and milk and cattle prices also increase.

Note that the change in corn prices is greater between the *basic/costs only* scenario and the *basic/with biofuels* scenario than it is between the *basic/with biofuels* scenario and the *basic/with 20 million acre shift* scenario. In other words, given all the assumptions of this analysis, the increase in biofuel demand caused by higher consumer gasoline prices has a greater impact on corn prices than does a 20 million acre expansion of forestry. As is discussed beginning on page 30, this result is sensitive to baseline levels of energy prices. If low energy prices result in a binding biofuel mandate, a modest increase in gasoline prices may have little effect on corn prices.

[13] Even these modest increases in farm-level commodity prices could be an overstatement. The increase in fuel costs would increase the costs of transporting agricultural products and of transforming raw farm commodities into consumer-ready foods. This would tend to push down the price of raw farm commodities even as it pushes up consumer food prices. The model used to conduct this analysis does not fully capture the impact this could have on producer-level prices. Estimates of consumer food price impacts reported on page 25 do reflect assumed increases in transportation and processing costs.

Table 8. Commodity price effects in the core scenarios

	2020			2030		
	Level	Absolute change	Percent change	Level	Absolute change	Percent change
Corn, farm, dollars per bushel						
Baseline	4.14			5.12		
Basic/costs only	4.16	0.02	0.4%	5.18	0.06	1.2%
Basic/with biofuels	4.26	0.12	2.9%	5.59	0.48	9.4%
Basic/with 20 mil. shift	4.34	0.20	4.8%	5.74	0.62	12.2%
Soybean, farm, dollars per bushel						
Baseline	10.51			12.25		
Basic/costs only	10.52	0.01	0.1%	12.26	0.01	0.1%
Basic/with biofuels	10.58	0.08	0.7%	12.55	0.30	2.5%
Basic/with 20 mil. shift	10.75	0.24	2.3%	12.89	0.65	5.3%
Wheat, farm, dollars per bushel						
Baseline	5.29			6.35		
Basic/costs only	5.30	0.01	0.3%	6.40	0.05	0.8%
Basic/with biofuels	5.36	0.08	1.4%	6.66	0.31	4.9%
Basic/with 20 mil. shift	5.46	0.18	3.3%	6.87	0.52	8.2%
Cotton, farm, cents per pound						
Baseline	67.40			78.79		
Basic/costs only	67.82	0.42	0.6%	80.46	1.67	2.1%
Basic/with biofuels	67.99	0.60	0.9%	81.17	2.38	3.0%
Basic/with 20 mil. shift	69.00	1.61	2.4%	83.44	4.65	5.9%
Steers, Neb. direct, dollars per cwt						
Baseline	102.99			121.33		
Basic/costs only	103.28	0.29	0.3%	122.08	0.75	0.6%
Basic/with biofuels	103.46	0.46	0.4%	123.19	1.87	1.5%
Basic/with 20 mil. shift	103.86	0.86	0.8%	124.31	2.99	2.5%
Hogs, 51-52% lean, dollars per cwt						
Baseline	56.14			65.97		
Basic/costs only	56.59	0.45	0.8%	67.11	1.14	1.7%
Basic/with biofuels	56.85	0.71	1.3%	68.86	2.89	4.4%
Basic/with 20 mil. shift	57.33	1.19	2.1%	69.96	3.98	6.0%
Broilers, 12 city, cents per pound						
Baseline	93.86			108.34		
Basic/costs only	94.01	0.15	0.2%	108.75	0.41	0.4%
Basic/with biofuels	94.32	0.46	0.5%	110.65	2.31	2.1%
Basic/with 20 mil. shift	95.02	1.16	1.2%	112.13	3.79	3.5%
Milk, dollars per cwt						
Baseline	19.80			24.07		
Basic/costs only	19.99	0.19	0.9%	24.50	0.43	1.8%
Basic/with biofuels	20.03	0.22	1.1%	24.77	0.70	2.9%
Basic/with 20 mil. shift	20.17	0.37	1.9%	25.16	1.09	4.5%

Farm income effects

The three scenarios highlight the complicated effects that climate change legislation could have on farm income (Table 9). In the *basic/costs only* scenario, there is a significant increase in production expenses ($9.2 billion in 2030) above baseline levels. These higher costs cause a small reduction in crop and livestock production that in turn slightly increases crop and livestock prices. The resulting increase in the farm value of crop and livestock sales is very small. As a consequence, net farm income declines almost as much as production costs increase. Net farm income falls by $7.3 billion (6.2%) relative to the baseline in 2030.

Adding in the effects of greater biofuel demand in the *basic/with biofuels* scenario results in a very different picture. Higher crop prices and an increase in corn production contribute to a $16.4 billion (5.6%) increase in crop receipts in 2030 above baseline levels. These higher crop prices mean that feed costs to the livestock sector exceed baseline levels by $4.4 billion in 2030. Even before considering fuel-related expenses, this increase in feed costs is greater than the $3.7 billion increase in livestock cash receipts, suggesting lower net income for the livestock sector.

Overall net farm income slightly exceeds the baseline in 2030, as the increase in receipts is more than enough to overcome the sharp increase in production expenses. Relative to the *basic/costs only* scenario, net farm income is $9.4 billion higher in the *basic/with biofuels* scenario, emphasizing the importance of the biofuel sector response to climate change legislation. As discussed on page 32, this result is very sensitive to energy prices; if lower oil prices resulted in a binding biofuel mandate, net farm income would remain below baseline levels.

The results for the *basic/with 20 million acre shift* scenario show the impacts of assumed acreage shifts to forestry on remaining crop and livestock producers. Crop receipts are essentially the same as in the *basic/with biofuels* scenario, as the effect of lower production is offset by higher crop prices. Both feed expenses and livestock receipts are higher than in the previous scenario. Total production expenses are marginally lower than in the *basic/with biofuels* scenario, as the effect of fewer planted acres outweighs higher feed costs and higher payments to nonoperator landlords, as rental rates increase. Overall, net farm income exceeds baseline levels by $1.5 billion in 2020 and by $5.1 billion in 2030.

Note that these estimates are before considering any receipts and costs associated with the sale of agricultural offsets. In the *basic/with 20 million acre shift* scenario, 20 million acres of new forestry would result in significant income from the sale of offsets. However, it is very difficult to estimate the magnitude of the impacts on net farm income. Those impacts would depend on the sale value of offsets, the cost of planting and maintaining trees, and the share of income that would accrue to persons whose income is included in the farm income accounts. Likewise, other sources of offset income could also have complicated impacts on net farm income.

Table 9. Farm income effects, excluding offsets, in the core scenarios, billion dollars*

	2020			2030		
	Level	Absolute change	Percent change	Level	Absolute change	Percent change
Crop receipts						
Baseline	215.13			295.98		
Basic/costs only	215.30	0.17	0.1%	296.61	0.63	0.2%
Basic/with biofuels	217.54	2.41	1.1%	312.42	16.44	5.6%
Basic/with 20 mil. shift	218.04	2.91	1.4%	312.31	16.33	5.5%
Livestock receipts						
Baseline	172.39			221.73		
Basic/costs only	172.96	0.57	0.3%	223.23	1.50	0.7%
Basic/with biofuels	173.28	0.88	0.5%	225.40	3.67	1.7%
Basic/with 20 mil. shift	174.02	1.63	0.9%	227.30	5.57	2.5%
Feed expenses						
Baseline	50.66			63.27		
Basic/costs only	50.70	0.04	0.1%	63.45	0.18	0.3%
Basic/with biofuels	51.19	0.52	1.0%	67.71	4.44	7.0%
Basic/with 20 mil. shift	51.94	1.27	2.5%	69.18	5.91	9.3%
Rental payments to nonoperators						
Baseline	11.45			17.28		
Basic/costs only	11.27	-0.18	-1.6%	16.61	-0.68	-3.9%
Basic/with biofuels	11.56	0.11	0.9%	18.76	1.48	8.6%
Basic/with 20 mil. shift	11.84	0.39	3.4%	19.34	2.06	11.9%
Total production expenses*						
Baseline	367.56			478.02		
Basic/costs only	369.81	2.25	0.6%	487.21	9.19	1.9%
Basic/with biofuels	371.13	3.57	1.0%	497.88	19.86	4.2%
Basic/with 20 mil. shift	370.85	3.28	0.9%	496.57	18.55	3.9%
Offset sale net income*						
Baseline	0.00			0.00		
Basic/costs only	0.00	0.00	n.a.	0.00	0.00	n.a.
Basic/with biofuels	0.00	0.00	n.a.	0.00	0.00	n.a.
Basic/with 20 mil. shift	0.00	0.00	n.a.	0.00	0.00	n.a.
Net farm income (exc. offsets)*						
Baseline	85.13			119.37		
Basic/costs only	83.57	-1.56	-1.8%	112.02	-7.35	-6.2%
Basic/with biofuels	85.19	0.06	0.1%	121.41	2.04	1.7%
Basic/with 20 mil. shift	86.62	1.49	1.7%	124.47	5.11	4.3%

* These estimates do not include any receipts or expenses associated with offset sales.

Commodity export effects

US climate change legislation could have important implications for farmers and consumers in other countries. Higher prices for crop and livestock products provide an incentive to increase production and limit consumption, reducing US export sales of farm commodities.

In the *basic/costs only* scenario, impacts on commodity prices are small, so the estimated reductions in US exports of major crop and livestock products are also small. However, in the *basic/with biofuels* scenario, greater production of biofuels sharply increases prices for corn and other commodities, and these higher prices result in lower US exports. US corn exports fall by 21.2% from baseline levels, with smaller reductions in wheat, soybean and meat exports.

In the *basic/with 20 million acre shift* scenario shifting 20 million new acres into forestry uses reduces the amount of cropland available for crop production, further increasing crop prices. By 2030, wheat exports decline by 24.3% from baseline levels, and the reductions in corn and soybean exports are almost as large. The decline in US meat exports is proportionately smaller, based on the assumption that livestock producers in other exporting countries also face higher feed costs.[14]

Consumer food expenditure effects

Climate change legislation is likely to result in higher consumer food costs. Most of the increase occurs not because of changes in farm commodity prices, but because of increased costs of transforming raw farm commodities into consumer-ready foods. Higher costs for fuel and electricity increase the cost of transporting and processing food.

In the *basic/costs only* scenario, consumer food expenditures increase by 1.0% in 2020 and by 1.8% in 2030 above baseline levels, with most of the impact occurring after commodities leave the farm. In the other two scenarios, higher farm-level commodity prices result in a slightly larger increase in consumer food expenditures. In the *basic/with 20 million acre shift* scenario, consumer food expenditures in 2030 exceed baseline levels by $48.6 billion, or 2.0%.

[14] US trade is determined in the FAPRI-MU model by a series of simple equations that are intended to mimic the behavior of a global model. These results could change significantly if the same analysis were done in conjunction with the global FAPRI model maintained by colleagues at the Center for Agricultural and Rural Development at Iowa State University and other affiliated institutions. Resource and time constraints led to the approach used in this analysis. One key issue is how responsive producers and consumers in other countries are to changes in US commodity prices. Another issue is whether other countries may adjust agricultural production to earn international offset income tied to reduced GHG emissions or increased carbon sequestration. These estimates do not assume any shifts in foreign agricultural production tied to offset sales in other countries (see the discussion of limitations of the analysis on pages 37 and 38).

Table 10. Commodity export effects in the core scenarios

	2020			2030		
	Level	Absolute change	Percent change	Level	Absolute change	Percent change
Corn, billion bushels						
Baseline	2.34			2.22		
Basic/costs only	2.33	-0.01	-0.4%	2.19	-0.03	-1.5%
Basic/with biofuels	2.26	-0.07	-3.2%	1.75	-0.47	-21.2%
Basic/with 20 mil. shift	2.23	-0.11	-4.6%	1.72	-0.50	-22.6%
Soybeans, billion bushels						
Baseline	1.27			1.23		
Basic/costs only	1.27	0.00	-0.4%	1.23	0.00	-0.3%
Basic/with biofuels	1.24	-0.03	-2.2%	1.13	-0.10	-8.3%
Basic/with 20 mil. shift	1.19	-0.08	-6.4%	1.02	-0.22	-17.5%
Wheat, billion bushels						
Baseline	0.85			0.70		
Basic/costs only	0.85	0.00	-0.4%	0.68	-0.01	-2.0%
Basic/with biofuels	0.84	-0.02	-1.8%	0.63	-0.07	-9.4%
Basic/with 20 mil. shift	0.79	-0.06	-7.1%	0.53	-0.17	-24.3%
Beef, pork and chicken, bil. pounds						
Baseline	16.52			18.72		
Basic/costs only	16.44	-0.08	-0.5%	18.55	-0.18	-0.9%
Basic/with biofuels	16.39	-0.13	-0.8%	18.16	-0.56	-3.0%
Basic/with 20 mil. shift	16.27	-0.25	-1.5%	17.86	-0.87	-4.6%

Table 11. Consumer food expenditure effects in the core scenarios, billion dollars

	2020			2030		
	Level	Absolute change	Percent change	Level	Absolute change	Percent change
Consumer food expenditures						
Baseline	1,724.3			2,381.0		
Basic/costs only	1,740.8	16.4	1.0%	2,423.9	43.0	1.8%
Basic/with biofuels	1,741.3	16.9	1.0%	2,426.9	46.0	1.9%
Basic/with 20 mil. shift	1,742.3	18.0	1.0%	2,429.6	48.6	2.0%

Additional scenarios

Free EITE allowances

The core scenarios assume that provisions in the House climate change bill to protect energy-intensive, trade-exposed (EITE) industries will make free allowances available to ethanol and nitrogen fertilizer producers. To examine the importance of the EITE provisions, two additional scenarios are examined:

1) The *no ethanol EITE* scenarios uses all the assumptions of the *basic/with 20 million acre shift* scenario, except ethanol producers are not assumed to be eligible for free EITE allowances. Thus, they face higher costs for natural gas used in the production process.
2) The *no EITE* scenario uses all the assumptions of the *no ethanol EITE* scenario, except nitrogen fertilizer producers are also assumed to be ineligible for free EITE allowances. Thus, they also face higher costs for natural gas used in the production process.

If ethanol producers are ineligible for free allowances, the increase in natural gas costs would counteract most of the benefit ethanol producers receive from higher gasoline prices. As a result, the increase in ethanol production in the *no ethanol* EITE scenario is much smaller than in the *basic/with 20 million acre shift* scenario.

With less demand for ethanol, corn prices and production are lower than in the scenario where free allowances were available. This results in a smaller increase in crop receipts and a smaller increase in net farm income. In the *no ethanol EITE* scenario, net farm income continues to be $1.4 billion above baseline levels in 2030, but it is $3.7 billion lower than in the *basic/with 20 million acre shift* scenario. In other words, providing free allowances to the ethanol industry increases 2030 net farm income by an estimated $3.7 billion.

When nitrogen fertilizer producers are also ineligible for free allowances, higher crop production expenses reduce net farm income. Corn production expenses are $6 per acre higher in 2020 and $8 per acre higher in 2030 in the *no EITE* scenario than in the *no ethanol EITE* scenario. This has only a modest effect on crop production and prices, but it increases total annual farm production expenses by more than $1 billion.

Net farm income in the *no EITE* scenario is about $1 billion lower in 2030 than in the *no ethanol EITE* scenario, and almost the same as in the baseline (as elsewhere, the estimates exclude potential net income from offset sales). In sum, the provision of free allowances to ethanol and nitrogen fertilizer producers has almost a $5 billion impact on net farm income in 2030. Note that in this analysis, the provision of free allowances to ethanol producers has a greater impact on net farm income than does the provision of free allowances to nitrogen fertilizer producers.

Table 12. Scenarios related to free EITE allowances

	2020			2030		
	Level	Absolute change	Percent change	Level	Absolute change	Percent change
Corn ethanol production, bil. gal.						
Baseline	18.59			30.79		
Basic/with 20 mil. shift	19.52	0.92	5.0%	34.64	3.84	12.5%
No ethanol EITE	18.85	0.26	1.4%	31.86	1.07	3.5%
No EITE	18.80	0.21	1.1%	31.68	0.88	2.9%
Corn variable expenses, $ per acre						
Baseline	346.65			434.46		
Basic/with 20 mil. shift	353.30	6.65	1.9%	459.65	25.19	5.8%
No ethanol EITE	353.30	6.65	1.9%	459.65	25.19	5.8%
No EITE	359.45	12.81	3.7%	467.94	33.48	7.7%
Corn price, dollars per bushel						
Baseline	4.14			5.12		
Basic/with 20 mil. shift	4.34	0.20	4.8%	5.74	0.62	12.2%
No ethanol EITE	4.28	0.14	3.5%	5.51	0.39	7.6%
No EITE	4.30	0.16	3.9%	5.52	0.40	7.9%
Corn production, billion bushels						
Baseline	15.43			18.88		
Basic/with 20 mil. shift	15.48	0.05	0.4%	19.49	0.61	3.2%
No ethanol EITE	15.35	-0.08	-0.5%	18.86	-0.02	-0.1%
No EITE	15.31	-0.11	-0.7%	18.78	-0.10	-0.5%
Crop receipts, billion dollars						
Baseline	215.13			295.98		
Basic/with 20 mil. shift	218.04	2.91	1.4%	312.31	16.33	5.5%
No ethanol EITE	216.93	1.80	0.8%	305.23	9.25	3.1%
No EITE	217.05	1.92	0.9%	305.20	9.22	3.1%
Production expenses, billion dollars*						
Baseline	367.56			478.02		
Basic/with 20 mil. shift	370.85	3.28	0.9%	496.57	18.55	3.9%
No ethanol EITE	370.17	2.61	0.7%	491.37	13.35	2.8%
No EITE	371.22	3.66	1.0%	492.52	14.50	3.0%
Net farm income, billion dollars*						
Baseline	85.13			119.37		
Basic/with 20 mil. shift	86.62	1.49	1.7%	124.47	5.11	4.3%
No ethanol EITE	85.85	0.72	0.8%	120.78	1.41	1.2%
No EITE	84.99	-0.14	-0.2%	119.69	0.32	0.3%

* These estimates do not include any receipts or expenses associated with offset sales.

Alternative baseline: Biofuel tax credits and tariffs expire on schedule

The impacts of climate change legislation on the agricultural sector depend on particular provisions of the legislation, how it is implemented, and how people respond to a new regulatory system. The impacts are also sensitive to the policy and market context. To make this point, the climate change scenarios are also evaluated against alternative baselines where key assumptions of the "core" baseline are slightly altered.

The first alternative baseline changes one set of policy assumptions from the core baseline. Instead of assuming that all biofuel tax credits and tariffs are extended indefinitely, this alternative baseline assumes that they expire on schedule (Table 13). This means, for example, that the ethanol tax credit of $0.45 per gallon expires at the end of 2010, that the biodiesel credit of $1.00 per gallon that expired at the end of 2009 is not revived, and that the $1.01 credit for cellulosic ethanol expires in 2012.

Reduced incentives for biofuel production and use result in a sharp decline in biofuel production. Ethanol production in this alternative baseline is more than 3 billion gallons below the core baseline level in 2020, and more than 20 billion gallons lower in 2030. Cellulosic production does not take off if credits are allowed to expire, and biodiesel production remains near the use mandate of 1 billion gallons per year. Note that even though ethanol production is sharply lower than in the baseline where credits and tariffs are extended, ethanol production does continue to grow over time. After 2020, rising oil prices are still sufficient to support corn ethanol production and use well above the 15 billion gallons that can be applied to meeting biofuel use mandates.

With sharply reduced demand from the biofuel sector, prices for corn and other crops do not rise nearly as much as in the baseline where biofuel credits and tariffs are continued. Less acreage is devoted to corn and switchgrass, but more land is planted to wheat and soybeans. Overall cropped acreage continues its long-term slow decline, rather than increasing slightly as it did in the baseline with extended credits and tariffs.

The livestock sector faces lower feed costs, so meat and milk production expands more rapidly and prices are lower.

Lower prices and production levels translate into lower crop receipts than in the baseline where credits and tariffs are extended. By 2030, the difference between the two alternative baselines is $29 billion. Less production, lower feed costs, and lower profitability all contribute to lower production expenses than in the core baseline. Net farm income is $4 billion lower in 2020 and almost $20 billion lower in 2030 than in the baseline where credits and tariffs are extended. Instead of real net farm income increasing steadily over time, it remains relatively constant.

Table 13. Alternative baseline where biofuel tax credits and tariffs expire on schedule

Calendar or marketing year	2015	2020	2025	2030	Change vs. baseline w/ tax credits, tariffs 2020	Change vs. baseline w/ tax credits, tariffs 2030
Assumptions (calendar year)						
W. Texas oil price, dollars per barrel	102.88	126.46	148.76	175.77	0.00	0.00
Ethanol tax credit, dollars per gallon	0.00	0.00	0.00	0.00	-0.45	-0.45
Ethanol specific tariff, dollars per gallon	0.00	0.00	0.00	0.00	-0.54	-0.54
Crop sector results (marketing year)						
Corn production, billion bushels	14.11	14.95	15.99	17.41	-0.47	-1.47
Corn ethanol use, billion bushels	5.09	5.52	6.33	7.86	-0.91	-2.43
Corn area planted, million acres	90.06	89.84	90.83	93.61	-2.63	-7.07
Soybean area planted, million acres	77.46	78.49	78.89	78.10	1.12	4.73
Wheat area planted, million acres	53.95	52.76	51.57	49.83	0.56	3.19
Hay area harvested, million acres	59.37	59.12	58.54	57.87	0.04	0.80
Switchgrass area, million acres	0.00	0.00	0.00	1.09	-0.52	-11.10
13 crops, hay, switchgrass, mil. acres	313.51	312.28	311.21	310.99	-1.51	-8.42
Corn price, dollars per bushel	3.90	3.91	4.09	4.46	-0.23	-0.66
Soybean price, dollars per bushel	9.73	10.24	10.86	11.58	-0.27	-0.67
Wheat price, dollars per bushel	4.99	5.15	5.43	5.86	-0.14	-0.49
Biofuel sector results (marketing year)						
Ethanol production, billion gallons	14.94	16.90	19.97	25.62	-3.06	-20.65
of which, from corn, billion gallons	14.34	15.96	18.61	23.51	-2.64	-7.28
Biodiesel production, billion gallons	1.01	1.03	1.01	1.07	-0.55	-0.66
Ethanol rack price, dollars per gallon	2.01	2.00	2.30	2.71	-0.32	-0.18
Livestock sector results (calendar year)						
Beef production, billion pounds	25.51	27.35	28.13	28.96	0.01	0.09
Pork production, billion pounds	24.88	26.05	28.06	30.23	0.10	0.53
Chicken production, billion pounds	39.28	43.18	46.99	50.69	-0.03	0.33
Milk production, billion pounds	199.18	208.74	217.06	224.79	0.21	1.24
Steer price, dollars per cwt.	102.25	102.79	110.99	119.79	-0.20	-1.54
Barrow & gilt price, dollars per cwt.	50.46	55.77	59.33	63.70	-0.37	-2.27
Wholesale chicken price, cents per lb.	86.89	93.93	99.75	106.50	0.07	-1.85
All milk price, dollars per cwt.	18.14	19.73	21.44	23.56	-0.08	-0.51
Farm income results (calendar year)						
Crop receipts, billion dollars	188.07	209.69	234.70	266.81	-5.44	-29.17
Livestock receipts, billion dollars	154.31	172.13	193.78	218.79	-0.26	-2.93
Production expenses, billion dollars	329.46	365.04	407.72	462.49	-2.52	-15.53
Net farm income, billion dollars	72.28	80.82	90.42	99.81	-4.31	-19.56
Net farm income, billion 2009 dollars	66.64	67.59	69.27	69.95	-3.06	-12.97
Food price inflation (calendar year)	2.7%	2.4%	2.4%	2.4%	0.0%	0.0%

Alternative baseline: Low oil prices

A second alternative baseline maintains biofuel tax credits and tariffs at 2009 levels, but uses a lower set of energy price projections (Table 14). Instead of using EIA's reference price scenario from its 2010 Annual Energy Outlook, this alternative uses EIA's low oil price scenario provided in the same report.

The lower oil prices provide little incentive for biofuel producers to ever produce more corn ethanol or biodiesel than those products can contribute to biofuel use mandates (15 billion gallons of corn starch-based ethanol and 1 billion gallons of biodiesel). This results in dramatically lower demand for corn than in the baseline with the higher EIA reference prices for oil. As a result, nominal corn prices remain near current levels for the next 20 years, and are $1.38 per bushel lower in 2030 than in the baseline with higher oil prices.

Sharply lower corn prices cause large shifts in acreage out of corn and into competing crops, which results in lower prices for soybeans, wheat and other crops. Lower corn prices and lower fuel prices both reduce livestock production costs, so production of meat and milk increases, resulting in lower livestock prices.

One seemingly anomalous result is that non-corn ethanol production actually exceeds levels in the baseline with higher oil prices, especially in the 2020-2025 period. A feature of current biofuel support policies is responsible. If cellulosic biofuel production falls short of its mandate, cellulosic producers receive a subsidy tied to the difference between a trigger level that rises over time and the wholesale price of gasoline. Thus, a lower gasoline price triggers a larger subsidy. In the model this subsidy is more than enough to offset the drop in ethanol prices that occurs because of lower oil and gasoline prices, so cellulosic ethanol producer income actually increases because of the lower oil price. Once the cellulosic mandate of 16 billion gallons is achieved, this subsidy is eliminated; in the low oil price baseline, this occurs after 2026, explaining the slower growth in cellulosic ethanol production after 2025.

Reduced corn production and lower crop prices in general result in significantly lower crop receipts than in the higher oil price baseline. The decline is only $5 billion in 2020, as increased production of cellulosic feedstocks like switchgrass mitigates the decline, but reaches $35 billion in 2030. Livestock receipts also decline relative to the higher oil price baseline, but this is a consequence of lower production costs, not an indicator of reduced profitability. Total farm production expenses are $17 billion lower than in the higher oil price baseline in 2020, and $43 billion lower in 2030. Net farm income exceeds the higher oil price baseline levels in 2020, but is down marginally in 2030, as lower sales receipts slightly outweigh lower production costs.

Food price inflation is slightly lower in this alternative baseline with lower oil prices.

Table 14. Alternative baseline with lower oil prices

Calendar or marketing year	2015	2020	2025	2030	Change vs. baseline w/ reference oil price 2020	2030
Assumptions (calendar year)						
W. Texas oil price, dollars per barrel	53.78	56.38	62.03	69.23	-70.07	-106.54
Ethanol tax credit, dollars per gallon	0.45	0.45	0.45	0.45	0.00	0.00
Ethanol specific tariff, dollars per gallon	0.54	0.54	0.54	0.54	0.00	0.00
Crop sector results (marketing year)						
Corn production, billion bushels	14.24	14.83	15.33	15.93	-0.59	-2.95
Corn ethanol use, billion bushels	5.18	5.09	5.02	5.03	-1.34	-5.27
Corn area planted, million acres	90.69	88.86	86.98	85.82	-3.62	-14.86
Soybean area planted, million acres	77.29	78.81	79.90	80.96	1.44	7.59
Wheat area planted, million acres	53.97	52.37	50.41	49.13	0.17	2.50
Hay area harvested, million acres	59.27	58.80	57.83	57.11	-0.28	0.04
Switchgrass area, million acres	0.34	3.53	9.34	11.34	3.01	-0.84
13 crops, hay, switchgrass, mil. acres	314.92	314.99	315.92	315.14	1.20	-4.26
Corn price, dollars per bushel	3.87	3.74	3.76	3.74	-0.40	-1.38
Soybean price, dollars per bushel	9.72	10.21	10.77	11.29	-0.30	-0.95
Wheat price, dollars per bushel	4.94	5.05	5.28	5.49	-0.24	-0.86
Biofuel sector results (marketing year)						
Ethanol production, billion gallons	15.68	20.08	28.73	31.55	0.12	-14.72
of which, from corn, billion gallons	14.61	14.73	14.77	15.02	-3.86	-15.77
Biodiesel production, billion gallons	1.00	1.10	1.04	1.00	-0.49	-0.73
Ethanol rack price, dollars per gallon	1.97	1.83	1.92	1.98	-0.49	-0.91
Livestock sector results (calendar year)						
Beef production, billion pounds	25.53	27.46	28.31	29.20	0.12	0.32
Pork production, billion pounds	25.10	26.61	28.90	31.46	0.67	1.75
Chicken production, billion pounds	39.31	43.29	47.17	51.06	0.08	0.69
Milk production, billion pounds	200.52	211.01	219.73	228.06	2.48	4.51
Steer price, dollars per cwt.	101.70	101.36	108.86	116.59	-1.63	-4.74
Barrow & gilt price, dollars per cwt.	49.53	53.62	56.17	58.86	-2.53	-7.11
Wholesale chicken price, cents per lb.	86.60	92.98	98.33	103.95	-0.88	-4.39
All milk price, dollars per cwt.	17.68	18.92	20.45	22.27	-0.88	-1.80
Farm income results (calendar year)						
Crop receipts, billion dollars	187.75	210.04	237.80	260.91	-5.09	-35.07
Livestock receipts, billion dollars	153.04	169.38	189.90	212.80	-3.01	-8.93
Production expenses, billion dollars	319.13	350.46	390.55	434.76	-17.10	-43.26
Net farm income, billion dollars	82.24	93.33	107.40	116.71	8.20	-2.66
Net farm income, billion 2009 dollars	74.72	77.45	81.55	81.08	6.80	-1.84
Food price inflation (calendar year)	2.4%	2.3%	2.3%	2.3%	-0.1%	-0.2%

Scenarios compared to alternative baselines: commodity market effects

To test the sensitivity of estimates of the impacts of climate change legislation to the market context, six additional scenarios were examined.

1) The first three scenarios make the same assumptions as the *basic/costs only*, *basic/with biofuels*, and *basic with 20 million acre shift* scenarios described previously, except that it is assumed that biofuel tax credits and tariffs expire on schedule.
2) The other three scenarios make the same assumptions as the *basic/costs only*, *basic/with biofuels*, and *basic with 20 million acre shift* scenarios, except that it is assumed that EIA's low oil price scenario is the point of departure for estimates of energy costs.

Table 15 summarizes commodity market impacts of the alternative baselines and scenarios for the year 2030. When the baseline allows biofuel credits and tariffs to expire on schedule, biofuel production, crop prices and net farm income are much lower than in the core baseline where those policies are extended. However, the estimated changes from this alternative baseline for the three climate change legislation scenarios are broadly similar. The increase in consumer costs of fuel causes both a significant increase in farm production expenses and a large increase in biofuel production that results in higher crop prices. Shifting land to forestry uses causes a further increase in crop prices.

When oil prices are much lower than in EIA's reference run, there is no incentive to produce more than the 15 billion gallons of corn-based ethanol than can be used to satisfy biofuel use mandates. The magnitude of the increase in gasoline prices that results in EIA's basic analysis of the House climate change legislation is not sufficient to change this, as the biofuel use mandates remain binding. With no change in corn-based ethanol use, commodity prices in the *basic/costs only* and *basic/with biofuels* scenarios are almost the same.

In contrast, shifting land to forestry uses has a larger marginal impact on commodity prices when oil prices are much lower than in EIA's reference run. For example, shifting 20 million acres to forestry uses in 2030 increases corn prices by more than 5% when oil prices are low compared to less than a 3% increase when oil prices are much higher, based on a comparison of the *basic/with biofuels*, and *basic with 20 million acre shift* scenarios. When low oil prices result in a binding biofuel mandate, a large share of corn use does not respond to marginal changes in corn prices. That means corn prices are more sensitive to changes in crop supplies than they are at higher oil prices. When oil prices are higher and biofuel mandates are not binding, a significant portion of any shift in corn production is absorbed by adjustments in ethanol production. Because of cross-commodity effects in supply and demand, changes in corn prices affect the prices of all other farm commodities.

Table 15. Scenarios compared to alternative baselines, 2030 commodity market effects

	Baseline with reference oil prices, extended tax credits			Baseline with reference oil prices, tax credits expire			Baseline with EIA low oil prices, extended tax credits		
	Level	Absolute change	Percent change	Level	Absolute change	Percent change	Level	Absolute change	Percent change
Corn ethanol production, bil. gal.									
Baseline	30.79			23.51			15.02		
Basic/costs only	30.60	-0.19	-0.6%	23.39	-0.12	-0.5%	14.98	-0.04	-0.3%
Basic/with biofuels	35.39	4.60	14.9%	27.80	4.28	18.2%	14.98	-0.05	-0.3%
Basic/with 20 mil. shift	34.64	3.84	12.5%	27.15	3.64	15.5%	14.97	-0.05	-0.4%
Corn price, dollars per bushel									
Baseline	5.12			4.46			3.74		
Basic/costs only	5.18	0.06	1.2%	4.52	0.06	1.4%	3.79	0.05	1.4%
Basic/with biofuels	5.59	0.48	9.4%	4.87	0.41	9.2%	3.82	0.08	2.1%
Basic/with 20 mil. shift	5.74	0.62	12.2%	5.02	0.56	12.7%	4.01	0.27	7.3%
Soybean price, dollars per bushel									
Baseline	12.25			11.58			11.29		
Basic/costs only	12.26	0.01	0.1%	11.58	0.00	0.0%	11.31	0.01	0.1%
Basic/with biofuels	12.55	0.30	2.5%	11.85	0.27	2.3%	11.30	0.00	0.0%
Basic/with 20 mil. shift	12.89	0.65	5.3%	12.20	0.62	5.4%	11.68	0.38	3.4%
Wheat price, dollars per bushel									
Baseline	6.35			5.86			5.49		
Basic/costs only	6.40	0.05	0.8%	5.91	0.05	0.8%	5.53	0.04	0.8%
Basic/with biofuels	6.66	0.31	4.9%	6.13	0.27	4.6%	5.53	0.05	0.9%
Basic/with 20 mil. shift	6.87	0.52	8.2%	6.34	0.48	8.1%	5.76	0.28	5.1%
Steers, Neb. direct, dollars per cwt									
Baseline	121.33			119.79			116.59		
Basic/costs only	122.08	0.75	0.6%	120.55	0.76	0.6%	117.12	0.54	0.5%
Basic/with biofuels	123.19	1.87	1.5%	121.19	1.40	1.2%	117.14	0.55	0.5%
Basic/with 20 mil. shift	124.31	2.99	2.5%	122.33	2.55	2.1%	118.44	1.85	1.6%
Hogs, 51-52% lean, dollars per cwt									
Baseline	65.97			63.70			58.86		
Basic/costs only	67.11	1.14	1.7%	64.83	1.13	1.8%	59.64	0.77	1.3%
Basic/with biofuels	68.86	2.89	4.4%	65.92	2.22	3.5%	59.67	0.81	1.4%
Basic/with 20 mil. shift	69.96	3.98	6.0%	67.10	3.40	5.3%	60.98	2.11	3.6%
All milk, dollars per cwt									
Baseline	24.07			23.56			22.27		
Basic/costs only	24.50	0.43	1.8%	23.99	0.44	1.8%	22.58	0.31	1.4%
Basic/with biofuels	24.77	0.70	2.9%	24.18	0.62	2.6%	22.57	0.31	1.4%
Basic/with 20 mil. shift	25.16	1.09	4.5%	24.59	1.03	4.4%	23.01	0.74	3.3%

Scenarios compared to alternative baselines: farm income and consumer food expenditures

Regardless of the market context, climate change legislation results in an increase in farm production expenses. The extent to which this effect is offset by higher market sales, however, is very dependent on the market and policy context.

When oil prices are at EIA reference levels, allowing biofuel tax credits and tariffs results in much lower crop receipts and net farm income. However, the House climate bill still would result in greater biofuel production and higher crop prices and sales receipts. The increase in 2030 crop receipts, however, is not quite as large as in the case when biofuel credits and tariffs are extended. This can be attributed to a slightly smaller increase in crop prices caused in part by the lower baseline level of biofuel production.

Because of the difference in the impacts on crop receipts, 2030 net farm income before offset sales in the *basic/with biofuels* scenario falls marginally short of baseline levels when biofuel tax credits and tariffs are not extended. In contrast, it exceeds baseline levels when biofuel tax credits and tariffs are maintained at 2009 levels. However, in both cases, adding in the effect of a 20 million acre shift into forestry is sufficient to push net farm income above baseline levels, even before considering potential net income from offset sales.

Results are substantially different when the scenarios are evaluated against a baseline with lower oil prices. With little impact on biofuel production levels, the *basic/with biofuels* scenario has little marginal impact on crop receipts or farm income relative to the *basic/costs only* scenario. In contrast, the marginal impact on net farm income of shifting 20 million acres to forestry uses is slightly greater when oil prices are low than when they are at EIA reference levels. This can be attributed to the larger incremental increase in crop prices caused by a binding biofuel mandate, as described previously. Before considering the net income associated with offset sales, net farm income remains below baseline levels.

Extending or failing to extend biofuel tax credits and tariffs has only a modest impact on consumer food expenditures, and the changes from baseline caused by the climate policy scenarios are very similar. When oil prices are much lower than in EIA's reference scenario, however, both the level of consumer food expenditures and the marginal impacts of the climate policy scenarios are lower.[15]

[15] The latter result can be attributed in part to an important assumption of the analysis. To determine energy costs in the policy scenarios, the proportional changes in energy costs in EIA's basic analysis of H.R. 2454 were applied to the baseline prices to determine energy costs in the scenarios. The result is a smaller absolute increase in energy costs when baseline energy prices are lower than when they are higher. An alternative approach would have been to apply the same absolute increase in energy costs.

Table 16. Scenarios compared to alternative baselines, 2030 farm income and consumer food expenditure effects, billion dollars

	Baseline with reference oil prices, extended tax credits			Baseline with reference oil prices, tax credits expire			Baseline with EIA low oil prices, extended tax credits		
	Level	Absolute change	Percent change	Level	Absolute change	Percent change	Level	Absolute change	Percent change
Crop receipts									
Baseline	295.98			266.81			260.91		
Basic/costs only	296.61	0.63	0.2%	267.49	0.67	0.3%	261.59	0.68	0.3%
Basic/with biofuels	312.42	16.44	5.6%	277.97	11.15	4.2%	261.90	0.99	0.4%
Basic/with 20 mil. shift	312.31	16.33	5.5%	278.78	11.97	4.5%	264.02	3.12	1.2%
Livestock receipts									
Baseline	221.73			218.79			212.80		
Basic/costs only	223.23	1.50	0.7%	220.34	1.55	0.7%	213.92	1.13	0.5%
Basic/with biofuels	225.40	3.67	1.7%	221.65	2.86	1.3%	213.97	1.18	0.6%
Basic/with 20 mil. shift	227.30	5.57	2.5%	223.72	4.92	2.3%	216.30	3.50	1.6%
Feed expenses									
Baseline	63.27			58.71			55.49		
Basic/costs only	63.45	0.18	0.3%	58.91	0.20	0.3%	55.68	0.19	0.3%
Basic/with biofuels	67.71	4.44	7.0%	60.68	1.96	3.3%	55.79	0.30	0.5%
Basic/with 20 mil. shift	69.18	5.91	9.3%	62.43	3.72	6.3%	57.75	2.26	4.1%
Rental payments to nonoperators									
Baseline	17.28			13.48			13.78		
Basic/costs only	16.61	-0.68	-3.9%	12.83	-0.66	-4.9%	12.98	-0.80	-5.8%
Basic/with biofuels	18.76	1.48	8.6%	14.40	0.92	6.8%	13.00	-0.78	-5.7%
Basic/with 20 mil. shift	19.34	2.06	11.9%	15.08	1.60	11.9%	13.85	0.07	0.5%
Total prod. expenses (exc. offsets)									
Baseline	478.02			462.49			434.76		
Basic/costs only	487.21	9.19	1.9%	471.80	9.32	2.0%	444.00	9.23	2.1%
Basic/with biofuels	497.88	19.86	4.2%	477.69	15.20	3.3%	444.52	9.76	2.2%
Basic/with 20 mil. shift	496.57	18.55	3.9%	476.92	14.44	3.1%	444.75	9.99	2.3%
Offset sale net income									
All scenarios	0.00			0.00			0.00		
Net farm income (exc. offsets)									
Baseline	119.37			100.69			116.71		
Basic/costs only	112.02	-7.35	-6.2%	93.57	-7.12	-7.1%	109.06	-7.65	-6.6%
Basic/with biofuels	121.41	2.04	1.7%	99.81	-0.88	-0.9%	109.86	-6.85	-5.9%
Basic/with 20 mil. shift	124.47	5.11	4.3%	103.45	2.76	2.7%	114.20	-2.51	-2.1%
Consumer food expenditures									
Baseline	2380.97			2375.65			2258.25		
Basic/costs only	2423.93	42.96	1.8%	2418.60	42.95	1.8%	2285.61	27.36	1.2%
Basic/with biofuels	2426.94	45.97	1.9%	2420.93	45.29	1.9%	2285.72	27.47	1.2%
Basic/with 20 mil. shift	2429.57	48.60	2.0%	2422.23	46.58	2.0%	2289.61	31.36	1.4%

Lessons learned

The study has examined several important aspects of the question of how climate change legislation might affect the agricultural sector. Although the scope of the report is limited and many questions remain, a number of important lessons have been learned in conducting this analysis.

1. *Uncertainties*. Estimates of the impacts of climate change legislation on the farm sector are subject to many uncertainties. Without knowing the precise form of legislation, how it would be implemented, and how individuals and firms around the world would respond to a complex new market environment, it is impossible to know for sure how it would affect US agriculture.
2. *Energy costs*. By raising energy costs, climate change legislation is likely to raise farm production expenses. Using EIA's basic analysis of H.R. 2454 and some assumptions about how the bill would be implemented, overall farm production expenses would increase by about 2% in 2030. Changes in production expenses could be much greater or smaller depending on the value of a GHG emission allowance.
3. *Biofuel effects when oil prices are high.* Biofuels play a critical role in the analysis. If world market conditions lead to high oil prices, biofuel production and use could exceed the levels mandated under existing US energy legislation. Climate legislation is likely to lead to higher consumer prices for gasoline and diesel fuel, further increasing incentives for biofuel production. In one scenario, this effect alone raises crop receipts by more than $16 billion in 2030, fully offsetting the estimated increase in farm production expenses.
4. *Biofuel effects when oil prices are low.* The world looks very different when oil prices are low enough that there is no incentive for biofuel production and use to exceed mandated levels. In this circumstance, a modest increase in the consumer cost of gasoline and diesel fuel may not induce any noticeable change in biofuel production. Without an increase in biofuel production, there is a much smaller impact on crop prices and receipts.
5. *Afforestation and agricultural production*. If landowners can earn offset income by planting more trees, there is likely to be at least some increase in forestry uses of land and some reduction in crop and pasture land. The resulting reduction in crop production would raise crop prices—in one scenario, a 20 million acre shift into forestry would by itself raise grain and oilseed prices by about 3% in 2030. Higher crop prices would benefit crop producers who own their own land, but tenants would face higher rental rates and livestock producers would face higher feed costs.
6. *Free allowances*. In the House-passed legislation, free allowances would be available to certain energy-intensive, trade exposed industries, at least for a transition period. If

nitrogen fertilizer and ethanol producers are eligible for these free allowances, it could hold down farm production expenses and result in higher biofuel production and crop prices. In one scenario where biofuel use exceeds mandated levels, the availability of free allowances covering half the direct fossil fuel use of nitrogen fertilizer and ethanol producers raises net farm income by $5 billion in 2030.

7. *Consumer food costs*. Climate change legislation could increase consumer food expenditures for at least two reasons. First, higher agricultural production expenses, increased biofuel production and shifts of agricultural land to forestry uses could all increase farm commodity prices. Second, and more importantly, higher energy costs mean increased costs of transporting and processing food. In one scenario, consumer food expenditures in 2030 increase by almost $50 billion, or about 2%.

Of all these lessons, the ones related to the biofuel sector are probably the most noteworthy contributions of this study. At least under certain policy and market conditions, biofuel production could have very large impacts on agricultural markets, and climate change legislation could significantly alter the incentives for biofuel production.

Limitations of the analysis

This study finds that the impacts of climate change legislation on the farm sector are very sensitive to provisions of the legislation, how it is implemented, and the market and policy context. The analysis focuses on three major consequences of climate change legislation: its effects on farm production expenses, the biofuel sector, and land use patterns.

The study also has important limitations and leaves many issues unresolved.

1. *Legislation considered.* The study focuses on particular aspects of a particular piece of legislation, H.R. 2454, approved by the House of Representatives in 2009. Other legislation will have different provisions, and could result in significantly different impacts on the agricultural sector.
2. *Offset income*. No attempt is made to estimate the effect on net farm income of agricultural offsets. Planting trees, for example, would generate income from the sale of offsets and, eventually, from the sale of forestry products, but it would also incur establishment and maintenance costs, none of which are considered here. Likewise, other potential sources of offset income are beyond the scope of this report.
3. *Regulation.* The analysis does not consider impacts of potential EPA regulation of GHG emissions in the absence of climate change legislation. More information regarding the

potential impacts of such regulations on energy costs would be needed to conduct the type of analysis reported here.

4. *Energy market impacts*. All of the scenarios examined in this report are based on one particular set of estimates of possible energy market impacts, EIA's basic analysis of H.R. 2454. As shown in Table 2, a range of other estimates are also available, even from the same agency that provided the energy market estimates used in this analysis.
5. *Land use shifts.* The amount of land that might shift to forestry uses because of climate change legislation is uncertain. The 20 million acre shift examined here is not based on a careful analysis of the economics of forestry production, but is simply an assumption made to illustrate potential impacts. Actual shifts in acreage could, of course, be greater or smaller, and the regional distribution of new forestry acres could be different. Adjustments in conservation reserve acreage could also affect commodity markets.
6. *International offsets*. If, for example, another country agrees to increase tree plantings to earn offset income, it could have an impact on the country's agricultural production, with implications for world trade and commodity prices. Reduced agricultural production would lead to higher farm commodity prices, which would in turn reduce the quantity of offsets supplied and raise the price of offsets and emission allowances.
7. *Climate change*. The analysis does not consider possible effects of climate change itself on agricultural production and agricultural markets. If US legislation or a broader international agreement altered future climate conditions, it could have impacts not considered here.
8. *Time frame*. The analysis focuses on the next 20 years, but climate change legislation is intended to have effects over much longer time frames. Other analysis indicates that allowance values would be likely to increase over time, suggesting that at least some impacts on the agricultural sector could be greater after 2030 than in the period examined in this study. Likewise, any effect of legislation on the world's climate is likely to be larger after 2030 than before.

The scope of this report is limited, but it does make clear that estimates of the impacts of climate change legislation are very sensitive to a great number of uncertainties. The report also makes clear that there are very important interactions among the fossil fuel, biofuel, and agricultural sectors that need to be considered in an evaluation of climate change legislation.

Appendix

The following tables summarize key features of the extended baseline used for the analysis. This baseline was developed using an extended version of the model FAPRI-MU uses each year to develop the FAPRI deterministic baseline outlook for US agricultural markets.

As discussed in the text of the report, the assumptions of this baseline are similar to those of the FAPRI 2010 baseline outlook, except that energy sector prices are based on the reference run in the Energy Information Administration's Annual Energy Outlook 2010, released in December 2009.

Only a few other minor adjustments were made to the baseline set of models to improve short-term projections and correct problems that only became obvious when the model was extended to 2030. For example, some changes were made to equations that determine cellulosic biofuel production and export demand for distillers grains to ensure the model would generate plausible estimates to 2030. In general, the model utilizes market information available in January 2010. Therefore it does not reflect recent changes in estimates of current-year crop acreage, commodity supply and use, farm income or other indicators of interest.

Table A.1. Corn market results in the extended baseline

Sep.-Aug. marketing year	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21
Area planted (mil. ac.)	89.9	89.7	90.0	90.7	90.9	91.0	91.4	91.8	92.1	92.5
Area harvested (mil. ac.)	82.6	82.4	82.8	83.4	83.7	83.8	84.2	84.7	85.0	85.4
Yield (bu./ac.)	161.9	163.9	166.0	168.2	170.4	172.7	174.8	176.8	178.8	180.8
Production (mil. bu.)	13,371	13,506	13,740	14,031	14,265	14,467	14,726	14,972	15,194	15,428
Ethanol use (mil. bu.)	4,717	4,775	4,937	5,227	5,358	5,524	5,774	5,947	6,202	6,430
Feed use (mil. bu.)	5,331	5,353	5,360	5,345	5,376	5,385	5,359	5,369	5,333	5,319
Other domestic use (mil. bu.)	1,299	1,309	1,318	1,325	1,334	1,341	1,346	1,354	1,359	1,366
Exports (mil. bu.)	2,048	2,102	2,160	2,154	2,205	2,232	2,271	2,308	2,314	2,337
Ending stocks (mil. bu.)	1,588	1,563	1,537	1,526	1,529	1,524	1,510	1,515	1,510	1,496
Market price ($/bu.)	3.76	3.79	3.86	3.92	3.95	3.97	4.04	4.06	4.09	4.14
Market receipts ($/ac.)	608.78	621.36	640.23	659.75	672.67	685.05	705.75	717.42	731.85	748.29
Variable expenses ($/ac.)	272.57	284.28	293.93	301.86	310.74	318.51	325.34	332.49	339.15	346.65
Market net return ($/ac.)	336.21	337.08	346.29	357.90	361.93	366.54	380.41	384.94	392.70	401.64

Sep.-Aug. marketing year	2021/22	2022/23	2023/24	2024/25	2025/26	2026/27	2027/28	2028/29	2029/30	2030/31
Area planted (mil. ac.)	93.1	93.8	94.6	95.4	96.3	97.1	98.1	99.0	99.8	100.7
Area harvested (mil. ac.)	86.0	86.7	87.5	88.3	89.2	90.0	90.9	91.8	92.7	93.6
Yield (bu./ac.)	182.8	184.8	186.9	189.0	191.1	193.2	195.3	197.5	199.6	201.8
Production (mil. bu.)	15,713	16,023	16,350	16,692	17,036	17,392	17,764	18,135	18,509	18,881
Ethanol use (mil. bu.)	6,751	7,088	7,448	7,824	8,215	8,613	9,024	9,447	9,870	10,298
Feed use (mil. bu.)	5,272	5,231	5,187	5,141	5,090	5,055	5,035	5,013	4,992	4,970
Other domestic use (mil. bu.)	1,372	1,379	1,385	1,392	1,398	1,404	1,410	1,416	1,422	1,429
Exports (mil. bu.)	2,352	2,357	2,362	2,365	2,365	2,352	2,326	2,293	2,259	2,219
Ending stocks (mil. bu.)	1,470	1,448	1,426	1,406	1,382	1,359	1,337	1,313	1,289	1,262
Market price ($/bu.)	4.23	4.31	4.39	4.48	4.57	4.67	4.77	4.88	4.99	5.12
Market receipts ($/ac.)	772.38	795.75	820.57	846.15	873.69	901.79	931.68	963.78	996.86	1032.32
Variable expenses ($/ac.)	354.08	362.73	370.29	376.94	384.84	393.61	402.68	413.06	423.77	434.46
Market net return ($/ac.)	418.31	433.02	450.29	469.21	488.85	508.18	529.00	550.72	573.09	597.86

Table A.2. Soybean market results in the extended baseline

Sep.-Aug. marketing year	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21
Area planted (mil. ac.)	76.2	77.1	77.0	76.9	77.1	77.3	77.4	77.4	77.4	77.4
Area harvested (mil. ac.)	75.3	76.2	76.1	76.1	76.3	76.5	76.5	76.6	76.6	76.6
Yield (bu./ac.)	42.8	43.2	43.6	44.0	44.4	44.8	45.2	45.5	45.9	46.2
Production (mil. bu.)	3,224	3,293	3,320	3,346	3,386	3,427	3,460	3,487	3,514	3,540
Crush use (mil. bu.)	1,822	1,861	1,891	1,919	1,953	1,988	2,019	2,050	2,080	2,107
Other domestic use (mil. bu.)	163	165	167	168	169	170	170	171	171	172
Exports (mil. bu.)	1,266	1,277	1,275	1,275	1,278	1,281	1,283	1,278	1,273	1,272
Ending stocks (mil. bu.)	264	264	262	257	253	251	249	247	247	245
Market price ($/bu.)	9.26	9.34	9.49	9.70	9.84	9.96	10.13	10.25	10.35	10.51
Market receipts ($/ac.)	396.61	403.67	413.87	426.47	436.74	446.44	457.93	466.98	474.83	485.68
Variable expenses ($/ac.)	130.77	135.88	140.76	145.05	149.20	152.86	156.24	159.69	162.89	166.32
Market net return ($/ac.)	265.84	267.78	273.11	281.42	287.54	293.58	301.69	307.28	311.94	319.37
Soybean meal price ($/ton)	278.49	279.36	282.23	284.77	284.68	284.53	285.55	284.82	285.96	286.94
Soybean oil price (cent/lb.)	38.75	39.61	40.10	41.28	42.82	44.27	45.36	46.74	47.34	48.44

Sep.-Aug. marketing year	2021/22	2022/23	2023/24	2024/25	2025/26	2026/27	2027/28	2028/29	2029/30	2030/31
Area planted (mil. ac.)	77.2	76.9	76.6	76.2	75.7	75.3	74.9	74.5	73.9	73.4
Area harvested (mil. ac.)	76.4	76.2	75.8	75.4	75.0	74.6	74.2	73.8	73.2	72.7
Yield (bu./ac.)	46.6	47.0	47.3	47.7	48.1	48.4	48.8	49.2	49.5	49.9
Production (mil. bu.)	3,560	3,576	3,589	3,597	3,604	3,613	3,622	3,627	3,629	3,629
Crush use (mil. bu.)	2,131	2,151	2,167	2,181	2,192	2,204	2,214	2,223	2,230	2,236
Other domestic use (mil. bu.)	172	172	172	171	171	171	171	170	169	168
Exports (mil. bu.)	1,268	1,264	1,260	1,255	1,251	1,249	1,247	1,244	1,239	1,233
Ending stocks (mil. bu.)	244	243	243	243	243	242	242	243	243	244
Market price ($/bu.)	10.67	10.84	11.00	11.17	11.34	11.51	11.69	11.87	12.05	12.25
Market receipts ($/ac.)	497.20	508.94	520.74	532.99	545.24	557.73	570.52	583.68	597.20	611.32
Variable expenses ($/ac.)	169.72	173.44	176.97	180.37	184.09	187.98	191.97	196.28	200.72	205.02
Market net return ($/ac.)	327.47	335.51	343.76	352.62	361.15	369.76	378.55	387.39	396.48	406.30
Soybean meal price ($/ton)	288.36	289.96	292.15	294.48	296.92	299.41	302.13	305.08	308.36	311.63
Soybean oil price (cent/lb.)	49.51	50.59	51.47	52.43	53.36	54.38	55.47	56.55	57.57	58.76

Table A.3. Wheat market results in the extended baseline

June-May marketing year	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21
Area planted (mil. ac.)	54.8	54.9	54.7	54.3	53.8	53.7	53.3	53.0	52.7	52.2
Area harvested (mil. ac.)	46.6	46.6	46.5	46.1	45.7	45.5	45.2	45.0	44.7	44.2
Yield (bu./ac.)	44.0	44.3	44.6	44.9	45.3	45.6	46.0	46.3	46.6	46.9
Production (mil. bu.)	2,050	2,065	2,074	2,070	2,069	2,078	2,081	2,083	2,081	2,076
Food use (mil. bu.)	976	986	995	1,005	1,014	1,023	1,033	1,043	1,054	1,063
Feed use (mil. bu.)	217	212	206	211	207	204	208	205	211	207
Seed use (mil. bu.)	74	74	73	73	73	73	73	72	72	71
Exports (mil. bu.)	972	922	917	893	891	892	881	880	856	854
Ending stocks (mil. bu.)	747	727	718	716	709	706	704	700	700	695
Market price ($/bu.)	4.74	4.83	4.93	4.94	5.02	5.09	5.13	5.21	5.20	5.29
Market receipts ($/ac.)	208.61	213.76	219.89	222.02	227.46	232.10	236.15	241.35	242.40	248.15
Variable expenses ($/ac.)	115.52	120.60	125.11	128.73	132.57	136.06	139.22	142.51	145.58	149.00
Market net return ($/ac.)	93.08	93.15	94.78	93.29	94.89	96.04	96.93	98.84	96.83	99.15

June-May marketing year	2021/22	2022/23	2023/24	2024/25	2025/26	2026/27	2027/28	2028/29	2029/30	2030/31
Area planted (mil. ac.)	51.8	51.3	50.8	50.3	49.7	49.2	48.7	48.1	47.4	46.6
Area harvested (mil. ac.)	43.9	43.5	43.1	42.6	42.1	41.7	41.2	40.7	40.1	39.5
Yield (bu./ac.)	47.3	47.6	48.0	48.3	48.7	49.1	49.4	49.8	50.2	50.5
Production (mil. bu.)	2,075	2,071	2,067	2,059	2,051	2,044	2,038	2,028	2,014	1,996
Food use (mil. bu.)	1,073	1,082	1,092	1,102	1,111	1,121	1,131	1,141	1,151	1,161
Feed use (mil. bu.)	207	207	207	207	207	207	208	208	208	209
Seed use (mil. bu.)	71	71	70	69	69	68	68	67	66	65
Exports (mil. bu.)	845	834	822	807	791	775	760	743	721	696
Ending stocks (mil. bu.)	689	681	674	666	657	649	641	633	623	612
Market price ($/bu.)	5.37	5.47	5.56	5.66	5.77	5.87	5.98	6.10	6.22	6.35
Market receipts ($/ac.)	253.94	260.41	266.91	273.79	280.95	288.18	295.55	303.49	311.89	320.81
Variable expenses ($/ac.)	152.38	156.31	159.78	162.88	166.56	170.57	174.73	179.46	184.33	189.12
Market net return ($/ac.)	101.56	104.10	107.13	110.91	114.39	117.60	120.82	124.04	127.56	131.69

Table A.4. Crop acreage results in the extended baseline (million acres)

Year	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Corn planted	89.89	89.67	90.00	90.67	90.94	90.96	91.41	91.82	92.13	92.47
Soybean planted	76.18	77.07	76.98	76.94	77.13	77.35	77.36	77.39	77.41	77.37
Wheat planted	54.83	54.88	54.72	54.28	53.84	53.67	53.32	53.02	52.67	52.21
Upland cotton planted	10.04	9.98	9.94	9.95	10.00	10.04	10.07	10.10	10.16	10.16
Sorghum planted	7.20	7.00	6.89	6.84	6.79	6.73	6.70	6.67	6.58	6.47
Barley planted	3.40	3.42	3.41	3.37	3.33	3.27	3.22	3.18	3.13	3.08
Oats planted	3.36	3.31	3.26	3.21	3.16	3.11	3.06	3.01	2.97	2.92
Rice planted	3.02	3.02	3.00	3.00	2.98	2.97	2.96	2.95	2.97	2.98
5 other crops*	6.54	6.46	6.46	6.45	6.46	6.48	6.50	6.51	6.53	6.53
Sum: 13 major crops	254.45	254.82	254.67	254.71	254.63	254.57	254.60	254.65	254.54	254.19
Hay harvested	59.96	59.80	59.64	59.48	59.37	59.31	59.28	59.24	59.19	59.08
Switchgrass	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.52
13 crops, hay, switchgrass	314.42	314.61	314.32	314.20	314.00	313.88	313.88	313.89	313.77	313.79
Conservation reserve	30.50	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00

Year	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Corn planted	93.08	93.81	94.60	95.44	96.26	97.13	98.06	98.96	99.84	100.68
Soybean planted	77.19	76.94	76.60	76.16	75.73	75.32	74.92	74.47	73.94	73.37
Wheat planted	51.80	51.32	50.83	50.26	49.68	49.16	48.68	48.09	47.41	46.63
Upland cotton planted	10.15	10.13	10.11	10.09	10.06	10.03	10.01	9.96	9.90	9.84
Sorghum planted	6.39	6.29	6.19	6.09	5.98	5.88	5.79	5.68	5.55	5.42
Barley planted	3.03	2.98	2.92	2.86	2.80	2.75	2.71	2.65	2.58	2.51
Oats planted	2.86	2.80	2.73	2.67	2.60	2.54	2.48	2.42	2.35	2.27
Rice planted	2.99	3.00	3.00	3.01	3.01	3.01	3.02	3.01	3.01	3.01
5 other crops*	6.53	6.53	6.52	6.51	6.49	6.49	6.48	6.47	6.45	6.42
Sum: 13 major crops	254.02	253.78	253.52	253.10	252.63	252.32	252.14	251.71	251.03	250.15
Hay harvested	58.93	58.77	58.59	58.37	58.15	57.95	57.78	57.59	57.35	57.07
Switchgrass	1.11	1.83	2.74	4.08	5.44	6.43	7.16	8.33	10.05	12.18
13 crops, hay, switchgrass	314.07	314.38	314.84	315.55	316.21	316.70	317.08	317.63	318.43	319.41
Conservation reserve	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00

*Sunflowerseed, peanuts, canola, sugar beets and sugarcane

Table A.5. Biofuel market results in the extended baseline

Sep.-Aug. marketing year	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21
WTI oil price ($/barrel)	80.27	88.30	95.56	101.19	106.54	111.71	117.03	121.33	125.16	129.20
Omaha gasoline rack ($/gal.)	2.17	2.40	2.59	2.73	2.86	3.00	3.13	3.26	3.38	3.49
Ethanol production (mil. gal.)	13,377	13,679	14,281	15,266	15,810	16,456	17,354	18,030	18,979	19,962
From corn starch (mil. gal.)	13,021	13,251	13,773	14,658	15,102	15,652	16,444	17,023	17,845	18,593
All other (mil. gal.)	355	428	508	608	708	804	910	1,007	1,134	1,369
Ethanol imports (mil. gal.)	425	427	470	631	980	1,363	1,908	2,238	2,594	2,453
Ethanol dom. use (mil. gal.)	13,680	13,982	14,616	15,754	16,660	17,675	19,112	20,121	21,425	22,255
Biodiesel prod. (mil. gal.)	925	1,029	1,055	1,148	1,286	1,389	1,440	1,526	1,540	1,586
Omaha ethanol rack ($/gal.)	1.82	1.83	1.88	1.99	2.02	2.05	2.16	2.19	2.32	2.32
Cellulosic ethanol rack ($/gal.)	3.33	3.15	3.02	3.05	3.04	3.01	3.05	3.04	3.18	3.18
Biodiesel rack ($/gal.)	3.92	4.01	4.03	4.14	4.31	4.45	4.55	4.68	4.73	4.83
Dry mill receipts ($/gal.)	2.20	2.21	2.26	2.37	2.41	2.43	2.54	2.57	2.70	2.70
Operating costs ($/gal.)	1.95	1.96	1.98	2.01	2.03	2.03	2.06	2.07	2.09	2.11
Net operating returns ($/gal.)	0.25	0.25	0.27	0.36	0.38	0.40	0.48	0.50	0.61	0.58

Sep.-Aug. marketing year	2021/22	2022/23	2023/24	2024/25	2025/26	2026/27	2027/28	2028/29	2029/30	2030/31
WTI oil price ($/barrel)	133.46	138.03	142.54	147.18	151.58	156.47	161.90	168.05	173.91	180.63
Omaha gasoline rack ($/gal.)	3.63	3.75	3.86	3.99	4.13	4.27	4.43	4.60	4.75	4.93
Ethanol production (mil. gal.)	21,451	23,264	25,443	27,775	30,237	33,000	36,117	39,443	42,823	46,270
From corn starch (mil. gal.)	19,587	20,637	21,756	22,932	24,159	25,412	26,715	28,060	29,413	30,792
All other (mil. gal.)	1,863	2,627	3,686	4,843	6,078	7,588	9,402	11,383	13,410	15,479
Ethanol imports (mil. gal.)	2,722	2,805	2,808	2,791	2,787	2,733	2,693	2,667	2,639	2,598
Ethanol dom. use (mil. gal.)	23,992	25,868	28,032	30,341	32,794	35,487	38,548	41,838	45,188	48,592
Biodiesel prod. (mil. gal.)	1,621	1,651	1,658	1,665	1,667	1,678	1,694	1,708	1,714	1,732
Omaha ethanol rack ($/gal.)	2.39	2.44	2.48	2.54	2.60	2.64	2.69	2.76	2.82	2.89
Cellulosic ethanol rack ($/gal.)	3.26	3.31	3.37	3.42	3.49	3.54	3.60	3.67	3.74	3.81
Biodiesel rack ($/gal.)	4.93	5.02	5.09	5.17	5.25	5.34	5.44	5.54	5.63	5.74
Dry mill receipts ($/gal.)	2.78	2.82	2.87	2.92	2.99	3.03	3.09	3.16	3.22	3.30
Operating costs ($/gal.)	2.16	2.19	2.23	2.26	2.31	2.35	2.40	2.46	2.52	2.59
Net operating returns ($/gal.)	0.62	0.63	0.64	0.66	0.68	0.68	0.68	0.70	0.70	0.71

Table A.6. Beef and pork market results in the extended baseline

Year	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Beef production (mil. lb.)	25,494	25,296	25,220	25,169	25,504	25,990	26,448	26,843	27,202	27,337
Beef imports (mil. lb.)	2,951	3,158	3,249	3,330	3,372	3,364	3,304	3,256	3,218	3,184
Beef exports (mil. lb.)	2,185	2,435	2,474	2,478	2,510	2,585	2,612	2,622	2,646	2,648
Beef domestic use (mil. lb.)	26,225	26,012	25,976	26,009	26,343	26,745	27,116	27,456	27,758	27,868
Beef retail wt. use (lb./cap.)	58.49	57.46	56.83	56.35	56.53	56.85	57.09	57.26	57.34	57.03
Neb. steer price ($/cwt)	95.57	101.12	102.44	102.86	102.41	101.97	101.72	101.87	101.99	102.99
OK City feeder steer ($/cwt)	119.45	129.95	132.16	133.45	131.66	130.87	130.18	130.17	130.41	131.70
Pork production (mil. lb.)	22,637	22,921	23,523	24,221	24,793	25,165	25,375	25,509	25,675	25,944
Pork imports (mil. lb.)	951	989	986	952	917	891	874	899	944	994
Pork exports (mil. lb.)	4,599	4,771	4,943	5,142	5,326	5,474	5,599	5,709	5,816	5,889
Pork domestic use (mil. lb.)	18,998	19,132	19,544	20,007	20,363	20,568	20,644	20,697	20,799	21,042
Pork retail wt. use (lb./cap.)	46.97	46.85	47.40	48.06	48.44	48.47	48.18	47.85	47.63	47.73
Barrow & gilt price ($/cwt)	53.77	55.95	53.49	51.74	50.75	50.24	51.28	53.23	55.20	56.14

Year	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Beef production (mil. lb.)	27,518	27,653	27,793	27,939	28,088	28,243	28,398	28,554	28,713	28,874
Beef imports (mil. lb.)	3,180	3,193	3,213	3,231	3,244	3,252	3,260	3,268	3,278	3,288
Beef exports (mil. lb.)	2,658	2,694	2,740	2,763	2,778	2,776	2,767	2,757	2,750	2,745
Beef domestic use (mil. lb.)	28,034	28,150	28,265	28,405	28,553	28,717	28,888	29,063	29,238	29,415
Beef retail wt. use (lb./cap.)	56.83	56.53	56.23	55.97	55.74	55.53	55.33	55.14	54.96	54.77
Neb. steer price ($/cwt)	103.79	105.49	107.61	109.75	111.81	113.65	115.45	117.33	119.29	121.33
OK City feeder steer ($/cwt)	133.54	136.76	140.84	144.97	148.91	152.42	155.81	159.26	162.85	166.58
Pork production (mil. lb.)	26,287	26,644	27,000	27,367	27,753	28,153	28,555	28,949	29,332	29,707
Pork imports (mil. lb.)	1,005	1,020	1,043	1,066	1,085	1,100	1,115	1,132	1,150	1,168
Pork exports (mil. lb.)	5,974	6,073	6,185	6,297	6,407	6,512	6,614	6,716	6,814	6,906
Pork domestic use (mil. lb.)	21,307	21,580	21,848	22,125	22,419	22,730	23,043	23,353	23,657	23,958
Pork retail wt. use (lb./cap.)	47.88	48.04	48.18	48.33	48.51	48.72	48.93	49.12	49.29	49.45
Barrow & gilt price ($/cwt)	56.49	57.29	58.39	59.56	60.62	61.56	62.52	63.58	64.74	65.97

Table A.7. Chicken and dairy market results in the extended baseline

Year	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Chicken production (mil. lb.)	36,401	37,130	37,850	38,545	39,266	40,035	40,813	41,608	42,422	43,217
Chicken imports (mil. lb.)	83	86	89	92	95	98	101	104	107	110
Chicken exports (mil. lb.)	6,333	6,507	6,659	6,809	6,978	7,197	7,417	7,650	7,843	7,979
Chicken dom. use (mil. lb.)	30,130	30,692	31,259	31,820	32,374	32,925	33,487	34,053	34,675	35,338
Chicken ret. wt. use (lb./cap.)	82.46	83.19	83.92	84.61	85.26	85.88	86.52	87.15	87.90	88.74
12-city chicken price (cent/lb.)	80.30	82.71	83.97	85.43	87.03	88.44	89.76	91.32	92.66	93.86
Milk cow numbers (1000)	8,949	8,922	8,900	8,882	8,867	8,857	8,842	8,822	8,802	8,783
Milk yield per cow (lb./cow)	21,316	21,604	21,886	22,166	22,447	22,712	22,969	23,227	23,487	23,743
Milk production (bil. lbs.)	190.75	192.75	194.80	196.87	199.04	201.16	203.09	204.91	206.72	208.53
Cheese production (bil. lbs.)	10.37	10.48	10.65	10.81	10.97	11.12	11.27	11.41	11.56	11.70
Fluid use (lbs./cap.)	201.15	200.69	199.84	199.41	199.15	198.74	198.16	197.58	197.05	196.52
Cheese use (lbs./cap.)	33.17	33.36	33.35	33.47	33.62	33.75	33.85	33.93	34.01	34.09
All milk price ($/cwt)	17.17	17.40	17.62	17.87	18.19	18.44	18.68	19.01	19.40	19.80

Year	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Chicken production (mil. lb.)	43,973	44,708	45,436	46,153	46,865	47,573	48,277	48,976	49,672	50,367
Chicken imports (mil. lb.)	113	116	119	122	125	128	131	134	137	140
Chicken exports (mil. lb.)	8,084	8,196	8,317	8,444	8,564	8,676	8,781	8,882	8,979	9,073
Chicken dom. use (mil. lb.)	35,992	36,619	37,230	37,823	38,418	39,018	39,619	40,220	40,822	41,427
Chicken ret. wt. use (lb./cap.)	89.54	90.24	90.88	91.46	92.03	92.58	93.13	93.65	94.16	94.65
12-city chicken price (cent/lb.)	95.00	96.37	97.79	99.16	100.57	101.99	103.46	105.01	106.65	108.34
Milk cow numbers (mil.)	8,763	8,744	8,729	8,718	8,711	8,705	8,698	8,694	8,691	8,690
Milk yield per cow (lb./cow)	23,990	24,228	24,447	24,652	24,842	25,027	25,208	25,384	25,556	25,725
Milk production (bil. lbs.)	210.22	211.86	213.40	214.93	216.39	217.87	219.27	220.68	222.11	223.55
Cheese production (bil. lbs.)	11.86	11.99	12.12	12.26	12.39	12.52	12.65	12.78	12.91	13.04
Fluid use (lbs./cap.)	196.12	195.65	195.11	194.58	194.04	193.50	192.94	192.39	191.84	191.30
Cheese use (lbs./cap.)	34.19	34.25	34.29	34.32	34.35	34.38	34.40	34.42	34.44	34.46
All milk price ($/cwt)	20.08	20.44	20.86	21.27	21.70	22.13	22.61	23.09	23.57	24.07

Table A.8. Farm income results in the extended baseline, billion dollars

Year	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Crop cash receipts	169.18	174.60	179.12	184.39	189.94	194.83	199.84	205.21	209.96	215.13
Livestock cash recepts	140.65	147.01	149.17	151.64	154.56	157.52	160.61	164.50	168.54	172.39
Farm-related cash receipts	23.06	23.54	24.07	24.60	25.13	25.59	26.04	26.51	26.99	27.49
Government payments	11.51	11.61	11.87	11.90	10.95	11.13	11.23	11.39	11.55	11.46
Non-money income	21.14	21.97	22.56	23.08	23.45	23.77	24.11	24.54	25.02	25.51
Change in inventory value	-0.01	0.30	0.72	1.07	1.05	0.96	0.91	0.81	0.70	0.71
Gross cash income	365.53	379.03	387.51	396.68	405.09	413.80	422.73	432.97	442.76	452.69
Feed expenses	43.02	43.98	44.76	45.82	46.81	47.58	48.40	49.27	49.96	50.66
Fertilizer	17.38	18.18	18.63	19.02	19.59	20.03	20.40	20.82	21.20	21.66
Fuel and electricity	17.10	18.21	19.69	20.68	21.55	22.57	23.56	24.53	25.41	26.41
Rental pay'ts to nonoperators	9.85	9.70	9.79	9.91	10.04	10.19	10.43	10.76	11.12	11.45
All other expenses	208.64	215.12	220.72	226.86	232.39	237.43	242.18	247.16	252.08	257.38
Total production expenses	295.99	305.19	313.58	322.30	330.38	337.79	344.97	352.54	359.77	367.56
Net farm income	69.54	73.84	73.93	74.38	74.71	76.01	77.76	80.43	82.99	85.13
(in 2009 dollars)	67.71	70.86	69.66	68.84	67.88	67.82	68.11	69.16	70.11	70.65

Year	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Crop cash receipts	221.10	227.85	235.12	242.52	249.94	258.07	266.58	276.25	286.23	295.98
Livestock cash recepts	175.79	180.17	185.17	190.21	195.24	200.19	205.26	210.54	216.03	221.73
Farm-related cash receipts	28.00	28.53	29.07	29.63	30.20	30.79	31.39	32.01	32.64	33.29
Government payments	11.56	11.64	11.69	11.77	11.84	11.92	12.00	12.08	12.16	12.25
Non-money income	26.03	26.59	27.20	27.88	28.62	29.43	30.30	31.23	32.21	33.26
Change in inventory value	0.76	0.78	0.81	0.82	0.84	0.92	1.00	0.96	0.92	0.88
Gross cash income	463.25	475.55	489.06	502.83	516.69	531.31	546.53	563.06	580.20	597.39
Feed expenses	51.56	52.61	53.66	54.77	55.91	57.11	58.47	60.00	61.60	63.27
Fertilizer	22.15	22.78	23.27	23.66	24.16	24.79	25.46	26.27	27.08	27.93
Fuel and electricity	27.37	28.52	29.55	30.46	31.56	32.76	34.02	35.49	37.04	38.40
Rental pay'ts to nonoperators	11.80	12.22	12.73	13.32	13.95	14.58	15.22	15.88	16.57	17.28
All other expenses	263.04	269.29	275.89	282.67	289.85	297.32	305.10	313.40	322.20	331.14
Total production expenses	375.92	385.42	395.11	404.87	415.42	426.56	438.28	451.03	464.48	478.02
Net farm income	87.32	90.12	93.96	97.96	101.27	104.75	108.26	112.03	115.72	119.37
(in 2009 dollars)	71.19	72.18	73.92	75.71	76.89	78.13	79.32	80.64	81.83	82.92